# A.M.U. (ENGINEERING)



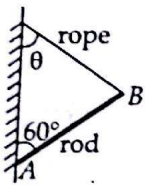
# Solved Paper 2011

## PHYSICS

1. A string that is stretched between fixed supports separated by 75.0 cm has resonant frequencies of 420 and 315 Hz, with no intermediate resonant frequencies. What is the lowest resonant frequency?
   (a) 250 Hz (b) 317 Hz
   (c) 180 Hz (d) 105 Hz

2. Suppose 4.0 mol of an ideal gas undergoes a reversible isothermal expansion from volume $V_1$ to volume $V_2 = 2.0V_1$ at temperature $T = 400$ K. Find the entropy change of the gas.
   (Take ln 2 = 0.693)
   (a) 23.0 J/K (b) 42.0 J/K
   (c) 51.6 J/K (d) 56.9 J/K

3. A uniform rod $AB$ of mass $m$ is hinged to a wall at its lower end, while its upper end is held by a rope attached to the wall. For what value of θ, the tension in the rope is equal to $mg/2$?
   (a) 30°
   (b) 60°
   (c) 45°
   (d) none of these



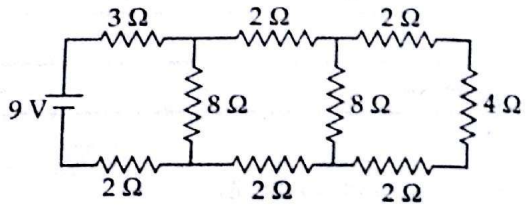

4. Three sinusoidal waves of the same frequency travel along a string in the positive $x$-direction. Their amplitudes are $y$, $y/2$ and $y/3$ and their phase constants are 0, $\pi/2$ and $\pi$ respectively. What is the amplitude of the resultant wave?
   (a) $0.63y$ (b) $0.72y$
   (c) $0.83y$ (d) $0.52y$

5. A sample of gas expands from an initial pressure and volume of 10 Pa and 1.0 $m^3$ to a final volume of 2.0 $m^3$. During the expansion, the pressure and volume are related by the equation $p = av^2$, where $a = 10$ N/$m^8$. Find the work done by the gas during the expansion.
   (a) 23 J (b) 18 J
   (c) 9 J (d) 43 J

6. Two point +ve charges $q$ each are placed at $(-a, 0)$ and $(a, 0)$. A third +ve charge $q_0$ is placed at $(0, y)$. Find the value of $y$ for which the force at $q_0$ is maximum.
   (a) $\frac{a}{\sqrt{3}}$ (b) $\frac{a}{\sqrt{2}}$
   (c) $a$ (d) $2a$

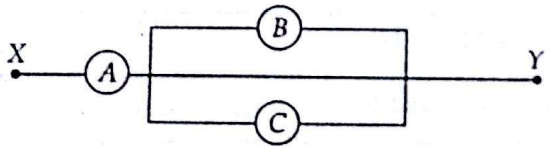
7. A particle of mass 40 mg and carrying a charge $5 \times 10^{-9}$ C is moving towards a fixed charge of magnitude $10^{-8}$ C. When it is at a distance of 10 cm from the fixed charge, it has a velocity of 50 cm/s. At what distance from the fixed charge will the particle come momentarily to rest?
   (a) $1.3 \times 10^{-3}$ m (b) $1.9 \times 10^{-3}$ m
   (c) $3.9 \times 10^{-2}$ m (d) $4.7 \times 10^{-2}$ m

8. In the circuit shown in the figure




   The current through 3 Ω resistance is
   (a) 0.5 A (b) 0.7 A
   (c) 1.0 A (d) 1.2 A

9. $A$, $B$ and $C$ are voltmeters of resistance $R$, $1.5R$ and $3R$ respectively. When some potential difference is applied between $X$ and $Y$, the voltmeter readings are $V_A$, $V_B$ and $V_C$ respectively. Then




   (a) $V_A = V_B = V_C$ (b) $V_A \neq V_B = V_C$
   (c) $V_A = V_B \neq V_C$ (d) $V_A \neq V_B \neq V_C$

10. A galvanometer has a resistance of 30 Ω and a current of 2.0 mA gives full scale deflection. How will you convert this galvanometer into a voltmeter of 0.2 volt range?
    (a) 700 Ω resistance should be connected parallel to the galvanometer.
    (b) 70 Ω resistance should be connected parallel to the galvanometer.

(c) 700 Ω resistance should be connected in series with the galvanometer.

(d) 70 Ω resistance should be used in series with the galvanometer.

11. A beam of 450 nm light is incident on a metal having work function 2 eV and placed in a magnetic field $B$. If the most energetic electrons emitted are bent into circular arc of radius 0.2 m, find $B$.

(a) $2.36 \times 10^{-4}$ T (b) $1.46 \times 10^{-5}$ T

(c) $6.9 \times 10^{-5}$ T (d) $9.2 \times 10^{-6}$ T

12. The de Broglie wavelength is given by

(a) $p = \frac{2\pi h}{\lambda}$ (b) $p = \frac{h}{2\lambda}$

(c) $p = \frac{2\pi}{h\lambda}$ (d) $p = \frac{2\pi}{\lambda}$

13. Which of the following truth tables corresponds to NAND gate?

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

(i)

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

(ii)

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

(iii)

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

(iv)

(a) (iv) (b) (iii)

(c) (ii) (d) (i)

14. The range of nuclear force is of the order of

(a) $2 \times 10^{-10}$ m (b) $1.5 \times 10^{-20}$ m

(c) $1.2 \times 10^{-4}$ m (d) $1.4 \times 10^{-15}$ m

15. What is the momentum of a photon having frequency $1.5 \times 10^{13}$ Hz?

(a) $3.3 \times 10^{-29}$ kg m/s

(b) $3.3 \times 10^{-34}$ kg m/s

(c) $6.6 \times 10^{-34}$ kg m/s

(d) $6.6 \times 10^{-32}$ kg m/s

16. The two headlights of an approaching car are 1.4 m apart. At what maximum distance will the eye resolve them. Assume that the pupil diameter is 5.0 mm and the wavelength of light is 550 nm.

(a) 5 km (b) 10 km

(c) 8 km (d) 5.3 km

17. Find the wavelength of light that may excite an electron in the valence band of diamond to the conduction band. The energy gap is 5.50 eV.

(a) 226 nm (b) 312 nm

(c) 432 nm (d) 550 nm

18. A copper wire of length 50.0 cm and total resistance of $1.1 \times 10^{-2}$ Ω is formed into a circular loop and placed perpendicular to a uniform magnetic field that is increasing at the constant rate of 10.0 mT/s. At what rate is thermal energy generated in the loop?

(a) $1.32 \times 10^{-8}$ W (b) $2.36 \times 10^{-4}$ W

(c) $3.68 \times 10^{-6}$ W (d) $4.23 \times 10^{-5}$ W

19. An electron is moving at a speed of 100 m/s along the $x$-axis through uniform electric and magnetic fields. The magnetic field is directed along the $z$-axis and has magnitude 5.0 T. In unit-vector notation, what is the electric field?

(a) $(100\ \text{V/m})\hat{j}$ (b) $(-100\ \text{V/m})\hat{k}$

(c) $(-500\ \text{V/m})\hat{k}$ (d) $(500\ \text{V/m})\hat{j}$

20. The half life of $_{92}U^{238}$ undergoing α-decay is $1.5 \times 10^{17}$ sec. What is the activity of 238 gm sample of $_{92}U^{238}$?

(a) $2.8 \times 10^{6}\ s^{-1}$ (b) $3.9 \times 10^{7}\ s^{-1}$

(c) $4.3 \times 10^{8}\ s^{-1}$ (d) $5.6 \times 10^{9}\ s^{-1}$

21. An intrinsic semiconductor has a resistivity of 0.50 Ω m at room temperature. Find the intrinsic carrier concentration if the mobilities of electrons and holes are 0.39 $m^2$/volt sec and 0.11 $m^2$/volt sec respectively

(a) $1.2 \times 10^{18}/m^3$ (b) $2.5 \times 10^{19}/m^3$

(c) $1.9 \times 10^{20}/m^3$ (d) $3.1 \times 10^{21}/m^3$

22. The wavelength of spectral line coming from a distant star shifts from 600 nm to 600.1 nm. The velocity of the star relative to earth is

(a) 50 km/s (b) 100 km/s

(c) 25 km/s (d) 200 km/s

23. A bulb is placed at a depth of $2\sqrt{7}$ m in water ($\mu_w = 4/3$) and a floating opaque disc is placed over the bulb so that the bulb is not visible from the surface. What is the minimum diameter of the disc?

(a) 8 m (b) 12 m

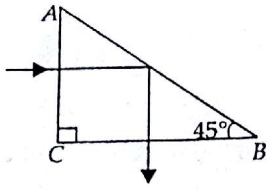
(c) 15 m (d) 20 m

24. What is the refractive index of material of a plano-convex lens, if the radius of curvature of the convex surface is 10 cm and focal length of the lens is 30 cm?

(a) $\frac{6}{5}$ (b) $\frac{7}{4}$

(c) $\frac{2}{3}$ (d) $\frac{4}{3}$

25. A ray of light incident normally on one of the faces of a right angle prism is found to be totally reflected as shown in figure. What is the minimum value of the refractive index of the material of the prism?




(a) $\sqrt{2}$
(b) $\sqrt{3/2}$
(c) 4/3
(d) none of these

26. In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by $5 \times 10^{-2}$ m towards the slits, the change in fringe width is $3 \times 10^{-5}$ m. If the distance between slits is $10^{-3}$ m, the wavelength of light will be
(a) 3000 Å (b) 4000 Å
(c) 6000 Å (d) 7000 Å

27. For base station to mobile communication, the required frequency band is
(a) 540 – 1600 kHz (b) 200 – 325 MHz
(c) 5.9 – 6.42 GHz (d) 840 – 935 MHz

28. A Carnot refrigerator extracts 35.0 kJ as heat during each cycle, operating with a coefficient of performance of 4.60. Find the energy per cycle transferred as heat to the surroundings.
(a) 42.6 kJ (b) 53.2 kJ
(c) 63.9 kJ (d) 72.5 kJ

29. A carrier wave of peak voltage 10 V is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 80%?
(a) 8 V (b) 10 V
(c) 12 V (d) 14 V

30. In the following equation, $x$, $t$ and $F$ represent respectively, displacement, time and force :

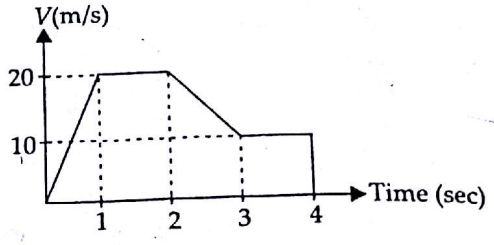
$$F = a + bt + \frac{1}{c + d \cdot x} + A\sin(\omega t + \phi).$$

The dimensional formula for $A \cdot d$ is
(a) $T^{-1}$ (b) $L^{-1}$
(c) $M^{-1}$ (d) $TL^{-1}$

31. The angle between the vectors $\vec{A} = \hat{i} + \hat{j}$ and $\vec{B} = \hat{i} + \hat{j} + c\hat{k}$ is 30°.
Find the unknown $c$.
(a) 0 (b) ± 1
(c) $\pm\sqrt{\frac{2}{3}}$ (d) $\pm\frac{1}{2}$

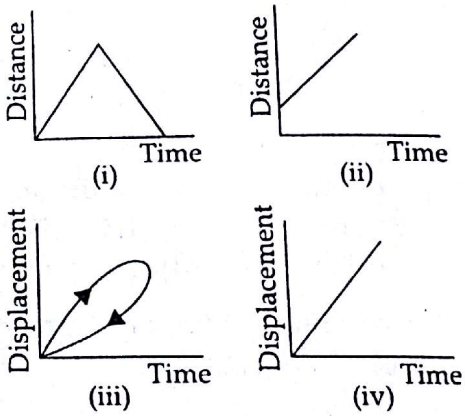
32. Resultant of two vectors $\vec{A}$ and $\vec{B}$ is of magnitude $P$. If $\vec{B}$ is reversed, then resultant is of magnitude $Q$. What is the value of $P^2 + Q^2$?
(a) $2(A^2 + B^2)$ (b) $2(A^2 - B^2)$
(c) $A^2 - B^2$ (d) $A^2 + B^2$

33. From the adjoining graph, the distance transversed by the particle in 4 sec is




(a) 60 m (b) 25 m
(c) 55 m (d) 30 m

34. Which of the following graphs is/are not possible?



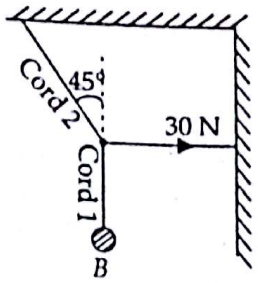

(a) (i) and (iii) (b) (i)
(c) (ii) and (iii) (d) (iii)

35. A body travelling along a straight line traverse one-third the distance with a velocity of 5 m/s. The remaining part of the distance was covered with velocity 3 m/s for half the time and with velocity 2 m/s for the other half of the time. The average velocity of the body over the whole time of motion will be
(a) 3 m/s (b) 5 m/s
(c) 2 m/s (d) 2.5 m/s

36. A projectile is thrown with an initial velocity of $\vec{V} = (p\hat{i} + q\hat{j})$ m/s. If the range of the projectile is double the maximum height reached by it, then

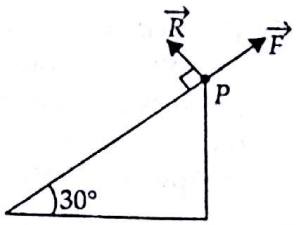
(a) $p = 2q$, (b) $q = 4p$
(c) $q = 2p$ (d) $q = p$

37. In the figure shown, the tension in the horizontal cord is 30 N. Find the weight of the body $B$.




(a) 40 N
(b) 30 N
(c) 20 N
(d) 10 N

38. In the following figure, an object of mass 1.2 kg is at rest at point $P$. If $R$ and $F$ are the reaction and the frictional force, respectively, then




(a) $R = 6$ N; $F = 6\sqrt{3}$ N
(b) $R = 3$ N; $F = 3\sqrt{3}$ N
(c) $R = 6$ N; $F = 3$ N
(d) $R = 6\sqrt{3}$ N; $F = 6$ N

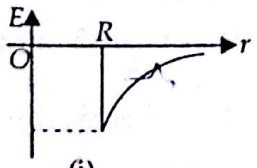
39. A body of mass 1.0 kg strikes elastically with another body at rest and continues to move in the same direction with one-fourth of its initial velocity. The mass of the other body is
(a) 0.6 kg (b) 2.4 kg
(c) 3.0 kg (d) 4.0 kg

40. Moment of inertia does not depend on
(a) mass distribution of body
(b) torque (c) shape of the body
(d) the position of axis of rotation

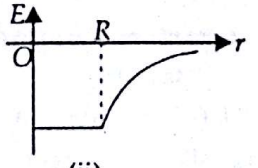
41. Three thin uniform rods each of mass $M$ and length $L$ are placed along the three axes of a Cartesian coordinate system. The moment of inertia of the system about z-axis is

(a) $\frac{ML^2}{3}$ (b) $\frac{2ML^2}{3}$
(c) $\frac{ML^2}{6}$ (d) $ML^2$

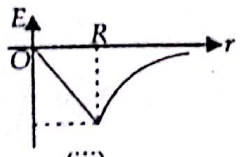
42. Which of the following graphs represents the gravitational field intensity due to solid sphere of radius $R$?



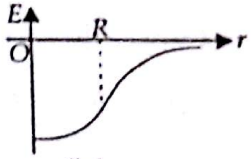
(i)



(ii)



(iii)



(iv)

(a) (i) (b) (ii)
(c) (iii) (d) (iv)

43. If a graph is plotted between $T^2$ and $r^3$ for a planet, then its slope will be

(a) $\frac{4\pi^2}{GM}$ (b) $\frac{GM}{4\pi^3}$
(c) $4\pi GM$ (d) $GM$

44. Three particles of equal mass $m$ are situated at the vertices of an equilateral triangle of side $l$. What should be the velocity of each particle, so that they move on a circular path without changing $l$?

(a) $\sqrt{\frac{Gm}{2l}}$ (b) $\sqrt{\frac{Gm}{l}}$
(c) $\sqrt{\frac{2Gm}{l}}$ (d) $\sqrt{\frac{Gm}{3l}}$

45. A projectile is fired vertically upward from the surface of earth with a velocity of $kv_e$, where $v_e$ is the escape velocity and $k < 1$. Neglecting air resistance, the maximum height to which it will rise, measured from the centre of the earth, is ($R$ = radius of earth)

(a) $\frac{R}{1-k^2}$ (b) $\frac{R}{k^2}$
(c) $\frac{1-k^2}{R}$ (d) $\frac{k^2}{R}$

46. The velocities of a particle in S.H.M. at positions $X_1$ and $X_2$ are $V_1$ and $V_2$ respectively. Its time period will be

(a) $2\pi\sqrt{\frac{(V_1^2 - V_2^2)}{(X_2^2 - X_1^2)}}$ (b) $2\pi\sqrt{\frac{(X_1^2 + X_2^2)}{(V_2^2 - V_1^2)}}$
(c) $2\pi\sqrt{\frac{(X_2^2 - X_1^2)}{(V_1^2 - V_2^2)}}$ (d) $2\pi\sqrt{\frac{(X_2^2 + X_1^2)}{(V_1^2 + V_2^2)}}$

47. When a closed pipe is suddenly opened, the second overtone of closed pipe and first overtone of open pipe differ by 100 Hz. The fundamental frequency of the closed pipe will be

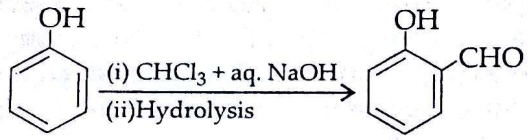
(a) 200 Hz (b) 150 Hz
(c) 100 Hz (d) 50 Hz

48. The phenomenon of beats can take place
(a) for longitudinal waves only
(b) for transverse waves only
(c) for sound waves only
(d) for both longitudinal and transverse waves

49. A solid sphere of mass 1.0 kg and diameter 0.3 m is suspended from a wire. If the twisting couple per unit twist for the wire is $6 \times 10^{-3}$ N m/radian, then the time period of small oscillations will be
(a) 0.7 sec (b) 7.7 sec
(c) 77 sec (d) 777 sec

50. A train approaching a railway crossing at a speed of 120 km/hr sounds a whistle at frequency 640 Hz when it is 300 m away from the crossing. The speed of sound in air is 340 m/s. What will be the frequency heard by a person standing on a road perpendicular to the track through the crossing at a distance of 400 m from the crossing?
(a) 680 Hz (b) 640 Hz
(c) 720 Hz (d) 358 Hz

## CHEMISTRY

51. 

The above transformation proceeds through
(a) electrophilic addition
(b) electrophilic substitution
(c) activated nucleophilic substitution
(d) benzyne intermediate

52. In the diazotization of aryl amine the use of nitrous acid is
(a) it suppresses hydrolysis of phenol
(b) it is a source of electrophilic nitrosonium ion
(c) it neutralizes the base liberated
(d) all of the above

53. When $MnO_2$ is fused with KOH, a coloured compound is formed, the product and its colour are
(a) $KMnO_4$, purple
(b) $K_2MnO_4$, dark green
(c) $Mn_2O_3$, brown (d) $Mn_3O_4$, black

54. The decay of $^{238}_{92}U$ nucleus by an α-particle emission produces a thorium nucleus
(a) $^{237}_{90}Th$ (b) $^{234}_{92}Th$
(c) $^{236}_{90}Th$ (d) $^{234}_{90}Th$

55. Considering the elements B, C, N, F and Si the correct order of their non-metallic character is
(a) B > C > Si > N > F (b) Si > C > B > N > F
(c) F > N > C > B > Si (d) F > N > C > Si > B

56. Complete the following nuclear reaction by choosing the correct option
$$^{241}_{95}Am + ^{4}_{2}He \longrightarrow + 2^{1}_{0}n$$
(a) $^{241}_{97}Bk$ (b) $^{243}_{97}Bk$
(c) $^{243}_{97}Am$ (d) $^{242}_{96}Cm$

57. $P_4O_{10}$ dissolves in water to give
(a) phosphorous acid
(b) orthophosphoric acid
(c) hypophosphorous acid
(d) pyrophosphoric acid

58. Which among the following expressions is not correct ?
(a) $\mu^{\infty} = \gamma_+ \lambda_+^{\infty} + \gamma_- \lambda_-^{\infty}$
(b) $\lambda^{\infty} = \frac{1}{n^+}\lambda_+^{\infty} + \frac{1}{n^-}\lambda_-^{\infty}$
(c) $\lambda^{\infty}_{cation} = \mu^{\infty}_{cation} \times$ faraday
(d) $\lambda^{\infty}_{anion} = \mu^{\infty}_{cation} \times$ faraday

59. The correct expression for Arrhenius equation showing the effect of temperature on the rate constant is ($T_2 > T_1$)
(a) $\log_{10}\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_1T_2}{T_2 - T_1}\right]$
(b) $\log_{10}\frac{k_2}{k_1} = \frac{R}{2.303E_a}\left[\frac{T_2 - T_1}{T_1T_2}\right]$
(c) $\log_{10}\frac{k_2}{k_1} = \frac{E_a}{R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$
(d) $\log_{10}\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_2T_1}\right]$

60. Which of the following relation is correct ?
(i) $x/m$ = constant (at high pressure)
(ii) $x/m$ = constant × $p^{1/n}$ (at intermediate pressure)
(iii) $x/m$ = constant × $p^n$ (at lower pressure)
(a) all are correct (b) all are wrong
(c) (i) & (ii) are correct (d) (iii) is correct

61. In the preparation of CaO from $CaCO_3$ using the equilibrium $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$ $K_p$ is expressed as :

$$\log K_p = 7.282 - \frac{8500}{T}$$

The complete decomposition of $CaCO_3$, the temperature in Celsius to be used is
(a) 1167 (b) 894
(c) 8500 (d) 850

62. If the salt $M_2X$, $QY_2$ and $PZ_3$ have the same solubilities, their $K_{sp}$ values are related as
(a) $K_{sp}(M_2X) = K_{sp}(QY_2) < K_{sp}(PZ_3)$
(b) $K_{sp}(M_2X) > K_{sp}(QY_2) = K_{sp}(PZ_3)$
(c) $K_{sp}(M_2X) < K_{sp}(QY_2) = K_{sp}(PZ_3)$
(d) $K_{sp}(M_2X) > K_{sp}(QY_2) > K_{sp}(PZ_3)$

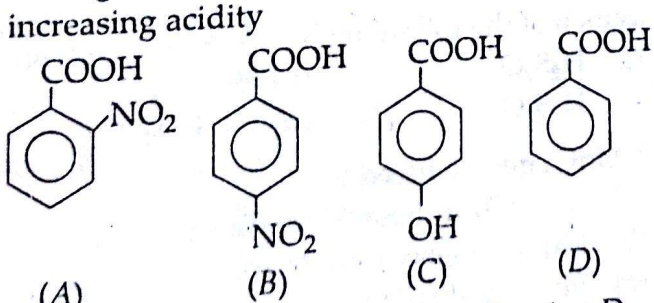
63. The emf of the cell involving the following reaction $2Ag^+ + H_2 \longrightarrow 2Ag + 2H^+$ is 0.80 volt. The standard oxidation potential of silver electrode is
(a) – 0.80 volt (b) 0.80 volt
(c) 0.40 volt (d) – 0.40 volt

64. In diborane ($B_2H_6$) there are
(a) three $3c$-$2e^-$ bonds and three $2c$-$2e^-$ bonds
(b) four $3c$-$2e^-$ bonds and two $2c$-$2e^-$ bonds
(c) two $3c$-$2e^-$ bonds and four $2c$-$2e^-$ bonds
(d) none of the above

65. The hybridization states of $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$ species are respectively
(a) $sp^3$, $sp^3$, $dsp^2$ (b) $dsp^2$, $sp^3$, $sp^3$
(c) $sp^3$, $dsp^2$, $dsp^2$ (d) $sp^3$, $dsp^2$, $sp^3$

66. Which of the following Grignard reagents is suitable for the preparation of 3-methyl-2-butanol ?
(a) 2-Butanone + methyl magnesium bromide
(b) Acetone + ethyl magnesium bromide
(c) Acetaldehyde + isopropyl magnesium bromide
(d) Ethyl propionate + methyl magnesium bromide

67. Arrange the following acids in order of their increasing acidity




(A) (B) (C) (D)

(a) $A < B < C < D$ (b) $B < C < A < D$
(c) $C < B < D < A$ (d) $C < D < B < A$

68. Which of the following are isoelectronic molecules?
(a) $NO^+$ and $F_2^{2-}$ (b) CO and $O_2^{2-}$
(c) CO and $NO^+$ (d) $O_2^{2-}$ and $N_2$

69. The following reagent is used for introducing a formyl group (– CHO) into the benzene ring
(a) CO + HCl (b) HCN + HCl
(c) both (a) & (b) (d) none of these

70. In the following sequence of reactions, the end product is

$$CaC_2 \xrightarrow{H_2O} A \xrightarrow{Hg^{2+}/H_2SO_4} B \xrightarrow{[O]} C \xrightarrow{Ca(OH)_2} D \xrightarrow{heat} E$$

(a) acetaldehyde (b) formaldehyde
(c) acetic acid (d) acetone

71. Arrange the following $CH_3CH_2CH_2Cl$(I), $CH_3CH_2-CHCl-CH_3$(II), $(CH_3)_2CHCH_2Cl$(III) and $(CH_3)_3C-Cl$(IV) in order of decreasing tendency towards $S_N2$ reactions
(a) I > III > II > IV (b) III > IV > II > I
(c) II > I > III > IV (d) IV > III > II > I

72. A carbonyl compound with molecular weight 86, does not reduce Fehling's solution but forms crystalline bisulphite derivatives and gives iodoform test. The possible compounds can be
(a) 2-pentanone and 3-pentanone
(b) 2-pentanone and 3-methyl-2-butanone
(c) 2-pentanone and pentanal
(d) 3-pentanone and 3-methyl-2-butanone

73. When propionic acid is treated with aqueous $NaHCO_3$, $CO_2$ is liberated. The 'C' of $CO_2$ comes from
(a) methyl group
(b) carboxylic acid group
(c) methylene group (d) bicarbonate

74. The energy of an electron in the first Bohr orbit of H atom is – 13.6 eV. The possible energy value of the excited state(s) for electrons in Bohr orbits of hydrogen is
(a) – 3.4 eV (b) – 4.2 eV
(c) – 6.8 eV (d) + 6.8 eV

75. The electrons identified by quantum numbers $n$ and $l$ (i) $n = 4, l = 1$ ; (ii) $n = 4, l = 0$ ; (iii) $n = 3, l = 2$ ; (iv) $n = 3, l = 1$ can be placed in order of increasing energy, from the lowest to highest as
(a) (iv) < (ii) < (iii) < (i)
(b) (ii) < (iv) < (i) < (iii)
(c) (i) < (iii) < (ii) < (iv)
(d) (iii) < (i) < (iv) < (ii)

76. One mole of an ideal gas expands at a constant temperature of 300 K from an initial volume of 10 litre to a final volume of 20 litre. The work done in expanding the gas is
(a) 750 Joule (b) 1726 Joule
(c) 1500 Joule (d) 3456 Joule

77. Assuming the salts to unionized in solution which of the following has highest osmotic pressure ?
(a) 1% CsCl (b) 1% RbCl
(c) 1% KCl (d) 1% NaCl

78. Which of the *d*-orbital is used in $sp^3d$ hybridization ?
(a) $d_{xy}$ (b) $d_{x^2-y^2}$
(c) $d_{z^2}$ (d) $d_{yz}$

79. Formic acid can be distinguished from acetic acid by reaction with
(a) $NaHCO_3$
(b) dil. acidified $KMnO_4$ solution
(c) 2, 4-dinitrophenyl hydrazine
(d) Na metal

80. An alkyl cyanide forms an amide when it is treated with
(a) $H_2O + HCl$ (b) $NaOH + H_2O$
(c) $H_2O_2 + NaOH$ (d) $H_2SO_4 + H_2O$

81. A compound '*X*' neither reacts with sodium displacing hydrogen nor with phosphorus pentachloride to give hydrogen chloride. *X* reduces an alkaline solution of Cu (II) salt on gentle warming. The structure of *X* is
(a) primary alcohol (b) secondary alcohol
(c) a ketone (d) an aldehyde

82. The end product (*B*) in the following sequence of reactions is

$$CH_3Cl \xrightarrow{KCN} A \xrightarrow{H^+/H_2O} B$$

(a) $CH_3COOH$ (b) $HCOOH$
(c) $CH_3NH_2$ (d) $CH_3COCH_3$

83. Given,

$$NH_{3(g)} + 3Cl_{2(g)} \rightleftharpoons NCl_{3(g)} + 3HCl_{(g)} - \Delta H_1$$
$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} - \Delta H_2$$
$$H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)} + \Delta H_3$$

The heat of formation of $NCl_3$ in terms of $\Delta H_1$, $\Delta H_2$ and $\Delta H_3$ is

(a) $\Delta H_f = -\Delta H_1 + \frac{1}{2}\Delta H_2 - \frac{3}{2}\Delta H_3$

(b) $\Delta H_f = -\Delta H_1 + \frac{1}{2}\Delta H_2 + \frac{3}{2}\Delta H_3$

(c) $\Delta H_f = \Delta H_1 - \frac{1}{2}\Delta H_2 - \frac{3}{2}\Delta H_3$

(d) none of these

84. For the reaction

$$N_2O_5 \longrightarrow 2NO_2 + \frac{1}{2}O_2$$

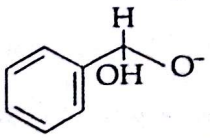
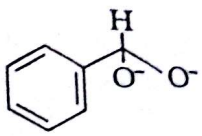
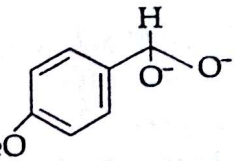
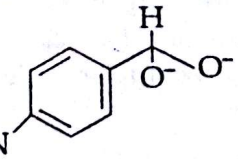
$$\frac{-d[N_2O_5]}{dt} = k_1[N_2O_5]$$

$$\frac{d[NO_2]}{dt} = k_2[N_2O_5]$$

$$\frac{d[O_2]}{dt} = k_3[N_2O_5]$$

The relation in between $k_1$, $k_2$ and $k_3$ is
(a) $2k_1 = k_2 = 4k_3$ (b) $k_1 = k_2 = k_3$
(c) $2k_1 = 4k_2 = k_3$ (d) none of these

85. In a Cannizzaro's reaction, the intermediate that will be the best hydride donor is

(a) 
(b) 
(c) MeO 
(d) $O_2N$ 

86. The gold numbers of *A*, *B*, *C* and *D* are 0.04, 0.0002, 10 and 25 respectively. The protective powers of *A*, *B*, *C* and *D* are in the order
(a) $A > B > C > D$ (b) $B > A > C > D$
(c) $D > C > B > A$ (d) $C > A > B > D$

87. When chlorine is passed through hot concentrated alkali solutions which one of the following is formed
(a) [tetraoxochloric(VII)]
(b) [trioxochlorate(V)]
(c) chloric(III) acid
(d) [monooxochlorate(I)]

88. Which of the following has —O—O— linkage
(a) $H_2S_2O_6$ (b) $H_2S_2O_8$
(c) $H_2S_2O_3$ (d) $H_2S_4O_6$

89. $KMnO_4$ gets reduced to
(a) $K_2MnO_4$ in neutral medium
(b) $MnO_2$ in acidic medium
(c) $Mn^{2+}$ in alkaline medium
(d) $MnO_2$ in neutral medium

90. Which of the following is an outer orbital complex?
(a) $[Fe(CN)_6]^{4-}$ (b) $[FeF_6]^{3-}$
(c) $[Co(NH_3)_6]^{3+}$ (d) $[Co(CN)_6]^{3-}$

91. Which of the following has largest number of isomers ?
(a) $[Ru(NH_3)_4Cl_2]^+$ (b) $[Co(en)_2Cl_2]^+$
(c) $[Ir(PR_3)_2H(CO)]^{2+}$ (d) $[Co(NH_3)_5Cl]^{2+}$

92. In the following nuclear transmutation

$$^{238}_{92}U + X \longrightarrow {}^{239}_{92}U \xrightarrow{-\beta^-} Y \xrightarrow{-\beta^-} {}^{239}_{94}Pu$$

$X$ and $Y$ respectively are
(a) ${}^{1}_{0}n$, ${}^{239}_{93}Np$ (b) ${}^{1}_{0}n$, ${}^{240}_{92}Np$
(c) $\gamma$, ${}^{239}_{93}Np$ (d) ${}^{1}_{0}H$, ${}^{239}_{92}Np$

93. Le Chatelier's principle is not applicable to
(a) $Fe_{(s)} + S_{(s)} \rightleftharpoons FeS_{(s)}$
(b) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$
(c) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
(d) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$

94. For a concentrated solution of a weak electrolyte $A_xB_y$, the degree of dissociation is given as
(a) $\alpha = \sqrt{K_{eq} / C(x+y)}$ (b) $\alpha = \sqrt{K_{eq} C / (xy)}$
(c) $\alpha = (K_{eq}/C^{x+y-1}x^x y^y)^{1/(x+y)}$
(d) $\alpha = \sqrt{K_{eq} / xyc}$

95. A fuel has the same knocking property as a mixture of 70% isooctane (2, 2, 4-trimethylpentane) and 30% $n$-heptane by volume. The octane number of the fuel is
(a) 100 (b) 70
(c) 50 (d) 40

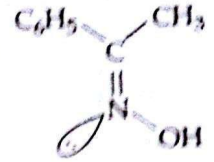
96. When Friedel-Crafts alkylation of benzene is carried out with $n$-propyl bromide, the major product is
(a) $n$-propyl benzene (b) isopropyl benzene
(c) 2-ethyl benzene (d) none of the above

97. Cumene $\xrightarrow[(ii)\ H_2O,H^+]{(i)\ O_2}$ ($X$) and ($Y$)

($X$) and ($Y$) respectively are
(a) toluene, propene
(b) toluene, propylchloride
(c) phenol, acetone
(d) phenol, acetaldehyde

98. Hydrolysis of $XeF_4$ and $XeF_6$ with water gives
(a) $XeOF_4$ (b) $XeO_2F_2$
(c) $XeO_3$ (d) $XeOF_2$

99. Arrange the following carbocation in order of increasing stability
[A] $(CH_3)_2\overset{+}{C}H$ [B] $(CH_3)_3\overset{+}{C}$
[C] $CH_3CH_2\overset{+}{C}H_2$ [D] $CH_3\overset{+}{C}HCH_2CH_3$
(a) $D < C < B < A$ (b) $C < D < A < B$
(c) $A < C < D < B$ (d) $B < D < C < A$

100. The Z isomer among the following is
(a) 
(b) 
(c) 
(d) 

## MATHEMATICS

101. If $a_i > 0$ for $i = 1, 2, \ldots, n$ and $a_1 a_2 \ldots a_n = 1$, then minimum value of $(2 + a_1)(2 + a_2) \ldots (2 + a_n)$ is
(a) $2^{3n/2}$ (b) $2^{n/2}$
(c) $2^{2n}$ (d) $2^n$

102. The solution set of the inequality
$4^{-x+\frac{1}{2}} - 7 \cdot (2^{-x}) - 4 < 0$ for $x \in R$ is
(a) $(-\infty, 2)$ (b) $(-2, \infty)$
(c) $(-\infty, \infty)$ (d) $(2, \infty)$

103. Let $a, b > 0$ satisfy $a^3 + b^3 = a - b$, then
(a) $a^2 + b^2 > 1$ (b) $a^2 + b^2 < 0$
(c) $a^2 + b^2 = 1$ (d) $a^2 - ab + b^2 < 1$

104. A fair coin is tossed 100 times. The probability of getting tail an odd number of times is
(a) $\frac{1}{2}$ (b) $\frac{1}{4}$
(c) 0 (d) 1

105. Let $f(\theta) = \sin\theta(\sin\theta + \sin 3\theta)$ then $f(\theta)$
(a) $\leq 0$ only for $\theta \leq 0$ (b) $\geq 0$ for all real $\theta$
(c) $\leq 0$ for all real $\theta$ (d) $\geq 0$ only for $\theta \geq 0$

106. In a triangle $ABC$, if $\tan\frac{A}{2} = \frac{5}{6}$, and $\tan\frac{B}{2} = \frac{20}{37}$, the sides $a, b, c$ of the triangle are in

(a) G.P. (b) H.P.
(c) A.P. (d) none of the above

**107.** The arithmetic mean of the roots of the equation $4\cos^3 x - 4\cos^2(\pi - x) + \cos x - 1 = 0$ in the interval $(0, 315)$ is equal to
(a) $100\pi$ (b) $49\pi$
(c) $50\pi$ (d) $51\pi$

**108.** If $a\sin^{-1}x - b\cos^{-1}x = c$, then $a\sin^{-1}x + b\cos^{-1}x$ is equal to
(a) $\frac{\pi ab + c(a-b)}{a+b}$ (b) 0
(c) $\frac{\pi ab - c(a-b)}{a+b}$ (d) $\frac{\pi}{2}$

**109.** If algebraic sum of distances of a variable line from points $(2, 0)$, $(0, 2)$ and $(-2, -2)$ is zero, then the line passes through the fixed point
(a) $(-1, -1)$ (b) $(1, 1)$
(c) $(2, 2)$ (d) $(0, 0)$

**110.** A line is drawn through the point $P(3, 11)$ to cut the circle $x^2 + y^2 = 9$ at points $A$ and $B$. Then $PA \cdot PB$ is equal to
(a) 205 (b) 9
(c) 139 (d) 121

**111.** The locus of the point of intersection of the tangents at the extremeties of a chord of the circle $x^2 + y^2 = a^2$ which touches the circle $x^2 + y^2 - 2ax = 0$ passes through the point
(a) $(a/2, 0)$ (b) $(0, a/2)$
(c) $(a, 0)$ (d) $(0, 0)$

**112.** If the lines joining the origin to the intersection of the line $y = mx + 2$ and the circle $x^2 + y^2 = 1$ are at right angles, then
(a) $m = \sqrt{3}$ (b) $m = \pm\sqrt{7}$
(c) $m = \sqrt{1}$ (d) $m = \sqrt{5}$

**113.** If the parabolas $y^2 = 4x$ and $x^2 = 32y$ intersect at $(16, 8)$ at an angle $\theta$, then $\theta =$
(a) $\tan^{-1} 5/3$ (b) $\tan^{-1} 4/5$
(c) $\tan^{-1} 3/5$ (d) $\pi/2$

**114.** If the normal at the point $P(\theta)$ to the ellipse $\frac{x^2}{14} + \frac{y^2}{5} = 1$ intersects it again at the point $Q(2\theta)$, then $\cos\theta =$
(a) $-\frac{2}{3}$ (b) $\frac{2}{3}$
(c) $\frac{3}{2}$ (d) $-\frac{3}{2}$

**115.** The eccentricity of the hyperbola with latus rectum 12 and semiconjugate axis $2\sqrt{3}$, is
(a) 3 (b) $\sqrt{\frac{3}{2}}$
(c) $2\sqrt{3}$ (d) 2

**116.** The projections of a directed line segment on the coordinate axes are 12, 4, 3. The direction cosines of the line are
(a) $\frac{12}{13}, \frac{4}{13}, \frac{3}{13}$ (b) $\frac{12}{13}, \frac{4}{13}, -\frac{3}{13}$
(c) $-\frac{12}{13}, \frac{4}{13}, \frac{3}{13}$ (d) $\frac{12}{13}, -\frac{4}{13}, -\frac{3}{13}$

**117.** The equation of the plane that contains the point $(1, -1, 2)$ and is perpendicular to each of the planes $2x + 3y - 2z = 5$ and $x + 2y - 3z = 8$ is
(a) $5x + 4y - z = 7$ (b) $5x - 4y + z = 7$
(c) $-5x + 4y - z = 7$ (d) $5x - 4y - z = 7$

**118.** If $I = \int_{\pi/6}^{\pi/3} \frac{dx}{1 + \sqrt{\tan x}}$, then $I =$
(a) $\frac{\pi}{12}$ (b) $\frac{\pi}{6}$
(c) $\frac{\pi}{4}$ (d) $\frac{\pi}{3}$

**119.** If $I_1 = \int_0^{\pi/2} f(\sin 2x)\sin x\, dx$ and $I_2 = \int_0^{\pi/4} f(\cos 2x)\cos x\, dx$ then $I_1/I_2 =$
(a) 1 (b) $\sqrt{2}$
(c) $\frac{1}{\sqrt{2}}$ (d) 2

**120.** The area bounded by the two parabolas $y^2 = x$ and $x^2 = y$ is given by
(a) 1 (b) $\frac{2}{3}$
(c) $\frac{1}{3}$ (d) $\frac{1}{2}$

**121.** If $f(x) = p|\sin x| + qe^{|x|} + r|x|^3$ and if $f(x)$ is differentiable at $x = 0$, then
(a) $p = 0$, $q = 0$ and $r = 0$
(b) $p + q = 0$ and $r$ is any real number
(c) $p + q + r = 0$ (d) $-p + q - r = 0$

**122.** If $f(0) = 0$, $f'(0) = 3$, then $y'(0)$ will be equal to, where $y = f(f(f(f(f(x)))))$
(a) 0 (b) 3
(c) $3^4$ (d) $3^5$

23. If $f(x) = xe^{x(1-x)}$, then $f(x)$ is
(a) increasing on $R$
(b) decreasing on $\left[-\frac{1}{2}, 1\right]$
(c) increasing on $\left(-\frac{1}{2}, 1\right)$
(d) decreasing on $R$

24. The parabola $y^2 = 4x$ and the circle $x^2 + y^2 - 6x + 1 = 0$ will
(a) intersect at exactly one point
(b) touch each other at two distinct points
(c) touch each other at exactly one point
(d) intersect at two distinct points

25. If $f(x) = \frac{x^2 - 1}{x^2 + 1}$ for every real number $x$, then the minimum value of $f$
(a) $-1$ (b) does not exist
(c) 0 (d) 1

26. The equation of the common tangent to the parabola $y^2 = 8x$ and rectangular hyperbola $xy = -1$ is
(a) $x - y + 2 = 0$ (b) $9x - 3y + 2 = 0$
(c) $2x + y + 1 = 0$ (d) $x + 2y - 1 = 0$

27. Let $A$ and $B$ be any two events, then $P(A \cap B)$
(a) $P(A \cup B) - P(A^C) - P(B^C)$
(b) $P(A) + P(B^C)$
(c) $P(B) + P(A^C)$
(d) none of the above

28. The solution of $\frac{dy}{dx} = x + y$, $y(0) = 0$ is
(a) $y = e^x + x - 1$ (b) $y = e^x - x - 1$
(c) $y = e^{-x} - x - 1$ (d) $y = e^{-x} + x + 1$

29. Let $f = \{(0, -1), (-1, -3), (2, 3), (3, 5)\}$ be a function from $z$ to $z$ defined by $f(x) = ax + b$. Then
(a) $a = 1, b = -2$ (b) $a = 2, b = 1$
(c) $a = 2, b = -1$ (d) $a = 1, b = 2$

30. Which of the following result is valid ?
(a) $(1 + x)^n > (1 + nx)$ for all natural number $n$
(b) $(1 + x)^n \geq (1 + nx)$ for all natural number $n$, where $x > -1$
(c) $(1 + x)^n \leq (1 + nx)$ for all natural number $n$
(d) $(1 + x)^n < (1 + nx)$ for all natural number $n$

31. If $n$ is a natural number, then
(a) $1^2 + 2^2 + \ldots + n^2 < n^3/3$
(b) $1^2 + 2^2 + \ldots + n^2 = n^3/3$
(c) $1^2 + 2^2 + \ldots + n^2 > n^3$
(d) $1^2 + 2^2 + \ldots + n^2 > n^3/3$

132. Which of the following statements is true ?
(a) $\sqrt{51}$ is a rational number
(b) each radius of a circle is a chord
(c) circle is a particular case of an ellipse
(d) the centre of a circle bisects each chord of the circle

133. If $n > 1$ and $n$ divides $\lfloor n-1 \rfloor + 1$, then
(a) $n$ is always even
(b) $n$ has to be a composite number
(c) $n$ is divisible by exactly two primes
(d) $n$ has to be a prime

134. If $\lim_{x \to 0} \frac{ae^x - b\cos x + ce^{-x}}{x \sin x} = 2$, then
(a) $a = 1, b = 2, c = 1$ (b) $a = 1, b = 1, c = 2$
(c) $a = 2, b = 1, c = 1$ (d) $a = b = c = 1$

135. The number of solutions of $z^3 + \bar{z} = 0$ is
(a) 2 (b) 4
(c) 5 (d) 3

136. Reflection of the line $\bar{a}z + a\bar{z} = 0$ in the real axis is
(a) $\bar{a}z - a\bar{z} = 0$ (b) $az + \bar{a}\bar{z} = 0$
(c) $\bar{a}z + a\bar{z} = 0$ (d) $az - \bar{a}\bar{z} = 0$

137. If both the roots of the equation $x^2 - 6ax + 2 - 2a + 9a^2 = 0$ exceed 3, then
(a) $a < \frac{1}{2}$ (b) $a > \frac{1}{2}$
(c) $a < 1$ (d) $a > \frac{11}{9}$

138. The number of real values of $x$ which satisfy the equation $\left|\frac{x}{x-1}\right| + |x| = \frac{x}{|x-1|}$ is
(a) 2 (b) 1
(c) infinite (d) zero

139. Let $I_n = \int_0^1 x^n \tan^{-1} x\,dx$. If $a_n I_{n+2} + b_n I_n = c_n$ for all $n \geq 1$, then
(a) $b_1, b_2, b_3, \ldots$ are in A.P.
(b) $b_1, b_2, b_3, \ldots$ are in G.P.
(c) $b_1, b_2, b_3, \ldots$ are in H.P.
(d) none of the above

140. If $H_n = 1 + \frac{1}{2} + \ldots + \frac{1}{n}$, then the value of $S_n = 1 + \frac{3}{2} + \frac{5}{3} + \ldots + \frac{2n-1}{n}$ is
(a) $H_n + 2n$ (b) $n - 1 + H_n$
(c) $H_n - 2n$ (d) $2n - H_n$

**141.** The value of $x$ satisfying $\log_2(3x-2) = \log_{1/2} x$ is

(a) 1 (b) $-\frac{1}{3}$

(c) $-1$ (d) $\frac{1}{3}$

**142.** If $\log_3 2$, $\log_3(2^x - 5)$ and $\log_3(2^x - \frac{7}{2})$ are in A.P., then $x$ is equal to

(a) 8 (b) $-8$

(c) 3 (d) $-3$

**143.** If ${}^{n-1}C_r = (k^2-3)({}^nC_{r+1})$, then $k$ belongs to

(a) $(\sqrt{3}, 2)$ (b) $(-\infty, -2)$

(c) $[-\sqrt{3}, \sqrt{3}]$ (d) $(2, \infty)$

**144.** The number of positive integers $n$ such that $2^n$ divides $n!$ is

(a) one (b) two

(c) infinite (d) zero

**145.** The expression ${}^nC_0 + 2{}^nC_1 + 3{}^nC_2 + \ldots\ldots + (n+1){}^nC_n$ is equal to

(a) $(n+1)2^n$ (b) $2^n(n+2)$

(c) $(n+2)2^{n-1}$ (d) $(n+2)2^{n+1}$

**146.** If $A$ and $B$ are coefficients of $x^n$ in the expansions of $(1+x)^{2n}$ and $(1+x)^{2n-1}$ respectively, then $B/A$ is equal to

(a) $\frac{1}{2}$ (b) 2

(c) 1 (d) $\frac{1}{n}$

**147.** If $A$ and $B$ are two square matrices of the same order and $m$ is a positive integer, then $(A+B)^m = {}^mC_0A^m + {}^mC_1A^{m-1}B + {}^mC_2A^{m-2}B^2 + \ldots\ldots + {}^mC_mB^m$, if

(a) $AB = -BA$ (b) $A^m = 0$, $B^m = 0$

(c) $AB = 2BA$ (d) $AB = BA$

**148.** If the system of linear equations $x + 2y - 3z = 1$, $(p+2)z = 3$, $(2p+1)y + z = 2$ has no solution, then

(a) $p = +2$ (b) $p = -2$

(c) $p = \frac{1}{2}$ (d) $p = 3$

**149.** If $\begin{vmatrix} \sin x & \cos x & \cos x \\ \cos x & \sin x & \cos x \\ \cos x & \cos x & \sin x \end{vmatrix} = 0$, then the number of distinct real roots of this equation in the interval $-\pi/2 < x < \pi/2$ is

(a) 2 (b) 0

(c) 1 (d) 3

**150.** Let $m$ be a positive integer and $0 \le r \le m$.

The value of $\sum_{r=0}^{m} \begin{vmatrix} 2r-1 & {}^mC_r & 1 \\ m^2-1 & 2^m & m+1 \\ \sin^2 m & \cos^2 m & \tan^2 m \end{vmatrix}$ will be

(a) $2^m$ (b) $m+1$

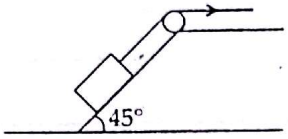
(c) $m^2 - 1$ (d) 0

# A.M.U. (ENGINEERING)

# Solved Paper 2010

## PHYSICS

1. A block of mass 200 kg is being pulled up by men on an inclined plane at angle of 45° as shown. The coefficient of static friction is 0.5. Each man can only apply a maximum force of 500 N. Calculate the number of men required for the block to just start moving up the plane




(a) 10 (b) 15
(c) 5 (d) 3

2. Two strings $A$ and $B$ are slightly out tune and produces beats of frequency 5 Hz. Increasing the tension in $B$ reduces the beat frequency to 3 Hz. If the frequency of string $A$ is 450 Hz, calculate the frequency of string $B$.
(a) 460 Hz (b) 455 Hz
(c) 445 Hz (d) 440 Hz

3. A resonance pipe is open at both ends and 30 cm of its length is in resonance with an external frequency 1.1 kHz. If the speed of sound is 330 m/s which harmonic is in resonance
(a) first (b) second
(c) third (d) fourth

4. The SHM of a particle is given by

$\frac{3}{2}O_2$ (in MKS units). Calculate the displacement and the magnitude of acceleration of the particle at $t = 1.5$ seconds.
(a) –3.0 m, 100 m/s² (b) +2.54 m, 200 m/s²
(c) –3.54 m, 140 m/s² (d) +3.55 m, 120 m/s²

5. Calculate the ratio of rms speed of oxygen gas molecules to that of hydrogen gas molecules kept at the same temperature
(a) 1 : 4 (b) 1 : 8
(c) 1 : 2 (d) 1 : 6

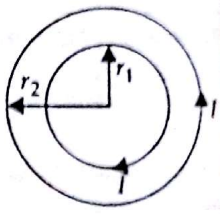
6. The coefficient of volume expansion of a liquid is $49 \times 10^{-5}\ K^{-1}$. Calculate the fractional change in its density when the temperature is raised by 30°C.
(a) $7.5 \times 10^{-3}$ (b) $3.0 \times 10^{-3}$
(c) $1.5 \times 10^{-3}$ (d) $1.1 \times 10^{-3}$

7. Avalanche breakdown in a $PN$ junction diode is due to
(a) sudden shift of Fermi level
(b) increase in the width of forbidden gap
(c) sudden increase of impurity concentration
(d) cumulative effect of increased electron collision and creation of added electron hole pairs

8. Any digital circuit can be realised by repetitive use of only
(a) NOT gates (b) OR gates
(c) AND gates (d) NOR gates

9. A solid sphere of mass 1 kg, radius 10 cm rolls down an inclined plane of height 7 m. The velocity of its centre as it reaches the ground level is
(a) 7 m/s (b) 10 m/s
(c) 15 m/s (d) 20 m/s

10. Two circular concentric loops of radii $r_1 = 20$ cm and $r_2 = 30$ cm are placed in the $XY$ plane as shown in the figure. A current $I = 7$ amp is flowing through them. The magnetic moment of this loop system is




(a) $+0.4\,\hat{k}\,(A\,m^2)$
(b) $-1.5\,\hat{k}\,(A\,m^2)$
(c) $+1.1\,\hat{k}\,(A\,m^2)$
(d) $+1.3\,\hat{j}\,(A\,m^2)$

11. In a Young's double slit experiment (slit distance $d$) monochromatic light of wavelength $\lambda$ is used and the fringe pattern observed at a distance $L$ from the slits. The angular position of the bright fringes are

(a) $\sin^{-1}\left(\frac{N\lambda}{d}\right)$ (b) $\sin^{-1}\left(\frac{\left(N+\frac{1}{2}\right)\lambda}{d}\right)$

(c) $\sin^{-1}\left(\frac{N\lambda}{L}\right)$ (d) $\sin^{-1}\left(\frac{\left(N+\frac{1}{2}\right)\lambda}{L}\right)$

12. Two energy levels of an electron in an atom are separated by 2.3 eV. The frequency of radiation emitted when the electrons goes from higher to the lower level is
(a) $6.95 \times 10^{14}$ Hz (b) $3.68 \times 10^{15}$ Hz
(c) $5.6 \times 10^{14}$ Hz (d) $9.11 \times 10^{15}$ Hz

13. What is the work function of a substance if photoelectrons are just ejected for a monochromatic light of wavelength $\lambda = 3300$ Å (answer in eV) ?
(a) 3.75 (b) 3.25
(c) 1.63 (d) 0.75

14. The linear momentum of an electron, initially at rest, accelerated through a potential difference of 100 V is
(a) $9.1 \times 10^{-24}$ (b) $6.5 \times 10^{-24}$
(c) $5.4 \times 10^{-24}$ (d) $1.6 \times 10^{-24}$

15. The de Broglie wavelength of a ball of mass 120 g moving at a speed of 20 m/s is
(a) $3.5 \times 10^{-34}$ m (b) $2.8 \times 10^{-34}$ m
(c) $1.2 \times 10^{-34}$ m (d) $2.1 \times 10^{-34}$ m

16. A square card of side length 1 mm is being seen through a magnifying lens of focal length 10 cm. The card is placed at a distance of 9 cm from the lens. The apparent area of the card through the lens is
(a) 1 $cm^2$ (b) 0.81 $cm^2$
(c) 0.27 $cm^2$ (d) 0.60 $cm^2$

17. A object moving at a speed of 5 m/s towards a concave mirror of focal length $f = 1$ m is at a distance of 9 m. The average speed of the image is
(a) $\frac{1}{5}$ m/s (b) $\frac{1}{10}$ m/s
(c) $\frac{5}{9}$ m/s (d) $\frac{4}{10}$ m/s

18. The magnetic field of an electromagnetic wave is given by
$B_y = 3 \times 10^{-7} \sin (10^3 x + 6.28 \times 10^{12} t)$.
The wavelength of the e.m. wave is
(a) 6.28 cm (b) 3.14 cm
(c) 0.63 cm (d) 0.32 cm

19. A 50 volt a.c. is applied across an *RC* (series) network. The rms voltage across the resistance is 40 volt, then the potential across the capacitance would be
(a) 10 V (b) 20 V (c) 30 V (d) 40 V

20. A pure inductance coil of 30 mH is connected to an a.c. source of 220 V. The rms current in the coil is
(a) 50.35 A (b) 23.4 A
(c) 30.5 A (d) 12.3 A

21. A square loop of wire, side length 10 cm is placed at angle of 45° with a magnetic field that changes uniformly from 0.1 T to zero in 0.7 seconds. The induced current in the loop (its resistance is 1 Ω) is
(a) 1.0 mA (b) 2.5 mA
(c) 3.5 mA (d) 4.0 mA

22. The angle of dip at a certain place on earth is 60° and the magnitude of earth's horizontal component of magnetic field is 0.26 G. The magnetic field at the place on earth is
(a) 0.13 G (b) 0.26 G
(c) 0.52 G (d) 0.65 G

23. The dimensional formula for the magnetic field is
(a) $MT^{-2}A^{-1}$ (b) $ML^2T^{-1}A^{-2}$
(c) $MT^{-2}A^{-2}$ (d) $MT^{-1}A^{-2}$

24. The maximum velocity to which a proton can be accelerated in a cyclotron of 10 MHz frequency and radius 50 cm is
(a) $6.28 \times 10^8$ m/s (b) $3.14 \times 10^8$ m/s
(c) $6.28 \times 10^7$ m/s (d) $3.14 \times 10^7$ m/s

25. The radius of the path of an electron moving at a speed of $3 \times 10^7$ m/s perpendicular to a magnetic field $5 \times 10^{-4}$ T is nearly
(a) 15 cm (b) 45 cm (c) 27 cm (d) 34 cm

26. The resistance of the wire in the platinum resistance thermometer at ice point is 5 Ω and at steam point is 5.25 Ω. When the thermometer is inserted in an unknown hot bath its resistance is found to be 5.5 Ω. The temperature of the hot bath is
(a) 100°C (b) 200°C
(c) 300°C (d) 350°C

27. The density of copper is $9 \times 10^3$ kg/$m^3$ and its atomic mass is 63.5 u . Each copper atom provides one free electron. Estimate the number of free electrons per cubic meter in copper.
(a) $10^{19}$ (b) $10^{23}$ (c) $10^{25}$ (d) $10^{29}$

28. A conductor has been given a charge $-3 \times 10^{-7}$ by transferring electrons. Mass increase (in kg) of the conductor and the number of electrons added to the conductor are respectively
(a) $2 \times 10^{-16}$ and $2 \times 10^{31}$
(b) $5 \times 10^{-31}$ and $5 \times 10^{19}$
(c) $3 \times 10^{-19}$ and $9 \times 10^{24}$
(d) $2 \times 10^{-18}$ and $2 \times 10^{12}$

29. Under the action of a given coulombic force the acceleration of an electron is $2.5 \times 10^{22}$ m/s$^2$. Then the magnitude of the acceleration of a proton under the action of same force is nearly
(a) $1.6 \times 10^{-19}$ m/s$^2$ (b) $9.1 \times 10^{31}$ m/s$^2$
(c) $1.5 \times 10^{19}$ m/s$^2$ (d) $1.6 \times 10^{27}$ m/s$^2$

30. An electron initially at rest falls a distance of 1.5 cm in a uniform electric field of magnitude $2 \times 10^4$ N/C. The time taken by the electron to fall this distance is
(a) $1.3 \times 10^2$ s (b) $2.1 \times 10^{-12}$ s
(c) $1.6 \times 10^{-10}$ s (d) $2.9 \times 10^{-9}$ s

31. The constant of proportionality $\frac{1}{4\pi\varepsilon_0}$ in Coulomb's law has the following dimensions
(a) $C^{-2}$ N m$^2$ (b) $C^2$ N$^{-1}$ m$^{-2}$
(c) $C^2$ N m$^2$ (d) $C^{-2}$ N$^{-1}$ m$^{-2}$

32. The pressure on a swimmer 20 m below the surface of water at sea level is
(a) 1.0 atm (b) 2.0 atm
(c) 2.5 atm (d) 3.0 atm

33. The potential energy of 4-particles each of mass 1 kg placed at the four vertices of a square of side length 1 m is
(a) $+4.0G$ (b) $-7.5G$
(c) $-5.4G$ (d) $+6.3G$

34. Two masses 8 kg and 12 kg are connected at the two ends of a string that goes over a frictionless pulley. Calculate the acceleration of the masses and the tension in the string. Take $g = 10$ m/s$^2$
(a) 8, 144 (b) 4, 112
(c) 6, 128 (d) 2, 96

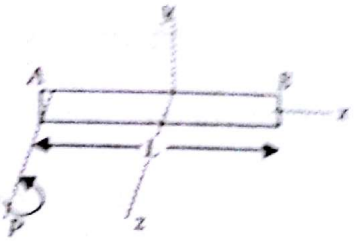
35. The backside of a truck is open and a box of 40 kg is placed 5 m away from the rear end. The coefficient of friction of the box with the surface of the truck is 0.15. The truck starts from rest with 2 m/s$^2$ acceleration. Calculate the distance covered by the truck when the box falls off.
(a) 20 m (b) 30 m
(c) 40 m (d) 50 m

36. The position of a particle $x$ (in meters) at a time $t$ seconds is given by the relation $\vec{r} = (3t\hat{i} - t^2\hat{j} + 4\hat{k})$. Calculate the magnitude of velocity of the particle after 3 seconds.
(a) 3.35 (b) 5.03
(c) 8.75 (d) 10.44

37. A monoatomic gas is kept at room temperature 300 K. Calculate the average kinetic energy of gas molecule (Use $k = 1.38 \times 10^{-23}$ MKS units)
(a) 0.138 eV (b) 0.062 eV
(c) 0.039 eV (d) 0.013 eV

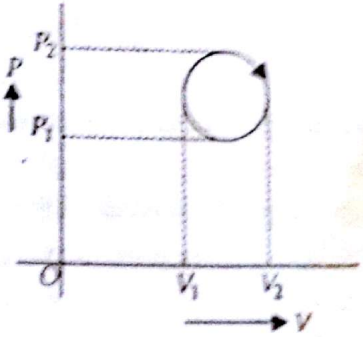
38. A uniform magnetic field $B = 1.2$ mT is directed vertically upward throughout the volume of a laboratory chamber. A proton ($m_p = 1.67 \times 10^{-27}$ kg) enters the laboratory horizontally from south to north. Calculate the magnitude of centripetal acceleration of the proton if its speed is $3 \times 10^7$ m/s
(a) $3.45 \times 10^{12}$ m/s$^2$ (b) $1.67 \times 10^{12}$ m/s$^2$
(c) $5.25 \times 10^{12}$ m/s$^2$ (d) $2.75 \times 10^{12}$ m/s$^2$

39. A rod of length $L$ and mass $M$ is rotating about an axis $P$ perpendicular to the rod and parallel to z-axis, passing through one end $A$ of the rod. The moment of inertia for rotation about this axis $P$ is




(a) $\frac{1}{12}ML^2$ (b) $\frac{1}{4}ML^2$
(c) $\frac{1}{3}ML^2$ (d) $\frac{5}{12}ML^2$

40. In the cyclic process shown in the P-V diagram calculate the work done.



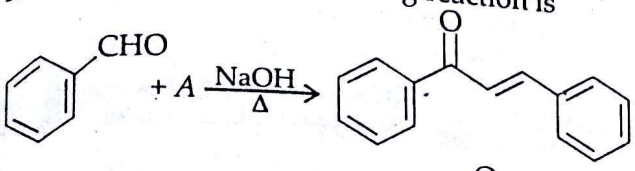
(a) $\pi\left(\frac{V_2 - V_1}{2}\right)^2$ (b) $\pi\left(\frac{P_2 - P_1}{2}\right)^2$

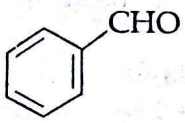
(c) $\frac{\pi}{4}(P_2 - P_1)(V_2 - V_1)$

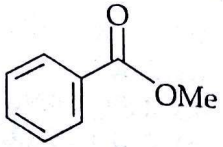
(d) $\pi(P_2V_2 - P_1V_1)$

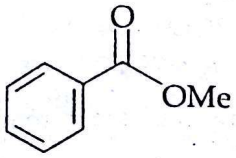
## CHEMISTRY

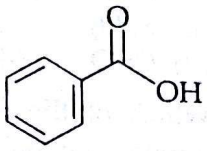
41. The reactant '$A$' in the following reaction is



(a) 

(b) 

(c) 

(d) 

42. Compound which shows positive mesomeric effect
(a) $CH_2 = CH-Cl$
(b) $C_6H_5-N^+-Me_3$
(c) $CH_2 = CH-CH_2Cl$
(d) $C_6H_5-CH = CHCl$

43. Which of the following is an outer orbital complex?
(a) $[Cr(NH_3)_6]^{3+}$ (b) $[Ni(NH_3)_6]^{2+}$
(c) $[Fe(CN)_6]^{3-}$ (d) $[Mn(CN)_6]^{4-}$

44. 0.32 g of metal gave on treatment with an acid 112 mL of hydrogen at NTP. Calculate the equivalent weight of the metal.
(a) 58 (b) 32 (c) 11.2 (d) 24

45. A current of 0.5 amperes is passed for 30 minute through a voltmeter containing $CuSO_4$ solution. Find the weight of Cu deposited.
(a) 3.18 g (b) 0.318 g
(c) 0.296 g (d) 0.150 g

46. Which of the following is not an artificial sweetener?
(a) Aspartame (b) Sucrolose
(c) Sucrose (d) Alitame

47. Gold number indicates
(a) protective action of lyophilic colloid
(b) charge on gold sol
(c) protective action of lyophobic colloid
(d) quantity of gold dissolved in a given sol

48. Which of the following will dissolve in excess of ammonia?
(a) AgI (b) AgBr
(c) AgCl (d) None of these

49. Who discovered the first noble gas compound?
(a) Neils Bohr (b) Neil Bartlett
(c) Neil Armstrong (d) William

50. Which of the following sets will have highest hydration enthalpy and highest ionic radius?
(a) Na and Li (b) Li and Rb
(c) K and Na (d) Cs and Na

51. What type of structure does $(NPCl_2)_4$ have?
(a) Linear (b) Hexagonal
(c) Cyclic (d) Polymeric

52. The pH of the solution produced by mixing equal volume of $2.0 \times 10^{-3}$ M $HClO_4$ and $1.0 \times 10^{-2}$ M $KClO_4$ is
(a) 2.7 (b) 2.3 (c) 3.0 (d) 1.0

53. Which of the following is non-existent?
(a) $AlF_6^{3-}$ (b) $CoF_6^{3-}$
(c) $BF_6^{3-}$ (d) $SiF_6^{2-}$

54. Which of the following is extracted from sea weeds?
(a) Quinine (b) Astatine
(c) Iodine (d) Germanium

55. How many hydrogen bonded water molecule(s) are associated with $CuSO_4 \cdot 5H_2O$?
(a) 1 (b) 2 (c) 3 (d) 4

56. The total number of atoms of all elements present in 1 mole of ammonium dichromate is
(a) 19 (b) $6.023 \times 10^{23}$
(c) $114.437 \times 10^{23}$ (d) $84.322 \times 10^{23}$

57. What is the magnetic moment of $Fe^{3+}$ ion in $[Fe(CN)_6]^{3-}$?
(a) 1.73 B.M. (b) 5.9 B.M.
(c) Diamagnetic (d) None of these

58. For the 19th electron of K the values of quantum number will be
(a) $X(t) = 5\cos$ (b) $\frac{1}{5}$ m/s
(c) $\frac{1}{10}$ m/s (d) $\frac{5}{9}$ m/s

59. Which of the following bases is not present in DNA?

(a) Alanine (b) Guanine
(c) Cytosine (d) Uracil

60. A student accidentally added conc. $H_2SO_4$ to potassium permanganate and it exploded due to the formation of an explosive which is
(a) MnO (b) $Mn_2O_3$
(c) $Mn_2O_5$ (d) $Mn_2O_7$

61. Which of the following is Vaska's compound ?
(a) $[Ni(PPh_3)_2Cl_2]$ (b) $[Rh(CO)_2Cl]_2$
(c) *trans*-$IrCl(CO)(PPh_3)_2$
(d) $IrCl(CO)_2(PPh_3)_2$

62. How many stereoisomers are possible in case of 3-chlorobutan-2-ol ?
(a) 2 (b) 6
(c) 8 (d) 4

63. Which of the following has smallest number of molecules ?
(a) 11.2 L of $O_2$ at NTP
(b) 8.0 g of $O_2$ (c) 0.1 mole of $O_2$
(d) $2.24 \times 10^4$ mL of $O_2$

64. Which of the following is not optically active ?
(a) Glycine (b) Tyrosine
(c) Lysine (d) Alanine

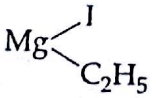
65. Which of the following is not a fat soluble vitamin?
(a) Vitamin A (b) Vitamin K
(c) Folic acid (d) Vitamin E

66. Which of the following exhibits square pyramidal geometry ?
(a) $XeF_6$ (b) $XeO_3$
(c) $BrF_5$ (d) $XeF_4$

67. Which complex of $Co^{2+}$ will have the weakest crystal field splitting ?
(a) $[Co(CN)_6]^{4-}$ (b) $[CoCl_6]^{4-}$
(c) $[Co(en)_3]^{2+}$ (d) $[Co(H_2O)_6]^{2+}$

68. The ratio of rates of diffusion of hydrogen chloride and ammonia gases is
(a) 1 : 1.46 (b) 1 : 2.92
(c) 1.46 : 1 (d) 1 : 0.73

69. What shall be the pH of a weak acid of $10^{-3}$ M concentration which is only 10% ionized ?
(a) 3 (b) 4 (c) 5 (d) 6

70. Which of the following is the major source of magnesium and is also a double salt ?
(a) $MgCO_3$ (b) $Mg_2P_2O_7$
(c)  (d) $KCl.MgCl_2.6H_2O$

71. Phosphine can be prepared by the reaction of water with
(a) calcium phosphide
(b) calcium hydride
(c) calcium dihydrogen phosphate
(d) calcium phosphate

72. The white ZnO turns yellow on heating because of
(a) Frenkel defect
(b) Metal excess defect
(c) Metal deficiency defect
(d) Schottky defect

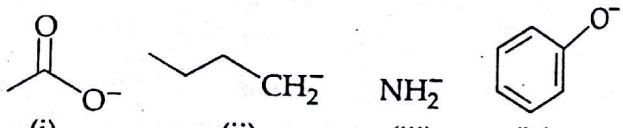
73. Which of the processes is used in thermite welding?
(a) $TiO_2 + 4Na \rightarrow Ti + 2Na_2O$
(b) $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$
(c) $SnO_2 + 2C \rightarrow Sn + 2CO$
(d) $Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr$

74. Which of the following has least tendency to undergo catenation ?
(a) C (b) Si (c) Ge (d) Sn

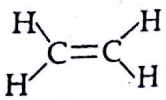
75. Methyl magnesium bromide on reaction with $SO_2$ followed by hydrolysis gives
(a) Methyl sulfonic acid
(b) Dithioacetic acid
(c) Methane sulfinic acid
(d) Ethane thiol

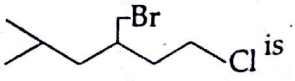
76. Which of the following configuration can undergo distortion?
(a) $t_{2g}^6 e_g^1$ (b) $t_{2g}^6 e_g^2$
(c) $t_{2g}^6 e_g^4$ (d) $t_{2g}^6 e_g^0$

77. Order of the base strength of the compounds

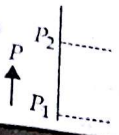


(i) (ii) (iii) (iv)
(a) iv > ii > i > ii (b) iii > ii > iv > i
(c) ii > iii > iv > i (d) ii > iii > i > iv

78. Which of the following molecules does not have net dipole moment ?
(a) $CH_3 - Br$ (b) $CH_2Cl_2$
(c) HCOOH (d) 

79. IUPAC name  is

(a) 1,1-dimethyl-3-bromoethyl-5-chloropentane
(b) 3-bromomethyl-1-chloro-5-methylhexane
(c) 1-bromomethyl-2-chloroethyl-4-methylpentane
(d) 4-bromomethyl-1-chloro-6-methylheptane

80. In bakelite, the rings are joined to each other through
(a) $-CH_2-$
(b) $-O-$
(c) 
(d) $-\overset{\overset{O}{\|}}{C}-$

## MATHEMATICS

81. If $A$ is a square matrix such that $A^2 = A$, then $(I-A)^3 + A$ is equal to
(a) $A$ (b) $I - A$ (c) $I$ (d) $3A$

82. For the equations $x + 2y + 3z = 1$, $2x + y + 3z = 2$, $5x + 5y + 9z = 4$,
(a) there is only one solution
(b) there exists infinitely many solutions
(c) there is no solution
(d) none of these

83. Let $f = \{(1, 1), (2, 4), (0, -2), (-1, -5)\}$ be a linear function from $Z$ into $Z$. Then $f(x)$ is
(a) $f(x) = 3x - 2$ (b) $f(x) = 6x - 8$
(c) $f(x) = 5x - 2$ (d) $f(x) = 7x + 2$

84. Let $f : R - \left\{\frac{5}{4}\right\} \to R$ be a function defined as $f(x) = \frac{5x}{4x+5}$. The inverse of $f$ is the map $g$ : Range $f \to R - \left\{\frac{5}{4}\right\}$ given by
(a) $g(y) = \frac{y}{5-4y}$ (b) $g(y) = \frac{5y}{5+4y}$
(c) $g(y) = \frac{5y}{5-4y}$ (d) none of these

85. Let * be a binary operation on the set $Q$ of rational numbers defined by $a * b = \frac{ab}{4}$. The identity with respect to this operation is
(a) 1 (b) 2 (c) 3 (d) 4

86. Let $A = \{1, 0, 1, 2\}$, $B = \{4, 2, 0, 2\}$ and $f, g : A \to B$ be functions defined by $f(x) = x^2 - x$ and $g(x) = 2\left|x - \frac{1}{2}\right| - 1$. Then
(a) $f = g$ (b) $f = 2g$
(c) $g = 2f$ (d) none of these

87. The complex number $z = \begin{vmatrix} 2 & 3+i & -3 \\ 3-i & 0 & -1+i \\ -3 & -1-i & 4 \end{vmatrix}$ is equal to
(a) $3 - 4i$ (b) $5 + 4i$
(c) $-5i$ (d) none of these

88. The number of solutions of the system of equations $\mathrm{Re}(z^2) = 0$, $|z| = 2$ is
(a) 4 (b) 3 (c) 2 (d) 1

89. The angle of elevation of the top of a T.V. tower from three points $A$, $B$, $C$ in a straight line in the horizontal plane through the foot of the tower are $\alpha$, $2\alpha$, $3\alpha$ respectively. If $AB = a$, the height of the tower is
(a) $a\tan\alpha$ (b) $a\sin\alpha$
(c) $a\sin2\alpha$ (d) $a\sin3\alpha$

90. The number of solutions of the equation $\tan x + \sec x = 2\cos x$ lying in the interval $[0, 2\pi]$ is
(a) 0 (b) 1 (c) 2 (d) 3

91. If $2\tan^{-1}(\cos x) = \tan^{-1}(2\mathrm{cosec}\, x)$, then $x$ is equal to
(a) $\pi/2$ (b) $\pi/3$ (c) $\pi/4$ (d) $\pi/6$

92. If $\tan^{-1}4x + \tan^{-1}6x = \pi/4$, then $x$ is equal to
(a) $\frac{1}{12}$ (b) $\frac{1}{12}$ or $-\frac{1}{2}$
(c) $-\frac{1}{2}$ (d) none of these

93. The longest side of a triangle is 5 times the shortest side and the third side is 50 cm shorter than the longest side. If the perimeter of the triangle is at least 60 cm, the minimum length of the shortest side is
(a) 9 cm (b) 10 cm
(c) 11 cm (d) none of these

94. For $2 \le r \le n$, ${}^nC_r + 2 \cdot {}^nC_{r-1} + {}^nC_{r-2} =$
(a) ${}^{n+1}C_{r-1}$ (b) $2 \cdot {}^{n+1}C_{r+1}$
(c) $2 \cdot {}^{n+2}C_r$ (d) ${}^{n+2}C_r$

95. The coefficients of the $(r-1)^{th}$, $r^{th}$ and $(r+1)^{th}$ terms in the expansion of $(x+1)^n$ are in the ratio 1 : 3 : 5. The pair $(n, r)$ is
(a) (6, 3) (b) (7, 3)
(c) (5, 3) (d) (5, 1)

96. If $S_1 = a_2 + a_4 + a_6 + \ldots$ upto 100 terms and $S_2 = a_1 + a_3 + a_5 + \ldots$ upto 100 terms of a certain A.P., then its common difference is
(a) $S_1 - S_2$ (b) $S_2 - S_1$
(c) $\frac{S_1 - S_2}{2}$ (d) none of these

97. If $\log_{10} 2$, $\log_{10}(2^x - 1)$ and $\log_{10}(2^x + 3)$ be three consecutive terms of an A.P., then
(a) $x = 0$ (b) $x = 1$
(c) $x = \log_2 5$ (d) $x = \log_{10} 2$

98. In a G.P. $t_2 + t_5 = 216$ and $t_4 : t_6 = 1 : 4$ and all terms are integers, then its first term is
(a) 16 (b) 14
(c) 12 (d) none of these

99. If $a$, $b$, $c$, $d$ and $p$ are different real numbers such that
$(a^2 + b^2 + c^2)p^2 - 2(ab + bc + cd)p + (b^2 + c^2 + d^2) \le 0$, then $a$, $b$, $c$ and $d$ are in
(a) A.P. (b) G.P.
(c) H.P. (d) none of these

100. If a variate takes values $a$, $ar$, $ar^2$, ..., $ar^{n-1}$, then which of the following relations between means hold?
(a) $A.H = G^2$ (b) $\frac{A+H}{2} = G$
(c) $A > G > H$ (d) $A = G = H$

101. The condition that $x^3 - px^2 + qx - r = 0$ may have two of its roots equal to each other but opposite in sign is
(a) $r = pq$ (b) $r = 2p^3 + pq$
(c) $r = p^2q$ (d) none of these

102. The length $L$ (in centimetre) of a copper rod is a linear function of its Celsius temperature $C$. In an experiment $L = 124.942$ when $C = 20$ and $L = 125.134$ when $C = 110$. The expression of $L$ in terms of $C$ is
(a) $L = \frac{0.192}{90}(C - 20) + 124.942$
(b) $L = \frac{0.192}{90}(C - 110) + 124.942$
(c) $L = \frac{192}{90}(C - 20) + 124.942$
(d) $L = \frac{192}{90}(C - 110) + 124.942$

103. $C_1$ is a circle with centre at the origin and radius equal to $r$ and $C_2$ is a circle with centre at $(3r, 0)$ and radius equal to $2r$. The number of common tangents that can be drawn to the two circles is
(a) 1 (b) 2 (c) 3 (d) 4

104. Let $f(x, y) = 0$ be the equation of a circle. If $f(0, \lambda) = 0$ has equal roots $\lambda = 1, 1$ and $f(\lambda, 0)$ has roots $\lambda = \frac{1}{2}, 2$, then the centre of the circle is
(a) $\left(1, \frac{1}{2}\right)$ (b) $\left(\frac{5}{4}, 1\right)$
(c) $(5, 4)$ (d) $\left(\frac{1}{2}, 1\right)$

105. The line $x + y = 6$ is normal to the parabola $y^2 = 8x$ at the point
(a) (4, 2) (b) (2, 4)
(c) (2, 2) (d) (3, 3)

106. $\vec{a}, \vec{b}, \vec{c}$ are three vectors of which every pair is non-collinear. If the vector $\vec{a} + \vec{b}$ and $\vec{b} + \vec{c}$ are collinear with $\vec{c}$ and $\vec{a}$ respectively, then $\vec{a} + \vec{b} + \vec{c}$ is
(a) a unit vector (b) the null vector
(c) equally inclined to $\vec{a}, \vec{b}, \vec{c}$
(d) none of these

107. A unit vector $\vec{a}$ makes angles $\pi/4$ with $\hat{i}$, $\pi/3$ with $\hat{j}$ and an acute angle $\theta$ with $\hat{k}$, then $\theta$ and $\vec{a}$ are
(a) $\frac{\pi}{3}, \frac{\sqrt{2}\,\hat{i} + \hat{j} + \hat{k}}{2}$ (b) $\frac{\pi}{3}, \frac{\sqrt{2}\,\hat{i} - \hat{j} + \hat{k}}{2}$
(c) $\frac{\pi}{3}, \frac{\sqrt{2}\,\hat{i} + \hat{j} - \hat{k}}{2}$ (d) $\frac{\pi}{3}, \frac{\hat{i} + \hat{j} + \hat{k}}{2}$

108. Let $\vec{a} = \hat{i} - \hat{k}$, $\vec{b} = x\hat{i} + \hat{j} + (1 - x)\hat{k}$ and $\vec{c} = y\hat{i} + x\hat{j} + (1 + x - y)\hat{k}$. Then $[\vec{a}\ \vec{b}\ \vec{c}]$ depends on
(a) only $x$ (b) only $y$
(c) neither $x$ nor $y$ (d) both $x$ and $y$

109. Equation of the plane through $(-1, -1, 1)$ which is parallel to $\vec{r} \cdot (\hat{i} + \hat{j} + \hat{k}) = 0$ is
(a) $\vec{r} \cdot (\hat{i} + \hat{j} + \hat{k}) + 1 = 0$ (b) $\vec{r} \cdot (\hat{i} + \hat{j} + \hat{k}) - 1 = 0$
(c) $\vec{r} \cdot (\hat{i} + \hat{j} + \hat{k}) + 3 = 0$ (d) $\vec{r} \cdot (\hat{i} + \hat{j} + \hat{k}) - 3 = 0$

110. The co-ordinates of a point on the line $\frac{x-1}{2} = \frac{y+1}{-3} = z$ at a distance $4\sqrt{14}$ from the point $(1, -1, 0)$ are
(a) $(9, -13, 4)$ (b) $(-9, 13, 4)$
(c) $(9, 13, -4)$ (d) none of these

111. The ratio in which the line segment joining the points $(4, 8, 10)$ and $(6, 10, -8)$ is divided by $xy$-plane is
(a) 5 : 4 externally (b) 5 : 4 internally
(c) 3 : 2 externally (d) none of these

112. $\lim_{x\to 1}\frac{x^{15}-1}{x^{10}-1}=$

(a) 2/3 (b) 3/2
(c) 1 (d) does not exist

113. The values of $a$ and $b$ such that the function defined by $f(x)=\begin{cases}7, & \text{if } x\le 2\\ ax+b, & \text{if } 2<x<9\\ 21, & \text{if } x\ge 9\end{cases}$ is a continuous function are

(a) $a=3, b=2$ (b) $a=2, b=3$
(c) $a=7, b=9$ (d) none of these

114. If $2^x+2^y=2^{x+y}$, then the value of $\frac{dy}{dx}$ at $x=y=1$ is

(a) 0 (b) −1 (c) 1 (d) 2

115. A stone is dropped into a quiet lake and waves move in circles at the speed of 6 cm per second. At the instant when the radius of the circular wave is 12 cm, the enclosed area is increasing at the rate of

(a) $120\pi$ cm$^2$/s (b) $130\pi$ cm$^2$/s
(c) $144\pi$ cm$^2$/s (d) none of these

116. For the function $f(x)=\frac{4}{3}x^3-8x^2+16x+5,\ x=2$ is a point of

(a) local maxima (b) local minima
(c) point of inflexion (d) none of these

117. $\int e^{x\log a}e^x\,dx$ is equal to

(a) $(ae)^x+C$ (b) $\frac{(ae)^x}{\log(ae)}+C$
(c) $\frac{e^x}{1+\log a}+C$ (d) none of these

118. $\int e^x\left(\text{cosec}^{-1}x+\frac{-1}{x\sqrt{x^2-1}}\right)dx$ is equal to

(a) $e^x\,\text{cosec}^{-1}x+C$ (b) $e^x\sin^{-1}x+C$
(c) $e^x\sec^{-1}x+C$ (d) $e^x\cos^{-1}x+C$

119. $\int_{-1}^{1}\sin^5 x\cos^4 x\,dx$ is

(a) 0 (b) 1 (c) 2 (d) 3

120. The coefficient of $x^3$ in the expansion of $e^{2x+3}$ as a series in powers of $x$ is

(a) $e^3$ (b) $\frac{3}{4}e^3$
(c) $\frac{4}{3}e^3$ (d) none of these

121. The area of the region bounded by the line $y=3x+2$, the $x$-axis and the ordinates $x=-1$ and $x=1$ is

(a) $\frac{13}{3}$ (b) $\frac{13}{4}$ (c) $\frac{13}{5}$ (d) $\frac{13}{6}$

122. The differential equation representing the family of curves $y=b\sin(x+a)$, where $a, b$ are arbitrary constants is

(a) $\frac{d^2y}{dx^2}+y=0$ (b) $\frac{d^2y}{dx^2}-y=0$
(c) $\frac{dy}{dx}+y=0$ (d) none of these.

123. The general solution of the differential equation $ydx+(x+2y^2)dy=0$ is

(a) $xy+y^2=c$ (b) $3xy+y^2=c$
(c) $xy+y^3=c$ (d) $3xy+2y^3=c$

124. If $A=\begin{bmatrix}1&1&1\\1&1&1\\1&1&1\end{bmatrix}$, then $A^n$ is

(a) $A$ (b) $\begin{bmatrix}3^{n-1}&3^{n-1}&3^{n-1}\\3^{n-1}&3^{n-1}&3^{n-1}\\3^{n-1}&3^{n-1}&3^{n-1}\end{bmatrix}$
(c) $\begin{bmatrix}3^n&3^n&3^n\\3^n&3^n&3^n\\3^n&3^n&3^n\end{bmatrix}$ (d) none of these

125. Value of $\begin{bmatrix}2&4&6\\2+3x&4+3y&6+3z\\2x&2y&2z\end{bmatrix}$ is

(a) 0 (b) 2 (c) 4 (d) 6

126. The value of $\begin{bmatrix}2y+4&5y+7&8y+1\\3y+5&6y+8&9y+2\\4y+6&7y+9&10y+3\end{bmatrix}$ is

(a) 2 (b) 3
(c) 5 (d) none of these

127. Coefficient of variations of two distributions are 55 and 65, and their standard deviations are 22 and 39 respectively. Their arithmetic means are respectively

(a) 15, 20 (b) 40, 60
(c) 30, 50 (d) none of these

128. A fair coin is tossed $n$ number of times. If the probability of having at least one head is more than 90%, then $n$ is greater than or equal to
(a) 2 (b) 3 (c) 4 (d) 5

129. Three cards are drawn successively without replacement from a pack of 52 well shuffled cards. The probability that first two cards are queens and the third card is a king is
(a) $\frac{4}{52}\times\frac{4}{51}\times\frac{4}{50}$ (b) $\frac{4}{52}\times\frac{2}{51}\times\frac{1}{50}$
(c) $\frac{4}{52}\times\frac{3}{51}\times\frac{3}{50}$ (d) $\frac{4}{52}\times\frac{3}{51}\times\frac{4}{50}$

130. Bag I contains 3 red and 4 black balls while another bag II contains 5 red and 6 black balls. One ball is drawn at random from one of the bags and it is found to be black. The probability that it was drawn from bag II is
(a) $\frac{7}{43}$ (b) $\frac{13}{43}$
(c) $\frac{21}{43}$ (d) none of these

131. For the binomial distribution $(p+q)^n$, whose mean is 20 and variance is 16, pair $(n, p)$ is
(a) $\left(100, \frac{1}{5}\right)$ (b) $\left(100, \frac{2}{5}\right)$
(c) $\left(50, \frac{1}{5}\right)$ (d) $\left(50, \frac{2}{5}\right)$

132. The maximum value of $Z = 4x + y$ subject to the constraints, $x + y \le 50$, $3x + y \le 90$, $x \ge 0$, $y \ge 0$ is
(a) 40 (b) 130 (c) 120 (d) 50

133. If $f(x)=\frac{x-1}{x+1}$, then $f(2x)$ is
(a) $\frac{f(x)+1}{f(x)+3}$ (b) $\frac{3f(x)+1}{f(x)+3}$
(c) $\frac{f(x)+3}{f(x)+1}$ (d) $\frac{f(x)+3}{3f(x)+1}$

134. Complex number $z=\frac{i-1}{\cos(\pi/3)+i\sin(\pi/3)}$ in polar form is
(a) $r=\sqrt{2}\left(\cos\frac{5\pi}{12}+i\sin\frac{5\pi}{12}\right)$
(b) $r=\sqrt{2}\left(\cos\frac{\pi}{4}+i\sin\frac{\pi}{4}\right)$
(c) $r=\sqrt{2}\left(\cos\frac{\pi}{6}+i\sin\frac{\pi}{6}\right)$
(d) none of these

135. The number of solutions of equation $\sin^4\theta - 2\sin^2\theta - 1 = 0$ which lie between 0 and $2\pi$ is
(a) 0 (b) 1 (c) 2 (d) 4

136. The product $r$ consecutive integers is divisible by
(a) $r!$ (b) $(r-1)!$
(c) $(r+1)!$ (d) none of these

137. The interior angles of a polygon are in arithmetic progression. The smallest angle is 120 and the common difference is 5. The number of sides of the polygon is
(a) 7 (b) 9 (c) 11 (d) 16

138. In a certain progression three consecutive terms are 30, 24, 20. The next term of the progression is
(a) 16 (b) $\frac{120}{7}$
(c) 18 (d) none of these

139. If $x$, $y$, $z$ are three positive numbers, then the minimum value of $\frac{y+z}{x}+\frac{z+x}{y}+\frac{x+y}{z}$ is
(a) 1 (b) 2 (c) 3 (d) 6

140. A person standing at the junction (crossing) of two straight paths represented by the equations $x + y + 1 = 0$ and $x - y + 1 = 0$ wants to reach the path whose equation is $6x - 7y + 8 = 0$ in least time. The equation of the path that he should follow is
(a) $7x + 6y + 7 = 0$ (b) $6x + 7y + 7 = 0$
(c) $7x + 6y + 4 = 0$ (d) $6x + 7y + 4 = 0$

141. If $ax^2 + 4xy + y^2 + ax + 3y + 2 = 0$ represents a parabola, then $a$ is
(a) $-4$ (b) 4 (c) 0 (d) 6

142. The position vector of a point $R$ which divides the line joining two points $P$ and $Q$ whose position vectors are $\hat{i}+2\hat{j}-\hat{k}$ and $-\hat{i}+\hat{j}-\hat{k}$ respectively, in the ratio 2 : 1 externally is
(a) $-3\hat{i}-\hat{k}$ (b) $3\hat{i}+\hat{k}$
(c) $2\hat{i}+\hat{j}-\hat{k}$ (d) none of these

143. Let $\vec{b}=4\hat{i}+3\hat{j}$ and $\vec{c}$ be two vectors perpendicular to each other in $xy$-plane, then a vector in the same plane having projections 1 and 2 along $\vec{b}$ and $\vec{c}$, respectively, is
(a) $\hat{i}+2\hat{j}$ (b) $2\hat{i}-\hat{j}$
(c) $2\hat{i}+\hat{j}$ (d) none of these

**144.** The value of $\lambda$ for which the lines $\frac{1-x}{3}=\frac{y-2}{2\lambda}=\frac{z-3}{2}$ and $\frac{x-1}{3\lambda}=\frac{y-1}{1}=\frac{6-z}{7}$ are perpendicular to each other is

(a) $-1$ (b) $-2$ (c) 1 (d) 2

**145.** If the function $f(x)$ satisfies $\lim_{x\to 1}\frac{f(x)-3}{x^2-1}=\pi$, then $\lim_{x\to 1} f(x)$ is

(a) 1 (b) 2 (c) 3 (d) $\pi$

**146.** If $f(x)=3e^{x^2}$, then $f'(x)-2x\,f(x)+\frac{1}{3}f(0)-f'(0)$ is equal to

(a) 0 (b) 1

(c) $\frac{7}{3}e^{x^2}$ (d) none of these

**147.** A car starts from a point $P$ at time $t=0$ seconds and stops at point $Q$. The distance $x$, in metres, covered by it, in $t$ seconds is given by $x=t^2\left(3-\frac{2}{3}t\right)$. The time taken by it to reach $Q$ in seconds is

(a) 1/2 (b) 3

(c) 1 (d) none of these

**148.** $\int e^x\left(\frac{1+\sin x}{1+\cos x}\right)dx=$

(a) $e^x\tan\frac{x}{2}+C$ (b) $e^x\cot\frac{x}{2}+C$

(c) $e^x\sin x+C$ (d) $e^x\cos x+C$

**149.** The sum of the series $\frac{1}{2\cdot 3}+\frac{1}{4\cdot 5}+\frac{1}{6\cdot 7}+\ldots+\infty=$

(a) $\log(2e)$ (b) $\log(e/2)$

(c) $\log(4/e)$ (d) none of these

**150.** The differential equation representing the family of parabolas having vertex at origin and axis along positive direction of $x$-axis is

(a) $y^2-2xy\frac{dy}{dx}=0$ (b) $y^2+2xy\frac{dy}{dx}=0$

(c) $y^2-2xy\frac{d^2y}{dx^2}=0$ (d) $y^2+2xy\frac{d^2y}{dx^2}=0$

# A.M.U. (ENGINEERING)

# Solved Paper 2009

## PHYSICS

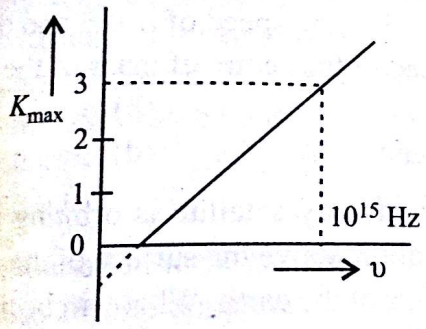
1. Consider Fraunhofer diffraction pattern obtained with a single slit at normal incidence. At the angular position of first diffraction minimum, the phase difference between the wavelets from the opposite edges of the slit is

(a) $\pi/4$ (b) $\pi/2$
(c) $\pi$ (d) $2\pi$

2. Which of the following lines of the H-atom spectrum belongs to the Balmer series?

(a) 1025 Å (b) 1218 Å
(c) 4861 Å (d) 18751 Å

3. Figure represents a graph of kinetic energy of most energetic photoelectrons, $K_{max}$ (in eV), and frequency ($\upsilon$) for a metal used as cathode in photoelectric experiment. The threshold frequency of light for the photoelectric emission from the metal is

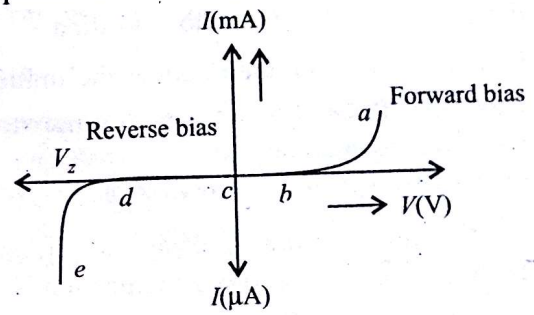



(a) $1 \times 10^{14}$ Hz (b) $1.5 \times 10^{14}$ Hz
(c) $2.1 \times 10^{14}$ Hz (d) $2.7 \times 10^{14}$ Hz

4. Using the following data
mass of hydrogen atom = 1.00783 u
mass of neutron = 1.00867 u
mass of nitrogen atom ($_7N^{14}$) = 14.00307 u
the calculated value of the binding energy of the nucleus of the nitrogen atom ($_7N^{14}$) is close to

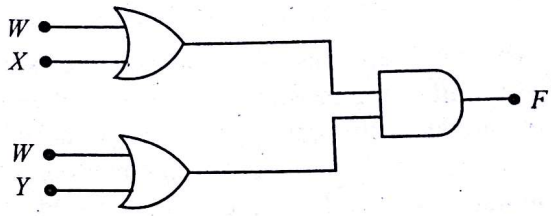
(a) 56 MeV (b) 98 MeV
(c) 104 MeV (d) 112 MeV

5. The graph given below represents the *I-V* characteristics of a zener diode. Which part of the characteristics curve is most relevant for its operation as a voltage regulator?




(a) *ab* (b) *bc* (c) *cd* (d) *de*

6. The diagram of a logic circuit is given below.




the output $F$ of the circuit is given by

(a) $W \cdot (X + Y)$ (b) $W \cdot (X \cdot Y)$
(c) $W + (X \cdot Y)$ (d) $W + (X + Y)$

7. A quantity $X$ is given by $\varepsilon_0 L \frac{\Delta V}{\Delta t}$, where $\varepsilon_0$ is the permittivity of free space, $L$ is a length, $\Delta V$ is a potential difference and $\Delta t$ is a time interval. The dimensional formula for $X$ is the same as that of

(a) electrical resistance (b) electric charge
(c) electric voltage (d) electric current

8. Displacement ($x$) of a particle is related to time ($t$) as

$$x = at + bt^2 - ct^3$$

where $a$, $b$ and $c$ are constants of the motion. The velocity of the particle when its acceleration is zero is given by

(a) $a + \frac{b^2}{c}$ (b) $a + \frac{b^2}{2c}$
(c) $a + \frac{b^2}{3c}$ (d) $a + \frac{b^2}{4c}$

9. A body is thrown vertically up with a velocity $u$. It passes three points $A$, $B$ and $C$ in its upward journey with velocities $\frac{u}{2}$, $\frac{u}{3}$ and $\frac{u}{4}$ respectively. The ratio of the separations between points $A$ and $B$ and between $B$ and $C$ *i.e.*, $\frac{AB}{BC}$ is

(a) 1 (b) 2 (c) $\frac{10}{7}$ (d) $\frac{20}{7}$

10. A body moves from a position $\vec{r}_1 = (2\hat{i} - 3\hat{j} - 4\hat{k})$ metre to a position $\vec{r}_2 = (3\hat{i} - 4\hat{j} + 5\hat{k})$ metre under the influence of a constant force $\vec{F} = (4\hat{i} + \hat{j} + 6\hat{k})$ newton. The work done by the force is

(a) 57 J (b) 58 J (c) 59 J (d) 60 J

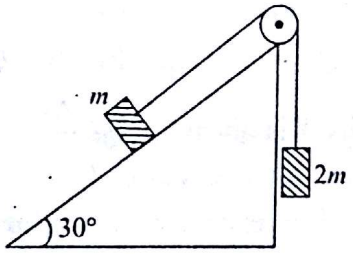
11. A particle moves in the $x$-$y$ plane under the influence of a force such that its linear momentum is

$$\vec{p}(t) = A[\hat{i}\cos(kt) - \hat{j}\sin(kt)]$$

where $A$ and $k$ are constants. The angle between the force and momentum is

(a) 0° (b) 30° (c) 45° (d) 90°

12. Two blocks of masses $m$ and $2m$ are connected by a light string passing over a frictionless pulley. As shown in the figure, the mass $m$ is placed on a smooth inclined plane of inclination 30° and $2m$ hangs vertically. If the system is released, the blocks move with an acceleration equal to




(a) $g/4$ (b) $g/3$ (c) $g/2$ (d) $g$

13. Identify the WRONG statement.

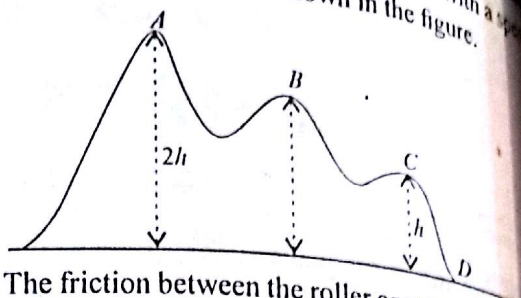
(a) The electrical potential energy of a system of two protons shall increase if the separation between the two is decreased.

(b) The electrical potential energy of a proton-electron system will increase if the separation between the two is decreased.

(c) The electrical potential energy of a proton-electron system will increase if the separation between the two is increased.

(d) The electrical potential energy of system of two electrons shall increase if the separation between the two is decreased.

14. A small roller coaster starts at point $A$ with a speed $u$ on a curved track as shown in the figure.




The friction between the roller coaster and the track is negligible and it always remains in contact with the track. The speed of roller coaster at point $D$ on the track will be

(a) $(u^2 + gh)^{\frac{1}{2}}$ (b) $(u^2 + 2gh)^{\frac{1}{2}}$

(c) $(u^2 + 4gh)^{\frac{1}{2}}$ (d) $u$

15. A particle is moving in the $x$-$y$ plane with a constant velocity along a line parallel to the $x$-axis away from the origin. The magnitude of its angular momentum about the origin

(a) is zero
(b) remains constant
(c) goes on increasing
(d) goes on decreasing

16. Two particles $A$ and $B$, initially at rest, move towards each other under a mutual force of attraction. At the instant when the speed of $A$ is $v$ and that of $B$ is $2v$, the speed of the centre of mass of the system is

(a) 0 (b) $v$
(c) $1.5v$ (d) $3v$

17. A geostationary satellite is orbiting the earth at a height of $6R$ above the surface of the earth; $R$ being the radius of the earth. What will be the time period of another satellite at a height $2.5R$ from the surface of the earth?

(a) $6\sqrt{2}$ hours (b) $6\sqrt{2.5}$ hours
(c) $6\sqrt{3}$ hours (d) 12 hours

18. $\vec{F}_{pe}$ represents electrical force on proton due to electron and $\vec{F}_{ep}$ on electron due to proton in hydrogen atom. Similarly, $\vec{F}'_{pe}$ represents gravitational force on proton due to electron and $\vec{F}'_{ep}$ the corresponding force on electron due to proton. Which of the following is NOT true?

(a) $\vec{F}_{pe} + \vec{F}_{ep} = 0$

(b) $\vec{F}'_{pe} + \vec{F}'_{ep} = 0$

(c) $\vec{F}_{pe} + \vec{F}'_{pe} + \vec{F}_{ep} + \vec{F}'_{ep} = 0$

(d) $\vec{F}_{pe} + \vec{F}'_{pe} = 0$

19. Two uniform brass rods $A$ and $B$ of length $l$ and $2l$ and radii $2r$ and $r$ respectively are heated to the same temperature. The ratio of the increase in the volume of $A$ to that of $B$ is

(a) 1 : 1 (b) 1 : 2

(c) 2 : 1 (d) 1 : 4

20. Water flows steadily through a horizontal pipe of a variable cross-section. If the pressure of water is $p$ at a point where the velocity of flow is $v$, what is the pressure at another point where the velocity of flow is $2v$, $\rho$ being the density of water?

(a) $p + 2\rho v^2$ (b) $p - 2\rho v^2$

(c) $p + \frac{3}{2}\rho v^2$ (d) $p - \frac{3}{2}\rho v^2$

21. A vessel contains oil (density 0.8 g cm$^{-3}$) over mercury (density 13.6 g cm$^{-3}$). A homogenous sphere floats with half volume immersed in mercury and the other half in oil. The density of the material of the sphere in g cm$^{-3}$ is

(a) 12.8 (b) 7.2

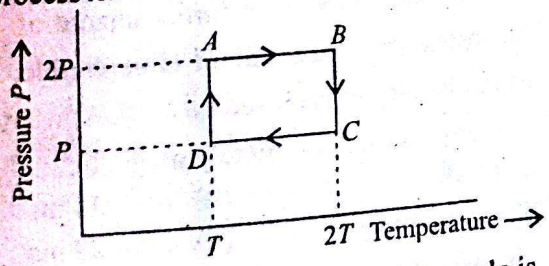
(c) 6.4 (d) 3.3

22. A steel wire of cross-sectional area $3 \times 10^{-6}$ m$^2$ can withstand a maximum strain of $10^{-3}$. Young's modulus of steel is $2 \times 10^{11}$ N/m$^2$. The maximum mass the wire can hold is (Take $g = 10$ m/s$^2$)

(a) 40 kg (b) 60 kg

(c) 80 kg (d) 100 kg

23. One mole of an ideal gas having initial volume $V$, pressure $2P$ and temperature $T$ undergoes a cyclic process $ABCDA$ as shown below.




The net work done in the complete cycle is

(a) zero (b) $\frac{1}{2} RT \ln 2$

(c) $RT \ln 2$ (d) $\frac{3}{2} RT \ln 2$

24. When two moles of oxygen is heated from 0°C to 10°C at constant volume, its internal energy changes by 420 J. What is the molar specific heat of oxygen at constant volume?

(a) 5.75 JK$^{-1}$ mol$^{-1}$ (b) 10.5 JK$^{-1}$ mol$^{-1}$

(c) 21 JK$^{-1}$ mol$^{-1}$ (d) 42 JK$^{-1}$ mol$^{-1}$

25. A vessel contains 32 gm of $O_2$ at a temperature $T$. The pressure of the gas is $P$. An identical vessel containing 4 gm of $H_2$ at a temperature $2T$ has a pressure of

(a) $8P$ (b) $4P$

(c) $P$ (d) $\frac{P}{8}$

26. A tuning fork produces 4 beats per second when sounded with a sonometer wire of vibrating length 48 cm. It produces 4 beats per second also when the vibrating length is 50 cm. What is the frequency of the tuning fork?

(a) 196 Hz (b) 284 Hz

(c) 375 Hz (d) 460 Hz

27. The displacement $y$ of a particle is given by $y = 4\cos^2\left(\frac{t}{2}\right)\sin(1000t)$. This expression may be considered to be a result of the superposition of how many simple harmonic motions?

(a) 2 (b) 3

(c) 4 (d) 5

28. A progressive wave in a medium is represented by the equation $y = 0.1\sin\left(10\pi t - \frac{5}{11}\pi x\right)$ where $y$ and $x$ are in cm and $t$ in seconds. The wavelength and velocity of the wave is

(a) $\frac{5}{11}$ m, 31.4 m/s (b) 4.4 m, 22 m/s

(c) 2.2 m, 11 m/s (d) $\frac{11}{5}$ m, 22 m/s

29. Identify the WRONG statement.

(a) In an electric field two equipotential surfaces can never intersect.

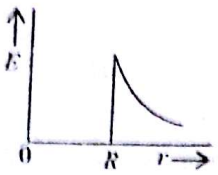
(b) A charged particle free to move in an electric field shall always move in the direction of $\vec{E}$.

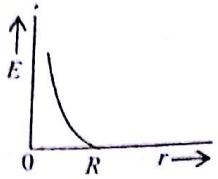
(c) Electric field at the surface of a charged conductor is always normal to the surface.

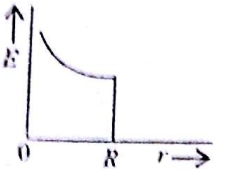
(d) The electric potential decrease along a line of force in an electric field.

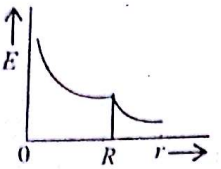
30. A metallic spherical shell of radius $R$ has a charge $-Q$ on it. A point charge $+Q$ is placed at the centre

of the shell. Which of the graphs shown below may correctly represent the variation of the electric field $E$ with distance $r$ from the centre of the shell?

(a) 


(b) 


(c) 


(d) 


**31.** Two positive point charges of 12 and 5 microcoulombs, are placed 10 cm apart in air. The work needed to bring them 4 cm closer is

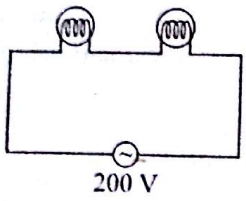
(a) 2.4 J (b) 3.6 J
(c) 4.8 J (d) 6.0 J

**32.** Two parallel plate capacitors of capacitances $C$ and $2C$ are connected in parallel and charged to a potential difference $V_0$. The battery is then disconnected and the region between the plates of the capacitor $C$ completely filled with a material of dielectric constant 2. The potential difference across the capacitors now becomes

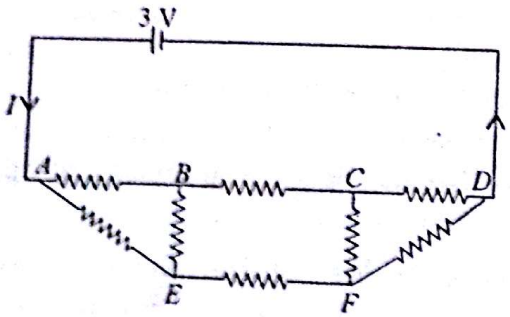
(a) $\frac{V_0}{4}$ (b) $\frac{V_0}{2}$ (c) $\frac{3V_0}{4}$ (d) $V_0$

**33.** Two bulbs marked 200 V-100 W and 200 V-200 W are joined in series and connected to a power supply of 200 V. The total power consumed by the two will be near to

(a) 35 watt
(b) 66 watt
(c) 100 watt
(d) 300 watt




**34.** Figure shows a network of eight resistors, each equal to 2 Ω, connected to a 3 V battery of negligible internal resistance. The current $I$ in the circuit is




(a) 0.25 A (b) 0.50 A
(c) 0.75 A (d) 1.0 A

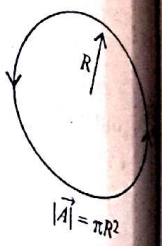
**35.** An electron is moving in an orbit of radius $R$ with time period $T$ as shown in the figure. The magnetic moment produced may be given by

(a) $\vec{m} = \frac{2\pi |e| \vec{A}}{T}$

(b) $\vec{m} = -\frac{2\pi |e| \vec{A}}{T}$

(c) $\vec{m} = \frac{|e| \vec{A}}{T}$

(d) $\vec{m} = -\frac{|e| \vec{A}}{T}$




$|e|$ represents the magnitude of the electron charge.

**36.** A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 m/s at right angles to the horizontal component of the earth's magnetic field of strength $0.30 \times 10^{-4}$ Wb/m$^2$. The instantaneous value of the induced potential gradient in the wire, from west to east, is

(a) $+ 1.5 \times 10^{-3}$ V/m
(b) $- 1.5 \times 10^{-3}$ V/m
(c) $+ 1.5 \times 10^{-4}$ V/m
(d) $- 1.5 \times 10^{-4}$ V/m

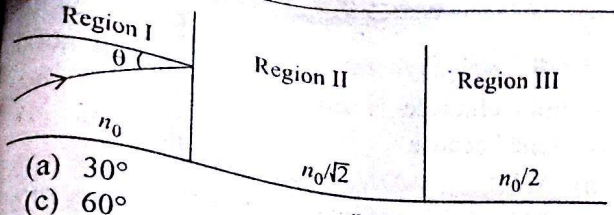
**37.** A uniformly wound solenoid coil of self-inductance $1.8 \times 10^{-4}$ H and resistance 6 Ω is broken up into two identical coils. These identical coils are then connected in parallel across a 12 V battery of negligible resistance. The time constant for the current in the circuit is

(a) $0.1 \times 10^{-4}$ s (b) $0.2 \times 10^{-1}$ s
(c) $0.3 \times 10^{-4}$ s (d) $0.4 \times 10^{-4}$ s

**38.** An $LC$ circuit contains a 20 mH inductor and a 50 μF capacitor with an initial charge of 10 mC. The resistance of the circuit is negligible. Let the instant the circuit is closed be $t = 0$. At what time is the energy stored completely magnetic?

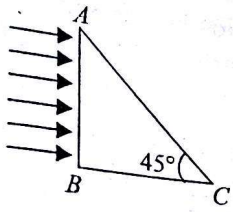
(a) $t = 0$ (b) $t = 1.54$ ms
(c) $t = 3.14$ ms (d) $t = 6.28$ ms

**39.** A beam of light is travelling from Region I to Region III (see the figure.) The refractive index in Region I, II and III are $n_0$, $\frac{n_0}{\sqrt{2}}$ and $\frac{n_0}{2}$ respectively. The angle of incidence θ for which the beam just misses entering Region III is




(a) 30° (b) 45°
(c) 60° (d) $\sin^{-1}(\sqrt{2})$

A beam of light consisting of red, green and blue colours is incident on a right-angled prism $ABC$. The refractive indices of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The colour/colours transmitted through the face $AC$ of the prism will be



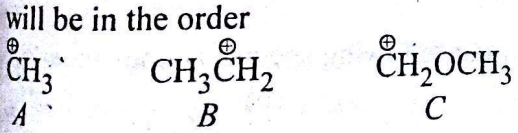

(a) red only (b) red and green
(c) all the three (d) none

## CHEMISTRY

In $XeF_6$, oxidation state and state of hybridisation of Xe, and shape of the molecule are, respectively
(a) +6, $sp^3d^3$, distorted octahedral
(b) +4, $sp^3d^2$, square planar
(c) +6, $sp^3$, pyramidal
(d) +6, $sp^3d^2$, square pyramidal

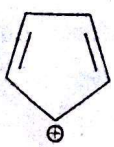
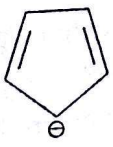
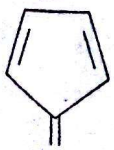
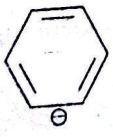
The following species will not exhibit disproportionation reaction
(a) $ClO^-$ (b) $ClO_2^-$
(c) $ClO_3^-$ (d) $ClO_4^-$

Relative stabilities of the following carbocations will be in the order




(a) $C > B > A$ (b) $C < B < A$
(c) $B > C > A$ (d) $C > A > B$

Which of the following species is aromatic ?

(a)  (b) 
(c)  (d) 

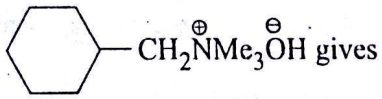
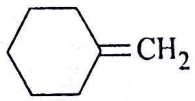
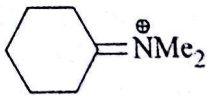
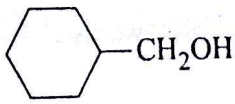
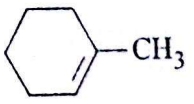
45. Benzalkonium chloride is a
(a) cationic surfactant and antiseptic
(b) anionic surfactant and soluble in most of organic solvents
(c) cationic surfactant and insoluble in most of organic solvents
(d) cationic surfactant and antimalarial

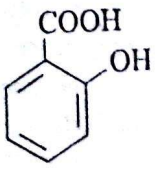
46. Which factor/s will increase the reactivity of $>C=O$ group ?
(i) presence of a group with positive inductive effect
(ii) presence of a group with negative inductive effect
(iii) presence of large alkyl group
(a) only (i) (b) only (ii)
(c) (i) and (iii) (d) (ii) and (iii)

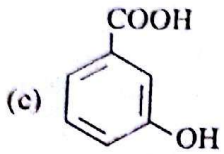
47. In the following reaction,

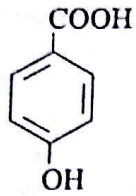
$$RCH_2CH=CH_2 + ICl \rightarrow [A]$$

Markownikoff's product [$A$] is
(a) $RCH_2\underset{Cl}{CH}-CH_2I$
(b) $RCH_2-\underset{I}{CH}-CH_2Cl$
(c) $RCH-\underset{I}{CH}=CH_2$
(d) $RCH=CH-CH_2I$

48. Thermal decomposition of  gives
(a)  (b) 
(c)  (d) 

49. Which of the following aromatic acids is most acidic ?
(a)  (b) 

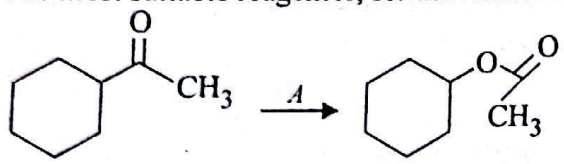
(c) 


(d) 


**50.** In the preparation of chlorobenzene from aniline, the most suitable reagent is
(a) chlorine in the presence of ultraviolet light
(b) chlorine in the presence of $AlCl_3$
(c) nitrous acid followed by heating with $Cu_2Cl_2$
(d) HCl and $Cu_2Cl_2$

**51.** Comparing basic strength of $NH_3$, $CH_3NH_2$ and $C_6H_5NH_2$ it may be concluded that
(a) basic strength remains unaffected
(b) basic strength of alkyl amines is lowest
(c) basic strength of aryl amines is lowest
(d) basic strength of $NH_3$ is highest.

**52.** The most suitable reagent *A*, for the reaction




is(are)
(a) $O_3$ (b) $H_2O_2$
(c) NaOH-$H_2O_2$
(d) *m*-chloroperbenzoic acid.

**53.** Mammals' fats are hydrolysed to release fatty acids by
(a) amylase (b) lactase
(c) lipase (d) insulin.

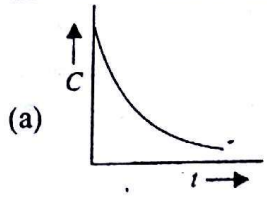
**54.** Which of the following represents *neo*-pentyl alcohol ?
(a) $CH_3CH(CH_3)CH_2CH_2OH$
(b) $(CH_3)_3C-CH_2OH$
(c) $CH_3(CH_2)_3OH$
(d) $CH_3CH_2CH(OH)C_2H_5$.

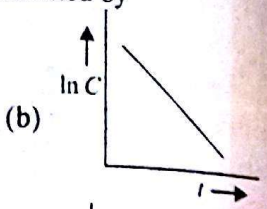
**55.** The most reactive compound towards electrophilic nitration is
(a) toluene (b) benzene
(c) benzoic acid (d) nitrobenzene.

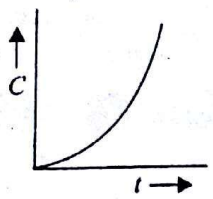
**56.** Arrange the following compounds in order of their decreasing reactivity with an electrophile, $E^{\oplus}$.
(*A*) Chlorobenzene, (*B*) 2,4-dinitrochlorobenzene, (*C*) *p*-nitrochlorobenzene
(a) $C > B > A$ (b) $B > C > A$
(c) $A > C > B$ (d) $A > B > C$.

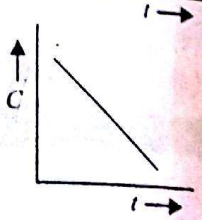
**57.** Sodium chloride is soluble in water but not in benzene because
(a) $\Delta H_{hydration} < \Delta H_{lattice\ energy\ in\ water}$ and $\Delta H_{hydration} > \Delta H_{lattice\ energy\ in\ benzene}$
(b) $\Delta H_{hydration} > \Delta H_{lattice\ energy\ in\ water}$ and $\Delta H_{hydration} < \Delta H_{lattice\ energy\ in\ benzene}$
(c) $\Delta H_{hydration} = \Delta H_{lattice\ energy\ in\ water}$ and $\Delta H_{hydration} < \Delta H_{lattice\ energy\ in\ benzene}$
(d) $\Delta H_{hydration} < \Delta H_{lattice\ energy\ in\ water}$ and $\Delta H_{hydration} = \Delta H_{lattice\ energy\ in\ benzene}$.

**58.** The plot between concentration versus time for a zero order reaction is represented by

(a) 


(b) 


(c) 


(d) 


**59.** Which of the following reaction cannot be a basis for electrochemical cell ?
(a) $H_2 + O_2 \longrightarrow H_2O$
(b) $AgNO_3 + Zn \longrightarrow Zn(NO_3)_2 + Ag$
(c) $AgNO_3 + NaCl \longrightarrow AgCl\downarrow + NaNO_3$
(d) $KMnO_4 + FeSO_4 + H_2SO_4 \longrightarrow K_2SO_4 + Fe_2(SO_4)_3 + MnSO_4 + H_2O$

**60.** The strength of 10 volume of $H_2O_2$ solution is
(a) 10 (b) 68
(c) 60.70 (d) 30.36

**61.** Which of the following species is non-linear?
(a) $ICl_2^-$ (b) $I_3^-$
(c) $N_3^-$ (d) $ClO_2^-$.

**62.** For the reaction, $2A + B = C + D$ the order of reaction is
(a) one with respect to [*B*]
(b) two with respect to [*A*]
(c) three
(d) can't be predicted.

**63.** The basic structural unit in silicates is
(a) $SiO_2$ (b) $[Si_2O_7]^{2-}$
(c) $SiO_4^{4-}$ tetrahedron (d) $[Si_2O_5]^{2-}$.

In which of the following reactions, $H_2O_2$ is acting as a reducing agent?
(a) $SO_2 + H_2O_2 \longrightarrow H_2SO_4$
(b) $2KI + H_2O_2 \longrightarrow 2KOH + I_2$
(c) $PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$
(d) $Ag_2O + H_2O_2 \longrightarrow 2Ag + H_2O + O_2$.

Which of the following oxides is most acidic in nature?
(a) BeO (b) MgO
(c) CaO (d) BaO.

The state of hybridisation of S in $SF_4$ is
(a) $sp^3$ and has a lone pair of electron
(b) $sp^2$ and has tetrahedral structure
(c) $sp^3d$ and has a trigonal bipyramidal structure
(d) $sp^3d^2$ and has an octahedral structure.

If two moles of glucose are oxidised in the body through respiration, then number of moles of ATP produced are
(a) 19 (b) 38
(c) 57 (d) 76.

The potential of the cell for the reaction $M_{(s)} + 2H^+ (1M) \longrightarrow H_{2(g)}, (1 \text{ atm}) + M^{2+} (0.1M)$ is 1.500 V. The standard reduction potential for $M^{2+}/M_{(s)}$ couple is
(a) 0.1470 V. (b) 1.470 V
(c) 14.70 V (d) none of these.

The element with atomic number 117 if discovered would be placed in
(a) noble gas family (b) alkali family
(c) alkaline earth family (d) halogen family.

van't Hoff factor of aq. $K_2SO_4$ at infinite dilution has value equal to
(a) 1 (b) 2
(c) 3 (d) between 2 and 3.

Which set of characteristics of ZnS crystal is correct?
(a) Coordination number (4 : 4) ; *ccp* ; $Zn^{++}$ ion in the alternate tetrahedral voids.
(b) Coordination number (6 : 6) ; *hcp* ; $Zn^{++}$ ion in all tetrahedral voids.
(c) Coordination number (6 : 4) ; *hcp* ; $Zn^{++}$ ion in all octahedral voids.
(d) Coordination number (4 : 4) ; *ccp* ; $Zn^{++}$ ion in all tetrahedral voids.

When a radioactive substance is kept in vacuum, the rate of its disintegration per second
(a) increases considerably
(b) is not affected
(c) suffers a slight decrease
(d) increases only if the products are gaseous.

73. An aqueous solution whose pH is zero will be called as
(a) acidic (b) basic
(c) neutral (d) amphoteric.

74. The bond angle and % of *d*-character in $SF_6$ are
(a) 120°, 20% (b) 90°, 33%
(c) 109°, 25% (d) 90°, 25%

75. Which of the following species will be diamagnetic?
(a) $[Fe(CN)_6]^{3-}$ (b) $[FeF_6]^{3-}$
(c) $[Co(C_2O_4)_3]^{3-}$ (d) $[CoF_6]^{3-}$

76. One component of a solution follows Raoult's law over the entire range $0 \le x_1 \le 1$. The second component must follow Raoult's law in the range when $x_2$ is
(a) close to zero (b) close to 1
(c) $0 \le x_2 \le 0.5$ (d) $0 \le x_2 \le 1$

77. Select wrong statement.
(a) If a very small amount of $AlCl_3$ is added to gold sol, coagulation occurs, but if a large qantity of $AlCl_3$ is added, there is no coagulation
(b) Organic ions are more strongly adsorbed on charged surfaces in comparison to inorganic ions
(c) Both emulsifier and peptising agents stabilise colloids but their actions are different
(d) Colloidal solutions are thermodynamically stable

78. An adiabatic process occurs in
(a) open system (b) closed system
(c) isolated system
(d) in all the given systems

79. Approximate relationship between dissociation constant of water ($K$) and ionic product of water ($K_w$) is
(a) $K_w = K$ (b) $K_w = 55.6 \times K$
(c) $K_w = 18 \times K$ (d) $K_w = 14 \times K$

80. For the reaction at 298 K
$A_{(g)} + B_{(g)} \longrightarrow C_{(g)}$
$\Delta E = -5$ cal and $\Delta S = -10$ cal $K^{-1}$
(a) $\Delta G = +2612$ cal (b) $\Delta G = -2612$ cal
(c) $\Delta G = +261.2$ cal (d) $\Delta G = -261.2$ cal

**81.** In an ellipse, if the lines joining focus to the extremities of the major axis form an equilateral triangle with the minor axis, then the eccentricity of the ellipse is

(a) $\frac{\sqrt{3}}{2}$ (b) $\frac{\sqrt{3}}{4}$

(c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{\frac{2}{3}}$

**82.** If the planes $x = cy + bz$,
$y = az + cx$,
$z = bx + ay$.
pass through a line, then $a^2 + b^2 + c^2 + 2abc$ is

(a) 0 (b) 1

(c) 2 (d) 3

**83.** If $\cos^{-1}x + \cos^{-1}y + \cos^{-1}z + \cos^{-1}t = 4\pi$, then the value of $x^2 + y^2 + z^2 + t^2$ is

(a) $xy + zy + zt$ (b) $1 - 2xyzt$

(c) 4 (d) 6

**84.** Four dice are rolled. The number of possible outcomes in which at least one dice shows 2 is

(a) 625 (b) 671

(c) 1023 (d) 1296

**85.** If $f(x + y) = f(x)\, f(y)$ for all $x$ and $y$ and if $f(5) = 2$ and $f'(0) = 3$, then $f'(5)$ is

(a) 0 (b) 2

(c) 5 (d) 6

**86.** The equation of the curve satisfying the differential equation $y_2(x^2 + 1) = 2xy_1$ passing through the point (0, 1) and having slope of tangent at $x = 0$ as 3 is

(a) $y = x^3 + 3x + 1$ (b) $y = x^3 - 3x + 1$

(c) $y = x^2 + 3x + 1$ (d) $y = x^2 - 3x + 1$

**87.** For the function $f(x) = \lim_{n\to\infty} \frac{\log(2+x) - x^{2n}\sin x}{1+x^{2n}}$, which of the following is true?

(a) $\lim_{x\to 1^-} f(x)$ does not exist

(b) $\lim_{x\to 1^+} f(x)$ does not exist

(c) Both limits exist and $\lim_{x\to 1^-} f(x) = \lim_{x\to 1^+} f(x)$

(d) Both limits exist and $\lim_{x\to 1^-} f(x) \neq \lim_{x\to 1^+} f(x)$

**88.** The curve $y - e^{xy} + x = 0$ has a vertical tangent at the point

(a) (1, 1) (b) (1, 0)

(c) (0, 1) (d) none of these

**89.** If a hyperbola passes through the foci of the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ and its transverse and conjugate axes coincide with the major and minor axes of the ellipse and product of their eccentricities be 1, then the equation of hyperbola is

(a) $\frac{x^2}{9} - \frac{y^2}{25} = 1$ (b) $\frac{x^2}{9} - \frac{y^2}{16} = 1$

(c) $\frac{x^2}{16} - \frac{y^2}{25} = 1$ (d) none of these

**90.** If $p$, $q$, $r$ are positive and are in A.P., then roots of the quadratic equation $px^2 + qx + r = 0$ are complex for

(a) $\left|\frac{r}{p} - 7\right| \geq 4\sqrt{3}$ (b) $\left|\frac{p}{r} - 7\right| < 4\sqrt{3}$

(c) all $p$ and $r$ (d) no $p$ and $r$

**91.** For any two sets $A$ and $B$ if $A \cap X = B \cap X = \phi$ and $A \cup X = B \cup X$ for some set $X$, then

(a) $A - B = A \cap B$ (b) $A = B$

(c) $B - A = A \cap B$ (d) none of these

**92.** If the coefficient of variation of a distribution is 45% and the mean is 12, then its standard deviation is

(a) 5.2 (b) 5.3

(c) 5.4 (d) none of these

**93.** The largest term in the expansion of $(4 + 2x)^{40}$ where $x = 1/3$ is

(a) 3rd (b) 5th

(c) 8th (d) none of these

**94.** The curve described parametrically by $x = t^2 + t$ and $y = t^2 - t$ represents

(a) a pair of straight lines

(b) an ellipse

(c) a parabola

(d) a hyperbola

**95.** Let $r$ be a relation from $R$ (set of real numbers) to $R$ defined by $r = \{(a, b) \mid a, b \in R \text{ and } a - b + \sqrt{3} \text{ is an irrational number}\}$. The relation $r$ is

(a) an equivalence relation

(b) reflexive only

(c) symmetric only (d) transitive only

**96.** The set

$C = \{z \mid z\bar{z} + a\bar{z} + \bar{a}z + b = 0, b \in R \text{ and } b < |a|^2\}$ is

(a) a finite set (b) an infinite set

(c) an empty set (d) none of these

97. For $\frac{|x-1|}{x+2} < 1$, $x$ lies in the interval
(a) $(-\infty, -2) \cup \left(-\frac{1}{2}, \infty\right]$
(b) $(-\infty, 1) \cup [2, 3]$
(c) $(-\infty, -4)$
(d) $\left[-\frac{1}{2}, 1\right]$

98. If $a, b, c > 0$ and if $abc = 1$, then the value of $a+b+c+ab+bc+ca$ lies in the interval
(a) $(-\infty, -6]$
(b) $(-6, 0)$
(c) $(0, 6)$
(d) $[6, \infty)$

99. If $P$ is a point $(x, y)$ on the line $y = -3x$ such that $P$ and the point $(3, 4)$ are on the opposite sides of the line $3x - 4y - 8 = 0$ then
(a) $x > \frac{8}{15}, y < -\frac{8}{5}$
(b) $x > \frac{8}{5}, y < -\frac{8}{15}$
(c) $x = \frac{8}{15}, y = -\frac{8}{5}$
(d) none of these

100. In a sequence of 21 terms, the first 11 terms are in A.P. with common difference 2 and the last 11 terms are in G.P. with common ratio 2. If the middle term of A.P. be equal to the middle term of the G.P., then the middle term of the entire sequence is
(a) $-\frac{10}{31}$
(b) $\frac{10}{31}$
(c) $\frac{32}{31}$
(d) $-\frac{31}{32}$

101. If $n$ is an integer and if
$$\begin{vmatrix} x^n & x^{n+2} & x^{n+3} \\ y^n & y^{n+2} & y^{n+3} \\ z^n & z^{n+2} & z^{n+3} \end{vmatrix} = (x-y)(y-z)(z-x)\left(\frac{1}{x}+\frac{1}{y}+\frac{1}{z}\right),$$
then $n$ equals
(a) 1
(b) $-1$
(c) 2
(d) none of these

102. A person draws a card from a pack of playing cards, replaces it and shuffles the pack. He continues doing this until he draws a spade. The chance that he will fail the first two times is
(a) $\frac{9}{64}$
(b) $\frac{1}{64}$
(c) $\frac{1}{16}$
(d) $\frac{9}{16}$

103. A particle is acted on by a force of 6 units in the direction $9\vec{i}+6\vec{j}+2\vec{k}$ and is displaced from the point $3\vec{i}+4\vec{j}-15\vec{k}$ to the point $7\vec{i}-6\vec{j}+8\vec{k}$. The work done is
(a) 18
(b) 15
(c) 12
(d) 9

104. A variable line through the point $\left(\frac{1}{5}, \frac{1}{5}\right)$ cuts the coordinate axes in the points $A$ and $B$. If the point $P$ divides $AB$ internally in the ratio 3 : 1, then the locus of $P$ is
(a) $3y + x = 20xy$
(b) $y + 3x = 20xy$
(c) $x + y = 20xy$
(d) $3x + 3y = 20xy$

105. The maximum value of $3\cos x + 4\sin x + 5$ is
(a) 5
(b) 6
(c) 7
(d) none of these

106. The number of positive integers satisfying the inequality ${}^{n+1}C_{n-2} - {}^{n+1}C_{n-1} \le 50$ is
(a) 9
(b) 8
(c) 7
(d) 6

107. The distance of the point on $y = x^4 + 3x^2 + 2x$ which is nearest to the line $y = 2x - 1$ is
(a) $\frac{4}{\sqrt{5}}$
(b) $\frac{3}{\sqrt{5}}$
(c) $\frac{2}{\sqrt{5}}$
(d) $\frac{1}{\sqrt{5}}$

108. Let $f : R \to R$ be a differentiable function such that $f(3) = 3$, $f'(3) = \frac{1}{2}$. Then the value of $\lim_{x \to 3} \int_3^{f(x)} \left[\frac{2t^3}{x-3}\right] dt$ is
(a) 25
(b) 26
(c) 27
(d) none of these

109. If $f(x)$ be continuous function such that the area bounded by the curve $y = f(x)$, the $x$-axis and the lines $x = a$ and $x = 0$ is $\frac{a^2}{2} + \frac{a}{2}\sin a + \frac{\pi}{2}\cos a$. Value of $f\left(\frac{\pi}{2}\right)$ is
(a) 1/2
(b) $a/2$
(c) $a^2/2$
(d) $\pi/2$

110. A curve through $(1, 0)$ and satisfying the differential equation $(1 + y^2)dx - xydy = 0$ is
(a) a circle
(b) a parabola
(c) an ellipse
(d) a hyperbola

111. If $f'(x) = g(x)$ and $g'(x) = -f(x)$ for all $x$ and $f(2) = 4 = f'(2)$, then $f^2(4) + g^2(4)$ is
(a) 8
(b) 16
(c) 32
(d) 64

**112.** Equation $\cos 2x + 7 = a(2 - \sin x)$ can have a real solution for

(a) all values of $a$ (b) $a \in [2, 6]$

(c) $a \in (-\infty, 2)$ (d) $a \in (0, \infty)$

**113.** Let $n(A) = 4$ and $n(B) = 6$. The number of one to one functions from $A$ to $B$ is

(a) 24 (b) 60

(c) 120 (d) 360

**114.** The sum of the series $1 + \frac{1}{3}\cdot\frac{1}{4} + \frac{1}{5}\cdot\frac{1}{4^2} + \frac{1}{7}\cdot\frac{1}{4^3} + \ldots\infty$ is

(a) $\log_e 1$ (b) $\log_e 2$

(c) $\log_e 3$ (d) $\log_e 4$

**115.** If $x^{2r}$ occurs in $\left(x + \frac{2}{x^2}\right)^n$, then $n - 2r$ must be of the form

(a) $3k - 1$ (b) $3k$

(c) $3k + 1$ (d) $3k + 2$

**116.** The equation of the circle which cuts orthogonally the circle $x^2 + y^2 - 6x + 4y - 3 = 0$, passes through $(3, 0)$ and touches the axis of $y$ is

(a) $x^2 + y^2 + 6x - 6y + 9 = 0$

(b) $x^2 + y^2 - 6x + 6y - 9 = 0$

(c) $x^2 + y^2 - 6x - 6y + 9 = 0$

(d) none of these

**117.** Let a relation $R$ in the set $N$ of natural numbers be defined as $(x, y) \Leftrightarrow x^2 - 4xy + 3y^2 = 0 \ \forall\ x, y \in N$. The relation $R$ is

(a) reflexive (b) symmetric

(c) transitive

(d) an equivalence relation

**118.** If $x, y, z$ are three consecutive positive integers, then

$$\log_e \sqrt{x} + \log_e \sqrt{z} + \left(\frac{1}{2xz+1}\right) + \frac{1}{3}\left(\frac{1}{2xz+1}\right)^3 + \frac{1}{5}\left(\frac{1}{2xz+1}\right)^5 + \ldots \text{ is}$$

(a) $\log_e \sqrt{y}$ (b) $\log_e y$

(c) $\log_e y^2$ (d) none of these

**119.** Solution set of $\log_e \frac{x-2}{x-3}$ is

(a) $(2, \infty)$ (b) $(-\infty, 2)$

(c) $(-\infty, \infty)$ (d) $(3, \infty)$

**120.** Let $z$ and $w$ be two complex numbers such that $|z| \le 1$, $|w| \le 1$ and $|z + iw| = |z - i\bar{w}| = 2$. Then $z$ equals

(a) 1 or $i$ (b) $i$ or $-i$

(c) 1 or $-1$ (d) $i$ or $-1$

**121.** If the system of equations $ax + ay - z = 0$

$bx - y + bz = 0$

$-x + cy + cz = 0$

has a non-trivial solution, then the value of $\frac{1}{1+a} + \frac{1}{1+b} + \frac{1}{1+c}$ is

(a) 0 (b) 1

(c) 2 (d) 3

**122.** A determinant of second order is made with the elements 0, 1. What is the probability that the determinant is non-negative ?

(a) $\frac{7}{12}$ (b) $\frac{11}{12}$

(c) $\frac{3}{16}$ (d) $\frac{15}{16}$

**123.** If $\vec{a} + \vec{b} + \vec{c} = \vec{0}$ and $|\vec{a}| = 7$, $|\vec{b}| = 3$, $|\vec{c}| = 5$ then angle between $\vec{b}$ and $\vec{c}$ is

(a) $\pi/3$ (b) $\pi/6$

(c) $\pi/4$ (d) $\pi/2$

**124.** A non-zero vector $\vec{a}$ is parallel to the line of intersection of the plane determined by vectors $\vec{i}$, $\vec{i} - \vec{j}$ and the plane determined by the vectors $\vec{i} + \vec{j}$, $\vec{i} - \vec{k}$. The angle between $\vec{a}$ and $\vec{i} + 2\vec{j} - 2\vec{k}$ is

(a) $\pi/3$ (b) $\pi/6$

(c) $\pi/4$ (d) none of these

**125.** Number of solutions of $|x - 1| = \cos x$ is

(a) 2 (b) 3

(c) 4 (d) none of these

**126.** If the slope of one of the lines represented by $ax^2 + 2hxy + by^2 = 0$ be the square of the other, then $\frac{a+b}{h} + \frac{8h^2}{ab}$ is

(a) 3 (b) 4

(c) 5 (d) 6

**127.** The value of $\left[(0.16)^{\log_{2.5}\left(\frac{1}{3} + \frac{1}{3^2} + \frac{1}{3^3} + \ldots\infty\right)}\right]^{1/2}$ is

(a) 1 (b) $-1$

(c) 0 (d) none of these

**128.** If $P_m$ stands for ${}^mP_m$, then

$1 + 1.P_1 + 2P_2 + 3P_3 + ... + n.P_n$ is equal to
(a) $n!$ (b) $(n+3)!$
(c) $(n+2)!$ (d) $(n+1)!$

If $y = f\left[\frac{3x+\pi}{5x+4}\right]$ and $f'(x) = \tan^2 x$, then $\frac{dy}{dx}$ at $x = 0$ is
(a) $\frac{12+5\pi}{16}$ (b) $\frac{12-5\pi}{16}$
(c) $\frac{5+12\pi}{16}$ (d) $\frac{5-12\pi}{16}$

Limit of $\int_0^x \left[\frac{1}{\sqrt{1+t^2}} - \frac{1}{1+t}\right] dt$ as $x \to \infty$ is
(a) $\log_2 e$ (b) $\log_e 2$
(c) $\log_2\left(\frac{1}{e}\right)$ (d) $\log_{\frac{1}{e}} 2$

The maximum value of $z = 10x + 6y$ subject to constraints $x \geq 0, y \geq 0, x + y \leq 12, 2x + y \leq 20$ is
(a) 72 (b) 80
(c) 104 (d) 110

If $2f(x^2) + 3f\left(\frac{1}{x^2}\right) = x^2 - 1$ for all $x \in R - \{0\}$ then $f(x^4)$ is
(a) $\frac{(1-x^4)(2x^4+3)}{5x^4}$ (b) $\frac{(1+x^4)(2x^4-3)}{5x^4}$
(c) $\frac{(1-x^4)(2x^4-3)}{5x^4}$ (d) none of these

If $\int (\log x)^2 dx = x[f(x)]^2 + Ax[f(x)-1] + C$, then
(a) $f(x) = \log x, A = 2$ (b) $f(x) = \log x, A = -2$
(c) $f(x) = -\log x, A = 2$
(d) $f(x) = -\log x, A = -2$

Let $a$ and $b$ be two integers such that $10a + b = 5$ and $P(x) = x + ax + b$. The integer $n$ such that $P(10).P(11) = P(n)$ is
(a) 15 (b) 65
(c) 115 (d) 165

The mean age of a combined group of men and women is 25 years. If the mean age of the group of men is 26 and that of the group of women is 21, then the percentage of men and women in the group is
(a) 46, 60 (b) 80, 20
(c) 20, 80 (d) 60, 40

A variable chord is drawn through the origin to the circle $x^2 + y^2 - 2ax = 0$. The locus of centre of circle drawn on this chord as diameter is
(a) $x^2 + y^2 + ax = 0$ (b) $x^2 + y^2 + ay = 0$
(c) $x^2 + y^2 - ax = 0$ (d) $x^2 + y^2 - ay = 0$

**137.** Let $R$ and $C$ denote the set of real numbers and complex numbers respectively. The function $f: C \to R$ defined by $f(z) = |z|$ is
(a) one to one (b) onto
(c) bijective
(d) neither one to one nor onto

**138.** If $x$ is complex, the expression $\frac{x^2+34x-71}{x^2+2x-7}$ takes all which lie in the interval $(a,b)$ where
(a) $a = -1$ $b = 1$ (b) $a = 1$ $b = -1$
(c) $a = 5$ $b = 9$ (d) $a = 9$ $b = 5$

**139.** If $a_1, a_2, a_3, ....., a_n$ be an A.P. of non-zero terms, then $\frac{1}{a_1a_2} + \frac{1}{a_2a_3} + ..... + \frac{1}{a_{n-1}a_n}$ is equal to
(a) $\frac{n-1}{a_1a_n}$ (b) $\frac{n}{a_1a_n}$
(c) $\frac{n+1}{a_1a_n}$ (d) none of these

**140.** If $B$ is an invertible matrix and $A$ is a matrix, then
(a) rank $(BA)$ = rank $(A)$
(b) rank $(BA)$ = rank $(B)$
(c) rank $(BA)$ > rank $(A)$
(d) rank $(BA)$ > rank $(B)$

**141.** $A$ and $B$ are two events such that $P(A) = 0.3$ and $P(A \cup B) = 0.8$. If $A$ and $B$ be independent events, then $P(B)$ is
(a) $\frac{3}{7}$ (b) $\frac{5}{7}$
(c) $\frac{6}{7}$ (d) none of these

**142.** If $\vec{u}_1$ and $\vec{u}_2$ be vectors of unit length and $\theta$ be the angle between them, then $\frac{1}{2}|\vec{u}_2 - \vec{u}_1|$ is
(a) $\sin\theta$ (b) $\sin\frac{\theta}{2}$
(c) $\cos\theta$ (d) $\cos\frac{\theta}{2}$

**143.** The image of the point (1, 2, 3) by the plane $x + y + z + 3 = 0$ is
(a) (–5, 4, –3) (b) (–5, – 4, – 3)
(c) (5, – 4, 3) (d) (5, 4, 3)

**144.** If $P = \sin^2\theta + \cos^4\theta$, then for all $\theta$

(a) $1 \le P \le 2$ (b) $\frac{3}{4} \le P \le 1$

(c) $\frac{1}{2} \le P \le \frac{3}{4}$ (d) $\frac{1}{4} \le P \le \frac{1}{2}$

**145.** The straight lines $L_1$, $L_2$, $L_3$ are parallel and lie in the same plane. A total of $m$ points are taken on $L_1$, $n$ points on $L_2$, $k$ points on $L_3$. The maximum number of triangles formed with vertices at these points are

(a) ${}^{m+n+k}C_3$

(b) ${}^{m+n+k}C_3 - {}^{m}C_3 - {}^{n}C_3$

(c) ${}^{m+n+k}C_3 + {}^{m}C_3 + {}^{n}C_3$

(d) none of these

**146.** If $y = \cos^{-1}(\cos x)$, then $\frac{dy}{dx}$ is

(a) 1 in the whole plane

(b) $-1$ in the whole plane

(c) 1 in the 2nd and 3rd quadrants of the plane

(d) $-1$ in the 3rd and 4th quadrants of the plane

**147.** The differential equation representing the family of curves $y^2 = 2c(x + c^{2/3})$, where $c$ is a positive parameter, is of

(a) order 3, degree 3 (b) order 2 degree 4

(c) order 1, degree 5 (d) order 5, degree 1

**148.** The range of function $f(x) = {}^{7-x}P_{x-3}$ is

(a) $\{1, 2, 3, 4\}$ (b) $\{3, 4, 5, 6\}$

(c) $\{0, 1, 2, 3, 4, 5\}$ (d) $\{1, 2, 3\}$

**149.** If $I = \left| \int_2^5 \frac{\sin x dx}{(1+x^2)} \right|$ then

(a) $I \ge \frac{1}{4}$

(b) $I$ lies in the interval $\left(\frac{1}{4}, \frac{1}{5}\right)$

(c) $I$ lies in the interval $\left(\frac{1}{5}, \frac{1}{6}\right)$

(d) $I \le \frac{1}{6}$

**150.** If $ax^2 + bx + c = 0$ and $2x^2 + 3x + 4 = 0$ have a common root where $a, b, c, \in N$ (set of natural numbers), the least value of $a + b + c$ is

(a) 13 (b) 11

(c) 7 (d) 9

# A.M.U. (ENGINEERING)

# Solved Paper 2008

## PHYSICS

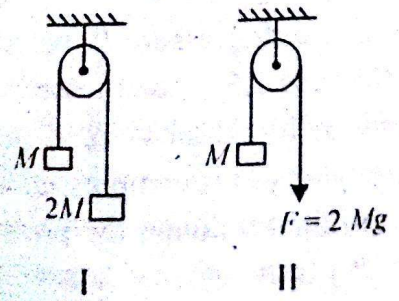
1. If $E$, $m$, $l$ and $G$ denote energy, mass, angular momentum and gravitational constant respectively, the quantity $(El^2/m^5G^2)$ has the dimensions of
(a) angle (b) length
(c) mass (d) time.

2. The vectors $\vec{A}=(\hat{i}+\hat{j}-2\hat{k})$, $\vec{B}=(2\hat{i}+2\hat{j}-\hat{k})$ and $\vec{C}=(-\hat{i}+\alpha\hat{j}+\hat{k})$ are coplanar when the constant $\alpha$ is equal to
(a) 1/3 (b) 1
(c) 3 (d) none of these.

3. The displacement ($x$) of a particle is related to time $t$ as $x=at+bt^2-ct^3$, where $a$, $b$ and $c$ are constants of motion. The velocity of the particle when its acceleration is zero is given by
(a) $a+\frac{b^2}{c}$ (b) $a+\frac{b^2}{2c}$
(c) $a+\frac{b^2}{3c}$ (d) $a+\frac{b^2}{4c}$

4. Which one of the following statements regarding Newton's first law of motion is incorrect?
(a) It is an independent statement.
(b) It defines an inertial frame of reference.
(c) It was first enunciated by Galileo.
(d) It is a special case of Newton's second law.

5. A pulley has two different arrangements I and II as shown.




I II

Neglecting the masses of the rope and the pulley, the ratio of the acceleration of the mass $M$ in the arrangement I to that in the arrangement II is
(a) 3 : 1 (b) 2 : 1
(c) 1 : 2 (d) 1 : 3.

6. A bullet of mass $m$, moving with a speed of $u$ penetrates a block of wood of thickness $x$ and emerges with a speed $v$. The force of resistance offered by the wood is given by
(a) $\frac{m}{x}(u^2-v^2)$ (b) $\frac{m}{2x}(u^2-v^2)$
(c) $\frac{m}{2x}(v^2-u^2)$ (d) $\frac{m}{x}(v^2-u^2)$

7. The displacement $x$ of a particle of mass 1.0 kg, moving in one dimension, under the action of a constant force is related to time $t$ by the equation $t=\sqrt{x}-3$ (in S.I. units). The work done by the force in the first 10 seconds, in Joules, is
(a) 640 J (b) 676 J
(c) 320 J (d) none of these.

8. Two particles of masses $m_1$ and $m_2$ $(m_1 > m_2)$, initially at rest, move towards each other under an inverse square law force of attraction. Pick out the correct statement about the centre of mass (CM) of the system.
(a) The CM moves towards $m_1$.
(b) The CM moves towards $m_2$.
(c) The CM remains at rest.
(d) The motion of CM is accelerated.

9. Choose the correct statement/statements from the following.
S1: The angular momentum of a body is always constant.
S2: The directions of the angular momentum vector and the angular velocity vector are always same.
S3: The direction of torque vector is always along the direction of change in angular momentum vector.
(a) S1 and S2 (b) S2 and S3

(c) S1 only (d) S3 only.

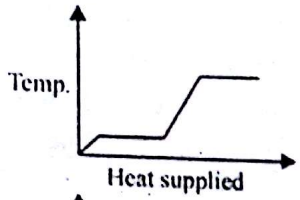
**10.** If the gravitational force between $A$ and $B$ (masses $2m$ and $3m$) respectively and separated by a distance $2d$) is 1 unit, the force between $C$ and $D$ (of masses $3m$ and $4m$ respectively with separation $3d$) will be between

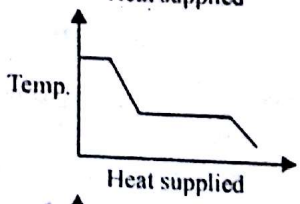
(a) 0 and 0.5 (b) 0.5 and 1.0
(c) 1.0 and 1.5 (d) 1.5 and 2.0

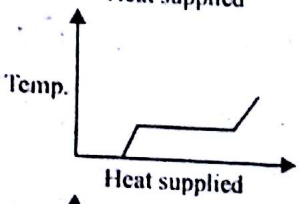
**11.** A planet (with $g_P$ as the acceleration due to gravity on its surface) has its mass and radius that is twice that of earth (having $g_E$ as the acceleration due to gravity on its surface). The ratio $g_E/g_P$ is equal to

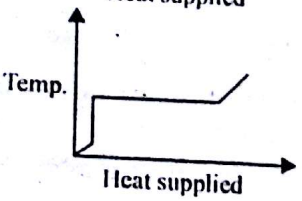
(a) 1/2 (b) $\sqrt{2}$
(c) 2 (d) 4.

**12.** A block of ice at −10°C is slowly heated and converted to steam at 100°C. Which of the following curves represents the phenomenon qualitatively?

(a)



(b)


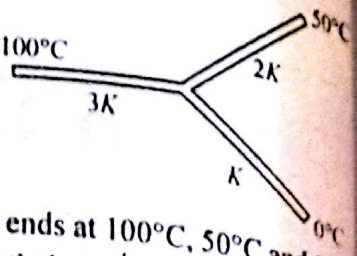

(c)



(d)



**13.** A thin copper wire of length $L$ increases its length by 1% when heated from temperature $T_1$ to $T_2$. What is the percentage change in area when a thin copper plate having dimensions $2L \times L$ is heated from $T_1$ to $T_2$?

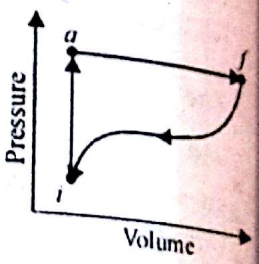
(a) 0.5% (b) 1%
(c) 2% (d) 4%.

**14.** Three rods of the same dimensions have thermal conductivities $3K$, $2K$ and $K$. They are arranged as shown, with their ends at 100°C, 50°C and 0°C. The temperature of their junction is




(a) 75°C (b) $\frac{200}{3}$°C
(c) $\frac{100}{3}$°C (d) 25°C.

**15.** When a system is taken from state $i$ to state $f$ along path $iaf$ in the figure, the heat absorbed $Q = 50$ cal and the work done $W = 20$ cal. If $W = -13$ cal for the return path $fi$, $Q$ for this path is




(a) 17 cal (b) −17 cal
(c) 43 cal (d) −43 cal.

**16.** Starting with the same initial conditions, an ideal gas expands from volume $V_1$ to $V_2$ in three different ways. The work done by the gas is $W_1$ if the process is purely isothermal, $W_2$ if purely isobaric and $W_3$ if purely adiabatic. Then

(a) $W_1 > W_2 > W_3$ (b) $W_2 > W_1 > W_3$
(c) $W_2 > W_3 > W_1$ (d) $W_1 > W_3 > W_2$

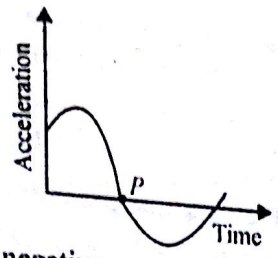
**17.** The volume of a gas and the number of molecules within that volume for three situations are (1) $2V_0$ and $N_0$ (2) $3V_0$ and $3N_0$ (3) $3V_0$ and $9N_0$. The situations are ranked according to the mean free path (greatest first) as

(a) (1), (2), (3) (b) (3), (2), (1)
(c) (2), (3), (1) (d) (2), (1), (3)

**18.** An ideal gas with pressure $P$, volume $V$ and ratio of specific heats 1.5 is compressed isothermally to one fourth of its initial volume and pressure $P_1$. When the same gas is compressed adiabatically to half of its initial volume, the pressure is $P_2$. The ratio $(P_1/P_2)$ is

(a) 1.6 (b) 1.5
(c) 1.4 (d) 0.5

The figure shows the plot of acceleration with time for a particle executing simple harmonic motion. The particle velocity at $P$ is




(a) positive (b) negative
(c) zero (d) not defined.

The equation $y = a\cos^2(2\pi nt - 2\pi x/\lambda)$ represents a wave with

(a) amplitude $a$, frequency $n$ and wavelength $\lambda$
(b) amplitude $a$, frequency $2n$ and wavelength $2\lambda$
(c) amplitude $a/2$, frequency $2n$ and wavelength $\lambda$
(d) amplitude $a/2$, frequency $2n$ and wavelength $\lambda/2$.

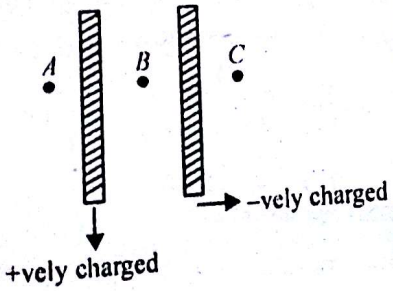
The radii of two concentric spherical conducting shells are $r_1$ and $r_2$ ($> r_1$). The charge on the outer shell is $q$. What will be the charge on the inner shell which is connected to the earth?

(a) $-\frac{r_1}{r_2}q$ (b) $-\frac{r_2}{r_1}q$
(c) $-q$ (d) zero.

Two identical charges are placed at the two corners of an equilateral triangle. The potential energy of the system is $U$. The work done in bringing an identical charge from infinity to the third vertex is

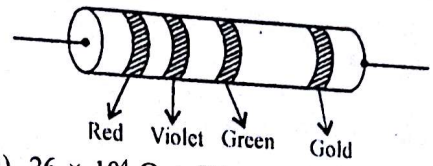
(a) $U$ (b) $2U$
(c) $3U$ (d) zero.

Two thin flat metal plates having large surface area are charged separately to acquire charge densitites $+\sigma$ and $-\sigma$. The plates are then brought near to each other and held parallel to each other. If $E_A$, $E_B$ and $E_C$ denote the electric fields at the points $A$, $B$ and $C$ respectively, then which of the following will be true?



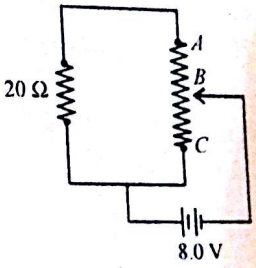

(a) $E_A = E_C = \frac{\sigma}{\varepsilon_0}$ (b) $E_A = E_B = E_C = \frac{\sigma}{\varepsilon_0}$
(c) $E_A = E_C = 0,\ E_B = \frac{\sigma}{\varepsilon_0}$
(d) $E_A = E_C = 0,\ E_B = \frac{2\sigma}{\varepsilon_0}$

24. The resistance of a resistor with the following colour code is equal to




(a) $26 \times 10^4\ \Omega \pm 5\%$
(b) $25 \times 10^4\ \Omega \pm 10\%$
(c) $35 \times 10^5\ \Omega \pm 5\%$
(d) $27 \times 10^5\ \Omega \pm 5\%$.

25. The variable point $B$ of a 80 Ω rheostat $AC$ has been set exactly in the midway such that the resistance of the part $AB$ is equal to the resistance of the part $BC$. The rheostat is connected with a resistance of 20 Ω and a battery of 8.0 V as shown in figure. The current supplied by the battery is




(a) $\frac{1}{2}$ A (b) $\frac{1}{5}$ A
(c) $\frac{2}{15}$ A (d) $\frac{1}{3}$ A.

26. A electron moves with a speed of $2 \times 10^5$ m/s along the positive $x$-direction in a magnetic field $\vec{B} = (\hat{i} - 4\hat{j} - 3\hat{k})$ tesla. The magnitude of the force (in Newton) experienced by the electron is

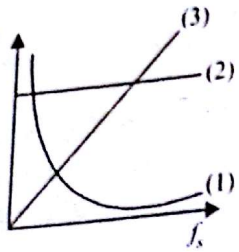
(a) $1.18 \times 10^{-13}$ (b) $1.28 \times 10^{-13}$
(c) $1.6 \times 10^{-13}$ (d) $1.72 \times 10^{-13}$.

27. A long straight wire of radius $R$ carries current $i$. The magnetic field inside the wire at distance $r$ from its centre is expressed as

(a) $\left(\frac{\mu_0 i}{\pi R^2}\right) \cdot r$ (b) $\left(\frac{2\mu_0 i}{\pi R^2}\right) \cdot r$
(c) $\left(\frac{\mu_0 i}{2\pi R^2}\right) \cdot r$ (d) $\left(\frac{\mu_0 i}{2\pi R}\right) \cdot r$

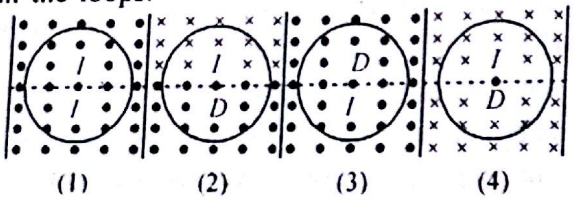
28. An alternating emf source with a certain emf amplitude is connected in turn, to a resistor, a

capacitor and then an inductor. Once connected to one of the elements, the source frequency $f_s$ is varied and the amplitude $I$ of the resulting current through the element is measured and plotted, as shown in the figure. Which of the following gives the identification of the respective curves?




(a) (1) – capacitive, (2) resistive, (3) inductive
(b) (1) – resistive, (2) capacitive, (2) inductive
(c) (1) – inductive, (2) resistive, (3) capacitive
(d) (1) – resistive, (2) inductive, (3) capacitive.

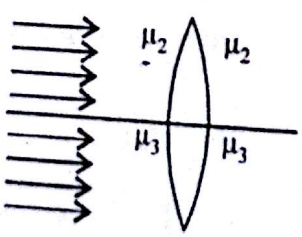
**29.** Four identical circular conducting loops are placed in uniform magnetic fields that are either increasing ($I$) or decreasing ($D$) in magnitude at identical rates. Arrange the magnitude of the currents induced ($i$) in the loops.




(a) $i_1 > i_2 > i_3 > i_4$ (b) $i_1 = i_2 > i_3 > i_4$
(c) $i_1 > i_2 > i_3 = i_4$ (d) $i_1 = i_2 > i_3 = i_4$.

**30.** Consider the following types of electromagnetic waves:
(1) radio waves, (2) green light, (3) gamma rays, (4) microwaves and (5) X-rays. Which of the following sequences arranges these in the correct order of increasing wavelengths?
(a) (1) (5) (3) (4) (2)
(b) (3) (5) (4) (2) (1)
(c) (5) (3) (2) (4) (1)
(d) (3) (5) (2) (4) (1).

**31.** A double convex lens, made of a material of refractive index $\mu_1$, is placed inside two liquids of refractive indices $\mu_2$ and $\mu_3$ as shown. $\mu_2 > \mu_1 > \mu_3$. A wide parallel beam of light is incident on the lens from the left. The lens will give rise to

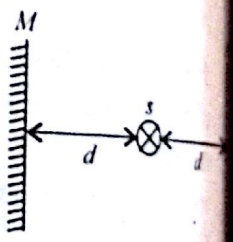



(a) a single convergent beam
(b) two different convergent beams
(c) two different divergent beams
(d) a convergent and a divergent beam.

**32.** In a single slit diffraction experiment, the slit is made double its original width. The central maximum of the diffraction pattern become
(a) narrower and fainter
(b) narrower and brighter
(c) broader and fainter
(d) broader and brighter.

**33.** A plastic sheet (refractive index = 1.6) covers one slit of a double slit arrangement for the Young's experiment. When the double slit is illuminated by monochromatic light (wavelength = 5867 Å), the centre of the screen appears dark rather than bright. The minimum thickness of the plastic sheet to be used for this to happen is
(a) 3300 Å (b) 6600 Å
(c) 2062 Å (d) 5500 Å.

**34.** The intensity of a point source of light $S$, placed at a distance $d$ in front of a screen $A$, is $I_0$ at the centre of the screen. Find the light intensity at the center of the screen if a completely reflecting plane mirror $M$ is placed at a distance $d$ behind the source, as shown in figure.




(a) $\frac{27I_0}{4\pi^2 \times 9}$ (b) $\frac{25I_0}{4\pi^2 \times 9}$
(c) $\frac{17I_0}{4\pi^2 \times 9}$ (d) $\frac{10I_0}{4\pi^2 \times 9}$

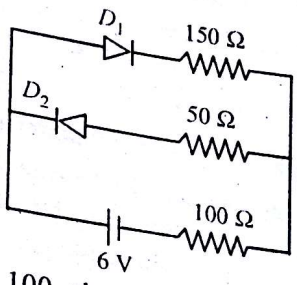
**35.** Which of the following can exhibit diffraction phenomenon?
(a) photons (b) electrons
(c) neutrons (d) all of these.

**36.** Radiation from a hydrogen discharge tube is incident on the cathode of a photocell. The work function of the cathode surface is 3.2 eV. To reduce the photocurrent to zero, the voltage (in volts)

the anode relative to the cathode must be made
(a) −0.2 (b) +3.2
(c) −10.4 (d) −13.6

37. The ratio of the radius of the nucleus of mass number 216 to the radius of the nucleus of mass number 64 is approximately
(a) 1.0 (b) 1.2
(c) 1.5 (d) 1.8

38. The circuit shown below contains two diodes $D_1$ and $D_2$ each with a forward resistance of 50 ohms and with infinite backward resistance.




The current through the 100 ohm resistance (in amp) is
(a) 0 (b) 0.02
(c) 0.03 (d) 0.04

39. The charge carriers in extrinsic semiconductors are made available for the conduction of current by
(a) exciting valence electrons from the valence band to the conduction band
(b) breaking bonds with impurity atoms
(c) their inherent charged nature achieved by doping
(d) ionizing the atoms of the doped impurity, to produce carriers.

40. For an amplitude modulated wave, the maximum amplitude is found to be 10 V while the minimum amplitude is found to be 2 V. The modulus index is
(a) 1/3 (b) 2/3
(c) 1 (d) none of these.

## CHEMISTRY

41. In the molecules NO, CO, $O_2^-$ and $O_2$, the correct sequence of bond order is
(a) NO = CO > $O_2^-$ > $O_2$
(b) $O_2^-$ > $O_2$ > NO > CO
(c) $O_2$ > $O_2^-$ > NO > CO
(d) CO > NO > $O_2$ > $O_2^-$.

42. Hybridisations of nitrogen in the ionic species $NO_2^+$, $NO_3^-$ and $NH_4^+$ respectively are
(a) $sp^2$, $sp^3$ and $sp^2$ (b) $sp$, $sp^2$ and $sp^3$
(c) $sp^2$, $sp$ and $sp^3$ (d) $sp^2$, $sp^3$ and $sp^3$.

43. The IUPAC name of $Hg[Co(NCS)_4]$ is
(a) mercury cobalt(II)tetrasulphocyanide
(b) mercury tetrathiocyanatocobalt(II)
(c) mercury tetrathiocyanato-N-cobaltate(II)
(d) tetrathiocyanatocobalt(II) mercurate.

44. Which of the following metal sulphide CuS, HgS, CdS and PbS may not dissolve in hot dil. $HNO_3$
(a) CuS (b) HgS
(c) CdS (d) PbS.

45. The number of lone pairs of electrons possessed by the central atom in the anionic species $I_3^-$ is
(a) one (b) two
(c) three (d) all are bond pairs.

46. Which of the following conjugate bases will be the most acidic in nature?
(a) $NO_3^-$ (b) $Cl^-$
(c) $HSO_4^-$ (d) $SO_4^{2-}$.

47. Lanthanide contraction is the characteristic property of 4*f*-block elements which is associated with the increase in
(a) atomic radius
(b) shielding by 4*f* electrons
(c) size of 4*f* orbitals
(d) effective nuclear charge.

48. KF combines with HF to form $KHF_2$. The molecule contains the species
(a) $K^+$, $F^-$ and $H^+$ (b) $K^+$, $F^-$ and HF
(c) $K^+$ and $HF_2^-$ (d) $[KHF]^+$ and $F^-$.

49. Which of the following molecules will exhibit zero dipole moment?
(a) $CH_2Cl_2$ (b) $ClO_2$
(c) $NH_3$ (d) $BF_3$.

50. Which of the following halides is least stable and has a doubtful existence?
(a) $Cl_4$ (b) $GeI_4$
(c) $SnI_4$ (d) $PbI_4$.

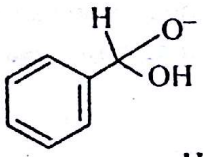
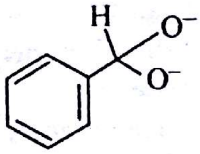
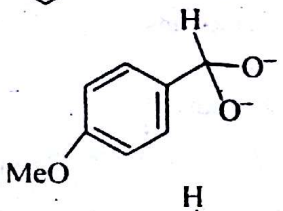
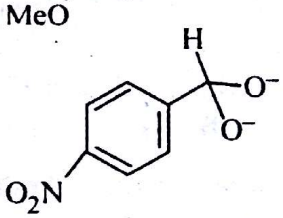
51. In the structure of $P_4O_{10}$ molecule the number of σ (sigma) and π (pi) bonds are
(a) 12 sigma and 4 pi

(b) 16 sigma and 4 pi
(c) 10 sigma and 4 pi
(d) 8 sigma and 4 pi.

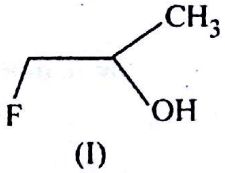
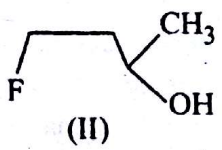
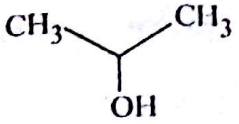
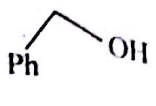
**52.** The compound formed when an excess of KCN is added to the aqueous solution of $CuSO_4$
(a) $[Cu(CN)_2]$ (b) $K_2[Cu(CN)_4]$
(c) $K[Cu(CN)_2]$ (d) $K_3[Cu(CN)_4]$.

**53.** Hybridization of the central atom in $PF_5$ involves the mixing of atomic orbitals
(a) $d_{z^2}$, $s$, $p_x$, $p_y$, $p_z$
(b) $s$, $p_x$, $p_y$, $p_z$, $d_{z^2}$
(c) $d_{x^2-y^2}$, $s$, $p_x$, $p_y$, $p_z$
(d) $s$, $p_x$, $p_y$, $p_z$, $d_{x^2-y^2}$

**54.** During debromination of *meso*-dibromobutane, the major product formed is
(a) *n*-butane (b) 1-butane
(c) *cis*-2-butene (d) *trans*-2-butene.

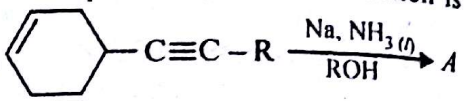
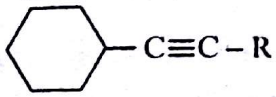
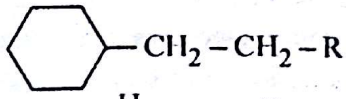
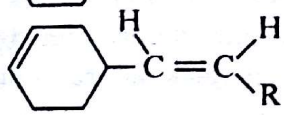
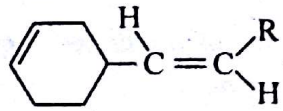
**55.** In the Cannizzaro reaction the intermediate that will be the best hydride donor is
(a) 
(b) 
(c) 
(d) 

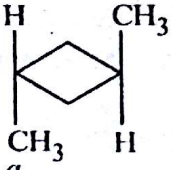
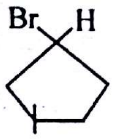
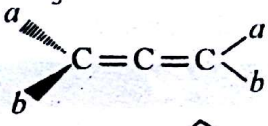
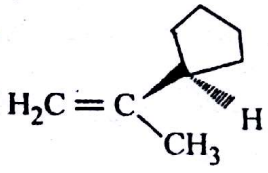
**56.** Among the given compounds, the most susceptible to nucleophilic attack at the carbonyl C is
(a) $CH_3COCl$ (b) $CH_3CHO$
(c) $CH_3COOCH_3$ (d) $CH_3COOCOCH_3$.

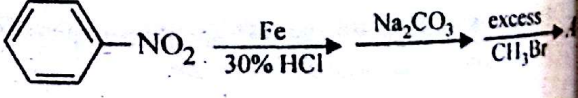
**57.** The order of reactivity of the following alcohols towards HCl would be

(I)

(II)

(III)

(IV)
(a) I > II > III > IV (b) I > III > II > IV
(c) IV > III > II > I (d) IV > III > I > II.

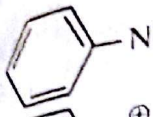
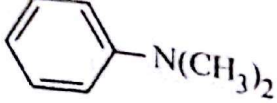
**58.** Among the following 1-butene (I), *cis*-2-butene (II), *trans*-2-butene (III), the decreasing order of stability is
(a) II > I > III (b) III > II > I
(c) II > III > I (d) I > III > II.

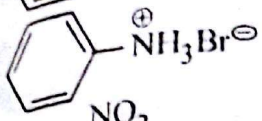
**59.** The IUPAC name of $CH_3CONHBr$ is
(a) 1-keto-N-bromoethanamine
(b) bromo acetamide (c) N-bromoethanamide
(d) N-bromo-1-aminoethanal.

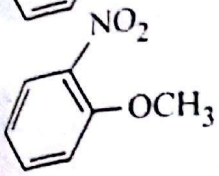
**60.** The main product (*A*) of the reaction is

(a) 
(b) 
(c) 
(d) 

**61.** Which of the following is a chiral molecule?
(a) 
(b) 
(c) 
(d) 

**62.** End product (*A*) of the following sequence of reaction is


(a)  (b) 

(c) 

(d) 

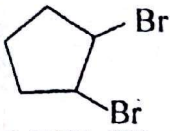
Which of the following is not an optically active amino acid ?

(a) lysine (b) leucine
(c) methionine (d) glycine.

A compound of the formula $C_4H_{10}O$ reacts with sodium and undergoes oxidation to give a carbonyl compound which does not reduce Tollen's reagent, the original compound is

(a) diethyl ether (b) *n*-butyl alcohol
(c) *sec*-butyl alcohol (d) *iso*-butyl alcohol.

Which of the following will form geometrical isomers?

(a)  (b) $H_3CCH_2CH = NOH$

(c) $O_2NCH_2CH = CHCH_3$

(d) all of the above.

The end product ($Y$) in the reaction sequence

$$CH_3CONH_2 \xrightarrow[\Delta]{P_2O_5} X \xrightarrow{Sn/HCl} Y, \text{ is}$$

(a) ethane nitrile (b) acetic acid
(c) ethanamine (d) chloroethane.

The second order Bragg diffraction of X-rays with wavelength of 2.00 Å from a set of parallel planes in a crystal occurs at 60°. The distance between the scattering planes in the crystal is

(a) 5.75 Å (b) 2.00 Å
(c) 4.00 Å (d) 2.30 Å.

For a cell reaction involving two electron change, the standard EMF of the cell is 0.295 V at 25°C. The equilibrium constant of the reaction at 25°C will be

(a) $29.5 \times 10^{-2}$ (b) 10
(c) $1 \times 10^{10}$ (d) $2.95 \times 10^{-10}$.

A 0.5 M NaOH solution offers a resistance of 31.6 ohm in a conductivity cell at room temperature. What shall be the approximate molar conductance of this NaOH solution if cell constant of the cell is 0.367 $cm^{-1}$?

(a) 234 S $cm^2$ $mol^{-1}$
(b) 23.2 S $cm^2$ $mol^{-1}$
(c) 4645 S $cm^2$ $mol^{-1}$
(d) 5464 S $cm^2$ $mol^{-1}$.

The precipitate of calcium fluoride ($K_{sp} = 1.7 \times 10^{-10}$) is obtained when equal volume of the following are mixed.

(a) 0.001 M $Ca^{2+}$ + 0.00001 M $F^-$
(b) $10^{-5}$ M $Ca^{2+}$ + $10^{-3}$ M $F^-$
(c) $10^{-2}$ M $Ca^{2+}$ + $10^{-3}$ M $F^-$
(d) $10^{-4}$ M $Ca^{2+}$ + $10^{-4}$ M $F^-$.

The standard reduction potential of $Cu^{2+}/Cu$ and $Cu^{2+}/Cu^+$ are 0.337 V and 0.153 V respectively. The standard electrode potential of $Cu^+/Cu$ half cell is

(a) 0.184 V (b) 0.827 V
(c) 0.521 V (d) 0.490 V.

If $N_0$ is the initial number of nuclei, number of nuclei remaining undecayed at the end of $n^{th}$ half-life is

(a) $2^{-n} N_0$ (b) $2^n N_0$
(c) $n^{-2} N_0$ (d) $n^2 N_0$.

The difference between heats of formation at constant pressure and constant volume for the reaction

$$2C_6H_{6(l)} + 15O_{2(g)} \rightarrow 12CO_{2(g)} + 6H_2O_{(l)}$$

at 25°C in kJ is

(a) –7.43 (b) +3.72
(c) –3.72 (d) +7.43.

The order of root mean square velocity of $H_2$, $N_2$, $O_2$ and HBr at NTP is

(a) $H_2 > O_2 > N_2 > HBr$
(b) $HBr > H_2 > O_2 > N_2$
(c) $H_2 > N_2 > O_2 > HBr$
(d) $N_2 > O_2 > H_2 > HBr$.

Which of the following solution has pH = 7?

(a) $NaNO_2 + H_2O$ (b) $Na_2CO_3 + H_2O$
(c) $NaCl + H_2O$ (d) $CH_3COONa + H_2O$.

For the reaction $C + D \rightarrow$ product
If the initial concentration of $C$ and $D$ is doubled,

the reaction rate is increased by a factor of 32. If the concentration of $D$ is doubled keeping that of $C$ fixed, the reaction rate becomes 4 times. The rate law will be

(a) $K[C]^3[D]^3$ (b) $K[C]^2[D]^3$
(c) $K[C]^3[D]^2$ (d) $K[C]^2[D]^2$.

77. For equilibrium $PCl_{5\,(g)} \rightleftharpoons PCl_{3\,(g)} + Cl_{2\,(g)}$ $K_p$ and $K_c$ will hold the following relationship.

(a) $K_p = K_c$ (b) $K_p = K_c(RT)$
(c) $K_p = K_c/RT$ (d) $K_c = K_p/RT$.

78. Consider the reaction

$CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2\,(g)} + H_{2\,(g)}$

The equilibrium amount of $CO_{2\,(g)}$ can be increased at a given temperature by

(a) adding a suitable catalyst
(b) decreasing the volume of the container
(c) adding an inert gas
(d) increasing the amount of $CO_{(g)}$.

79. In the process of ice melting at –15°C at atmospheric pressure,

(a) $\Delta G < 0$ (b) $\Delta G > 0$
(c) $\Delta G = 0$ (d) $\Delta G = \infty$.

80. The volume of $CO_2$ formed at STP on burning a mixture of 0.5 mole of methane and 24 gram of oxygen is

(a) 84 litre (b) 8.4 litre
(c) 22.4 litre (d) 0.84 litre.

## MATHEMATICS

81. If both the roots of the equations $ax^2 + px + q = 0$ and $bx^2 + lx + m = 0$ $(a \neq b)$ are common, then

(a) $pm = lq$ (b) $pq = lm$
(c) $p^2l = m^2q$ (d) $pm^2 = lq^2$.

82. A binary operation $o$ is defined on the set of integers $I$ by $poq = 3p^2 + 2q^2 - 5pq$
If $ao1 = 1$, then $a$ is equal to

(a) –1 (b) 1
(c) –2 (d) none of these.

83. If $A$ and $B$ are two non-empty sets, then $B \cap (A \cup B)^C$, where $X^C$ denotes the complement of $X$, is equal to

(a) $A^C$ (b) $B$
(c) $A^C \cap B$ (d) $\phi$.

84. Let $S$ be a finite set containing $n$ elements. Then the total number of binary operations on $S$ is

(a) $n^n$ (b) $2^{n^2}$
(c) $n^{n^2}$ (d) $n^2$.

85. If sets $A$ and $B$ are defined as
$A = \{(x, y) : y = 1/x, x \neq 0, x \in R\}$
$B = \{(x, y) : y = -x, x \in R\}$, then

(a) $A \cap B = A$ (b) $A \cap B = B$
(c) $A \cap B = \phi$ (d) none of these.

86. Given the relation $R = \{(1, 2), (2, 3)\}$ on the set $A = \{1, 2, 3\}$, the number of ordered pairs which when added to $R$ make it an equivalence relation is

(a) 5 (b) 6
(c) 7 (d) none of these.

87. Let $f : R \to R$ be a function defined by

$f(x) = \dfrac{e^x - e^{-x}}{e^x + e^{-x}}$, then

(a) $f$ is bijection (b) $f$ is an injection only
(c) $f$ is a surjection only
(d) $f$ is neither an injection nor a surjection.

88. If $a = \cos\alpha + i\sin\alpha$, $b = \cos\beta + i\sin\beta$
$c = \cos\gamma + i\sin\gamma$ and $\dfrac{b}{c} + \dfrac{c}{a} + \dfrac{a}{b} = 1$, then $\sin(\alpha - \beta) + \sin(\beta - \gamma) + \sin(\gamma - \alpha)$ is equal to

(a) 0 (b) 1
(c) –1 (d) ±1.

89. If $\omega$ $(\neq 1)$ be a cube root of unity and $(1 + \omega)^7 = A + B\omega$, then $A$ and $B$ are respectively the numbers

(a) 0, 1 (b) 1, 1
(c) 1, 0 (d) –1, –1.

90. For any complex number $z$ and its conjugate $\bar{z}$, the number of roots of the equation $z^2 + \bar{z} = 0$ is equal to

(a) 1 (b) 4
(c) 3 (d) 2.

91. Let $\dfrac{C}{5} = \dfrac{F - 32}{9}$. If C lies between 10 and 20, then

(a) $50 < F < 78$ (b) $50 < F < 68$
(c) $49 < F < 68$ (d) $49 < F < 78$.

92. Consider $\dfrac{x}{2} + \dfrac{y}{4} \geq 1$ and $\dfrac{x}{3} + \dfrac{y}{2} \leq 1, x, y \geq$
Then number of possible solutions are

(a) zero (b) unique
(c) infinite (d) none of these.

$a$, $b$, and $c$ are three numbers in A.P. If $x$ is the arithmetic mean of $a$ and $b$ and $y$ is the arithmetic mean of $b$ and $c$, then the arithmetic mean of $x$ and $y$ is
(a) $b$ (b) $a$
(c) $\frac{a+b+c}{2}$ (d) none of these.

If $a, b, c, d$ and $p$ are different real numbers such that $a^2p^2 + b^2(p^2+1) + c^2(p^2+1) + d^2 \le 2(ab + bc + cd)p$, then $a, b, c$ and $d$ are in
(a) G.P. (b) A.P.
(c) H.P. (d) none of these.

Let $x = \frac{1}{1\cdot2} + \frac{1}{2\cdot3} + \ldots + \frac{1}{n(n+1)} - \frac{n}{n+1}$.
The value of $x$ for $n \ge 1$ is
(a) 0 (b) 1
(c) $-1$ (d) 2.

For $n \in N$, $n(n+1)(n+5)$ is a multiple of
(a) 4 (b) 12
(c) 3 (d) none of these.

If $x = y\cos\frac{2\pi}{3} = z\cos\frac{4\pi}{3}$, then $xy + yz + zx$ is equal to
(a) $-1$ (b) 0
(c) 1 (d) 2.

The value of $\sqrt{3}\cot 20° - 4\cos 20°$ is
(a) 1 (b) $-1$
(c) 0 (d) none of these.

If $\sin x + \operatorname{cosec} x = 2$, then $\sin^n x + \operatorname{cosec}^n x$ is equal to
(a) 2 (b) $2^n$
(c) $2^{n-1}$ (d) $2^{n-2}$.

The orthocentre of the triangle formed by the lines $xy = 0$ and $x + y = 1$ is
(a) $\left(\frac{1}{2}, \frac{1}{2}\right)$ (b) $\left(\frac{1}{3}, \frac{1}{3}\right)$
(c) $(0, 0)$ (d) $\left(\frac{1}{4}, \frac{1}{4}\right)$

The locus of the mid-point of the portion intercepted between the axes by the line $x\cos\alpha + y\sin\alpha = p$, where $p$ is a constant, is
(a) $x^2 + y^2 = 4p^2$ (b) $\frac{1}{x^2} + \frac{1}{y^2} = \frac{4}{p^2}$
(c) $x^2 + y^2 = \frac{4}{p^2}$ (d) $\frac{1}{x^2} + \frac{1}{y^2} = \frac{2}{p^2}$

**102.** The pair of straight lines perpendicular to the pair $ax^2 + 2hxy + by^2 = 0$ has the equation
(a) $ax^2 - 2hxy + by^2 = 0$
(b) $ay^2 + 2hxy + bx^2 = 0$
(c) $bx^2 + 2hxy + ay^2 = 0$
(d) $bx^2 - 2hxy + ay^2 = 0$.

**103.** If the two pairs of lines $x^2 - 2mxy - y^2 = 0$ and $x^2 - 2nxy - y^2 = 0$ are such that one of them represents the bisector of the angles between the other, then
(a) $mn + 1 = 0$ (b) $mn - 1 = 0$
(c) $\frac{1}{m} + \frac{1}{n} = 0$ (d) $\frac{1}{m} - \frac{1}{n} = 0$

**104.** To which of the following circles, the line $y - x + 3 = 0$ is normal at the point $(3 + 3/\sqrt{2}, 3/\sqrt{2})$?
(a) $(x - 3 - 3/\sqrt{2})^2 + (y - 3/\sqrt{2})^2 = 9$
(b) $(x - 3/\sqrt{2})^2 + (y - 3/\sqrt{2})^2 = 9$
(c) $x^2 + (y-3)^2 = 9$
(d) $(x-3)^2 + y^2 = 9$.

**105.** The circles $x^2 + y^2 - 4x - 6y - 12 = 0$ and $x^2 + y^2 + 4x + 6y + 4 = 0$
(a) touch externally
(b) touch internally
(c) intersect at two points
(d) do not intersect.

**106.** A circle passes through the origin and has its centre on $y = x$. If it cuts $x^2 + y^2 - 4x - 6y + 10 = 0$ orthogonally, then the equation of the circle is
(a) $x^2 + y^2 - x - y = 0$
(b) $x^2 + y^2 - 6x - 4y = 0$
(c) $x^2 + y^2 - 2x - 2y = 0$
(d) $x^2 + y^2 + 2x + 2y = 0$.

**107.** Three normals to the parabola $y^2 = x$ are drawn through a point $(C, 0)$, then
(a) $C = 1/4$ (b) $C = 1/2$
(c) $C > 1/2$ (d) none of these.

**108.** The radius of the circle passing through the foci

of the ellipse $\frac{x^2}{16}+\frac{y^2}{9}=1$, and having its centre at $(0, 3)$ is

(a) 4 (b) 3

(c) $\sqrt{12}$ (d) 7/2.

108. If $x = 9$ is the chord of contact of hyperbola $x^2 - y^2 = 9$, then the equation of the corresponding pair of tangents is

(a) $9x^2 - 8y^2 + 18x - 9 = 0$

(b) $9x^2 - 8y^2 - 18x + 9 = 0$

(c) $9x^2 - 8y^2 - 18x - 9 = 0$

(d) $9x^2 - 8y^2 + 18x + 9 = 0$.

110. How many 10-digit numbers can be written by using the digits 1 and 2 ?

(a) ${}^{10}C_1 + {}^{9}C_2$ (b) $2^{10}$

(c) ${}^{10}C_2$ (b) 10!.

111. In an examination, there are three multiple choice questions and each question has 4 choices. Number of ways in which a student can fail to get all answers correct is

(a) 11 (b) 12

(c) 27 (d) 63.

112. The term independent of $x$ in the expansion of $\left(\frac{3}{2}x^2-\frac{1}{3x}\right)^9$ is

(a) 5/12 (b) 12/5

(c) 5/6 (d) none of these.

113. The approximate value of $(7.995)^{1/3}$ correct to 4 decimal places is

(a) 1.9985 (b) 1.9996

(c) 1.9880 (d) 1.9991

114. If $\alpha, \beta$ are the roots of the equation $x^2 - px + q = 0$, then

$(\alpha+\beta)x-\frac{\alpha^2+\beta^2}{2}x^2+\frac{\alpha^3+\beta^3}{3}x^3-\ldots$ is equal to

(a) $\log_e(1 + px + qx^2)$

(b) $\log_e(1 + qx + px^2)$

(c) $\log_e(1 - px + qx^2)$

(d) $\log_e(1 - px - qx^2)$.

115. The coefficient of $x^4$ in the expansion of $e^{2x-3}$ is

(a) $\frac{3}{2e^3}$ (b) $\frac{2}{3e^3}$

(c) $\frac{2}{3}e^3$ (d) $\frac{3}{2}e^3$

116. The variance of 20 observations is 10. If each observation is multiplied by 3, the new variance of the resulting observations is

(a) 30 (b) 300

(c) 90 (d) 9.

117. If a variable takes discrete values $x + 4$, $x-\frac{7}{2}$, $x-\frac{5}{2}$, $x - 3$, $x - 2$, $x+\frac{1}{2}$, $x-\frac{1}{2}$, $x + 5$ ($x$ is positive), then the median is

(a) $x-\frac{5}{4}$ (b) $x-\frac{1}{2}$

(c) $x - 2$ (d) $x+\frac{5}{4}$

118. The probability that $A$ can solve a problem is 2/3 and $B$ can solve it is 3/4. If both attempt the problem, what is the probability that the problem gets solved ?

(a) $\frac{11}{12}$ (b) $\frac{7}{12}$

(c) $\frac{5}{12}$ (d) $\frac{1}{2}$

119. If $A$ and $B$ are two events such that $P(A) = 0.5$, $P(B) = 0.69$ and $P(A \cap B) = 0.35$, then $P(A \cap \bar{B})$

(a) 0.88 (b) 0.12

(c) 0.19 (d) 0.34

120. If the lines $\frac{x-1}{-3}=\frac{y-2}{2k}=\frac{z-3}{2}$ and $\frac{x-1}{3k}=\frac{y-1}{1}=\frac{z-6}{-5}$ are perpendicular, then the value of $k$ is

(a) $-\frac{10}{7}$ (b) $\frac{10}{7}$

(c) $\frac{7}{10}$ (d) none of these.

121. The line $\frac{x-2}{3}=\frac{y+1}{2}=\frac{z-1}{1}$ intersects the curve $xy = c^2$, $z = 0$ if $c =$

(a) $\pm 1$ (b) $\pm 1/3$

(c) $\pm\sqrt{5}$ (d) none of these.

122. The points $A(5, -1, 1)$, $B(7, -4, 7)$, $C(1, -6, 10)$ and $D(-1, -3, 4)$ are the vertices of

(a) parallelogram (b) rectangle

(c) trapezium (d) square.

123. If $\vec{a}, \vec{b}$ and $\vec{c}$ are unit vectors such that $\vec{a}+\vec{b}+\vec{c}=\vec{0}$, then the value of $\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}$ is

(a) 1 (b) 3
(c) $-3/2$ (d) none of these.

124. If $C$ is the middle point of $AB$ and $P$ is any point outside $AB$, then

(a) $\overrightarrow{PA}+\overrightarrow{PB}=\overrightarrow{PC}$ (b) $\overrightarrow{PA}+\overrightarrow{PB}=2\overrightarrow{PC}$
(c) $\overrightarrow{PA}+\overrightarrow{PB}=-\overrightarrow{PC}$ (d) $\overrightarrow{PA}+\overrightarrow{PB}=-2\overrightarrow{PC}$

125. Let $\vec{a}=\hat{i}+\hat{j}$ and $\vec{b}=2\hat{i}-\hat{k}$. Then the point of intersection of the lines $\vec{r}\times\vec{a}=\vec{b}\times\vec{a}$ and $\vec{r}\times\vec{b}=\vec{a}\times\vec{b}$ is

(a) $-\hat{i}+\hat{j}+\hat{k}$ (b) $3\hat{i}-\hat{j}+\hat{k}$
(c) $3\hat{i}+\hat{j}-\hat{k}$ (d) $\hat{i}-\hat{j}-\hat{k}$.

126. From the matrix equation $AB = AC$, it can be concluded that $B = C$ provided

(a) $A$ is singular (b) $A$ is non-singular
(c) $A$ is symmetric (d) $A$ is square.

127. The system of linear equations

$$x + ky + 3z = 0$$
$$3x + ky - 2z = 0$$
$$2x + 3y - 4z = 0$$

possess a non-trivial solution if

(a) $k = 33/2$ (b) $k = 1$
(c) $k = 0$ (d) none of these.

128. Let $\omega \neq 1$ be the cube root of unity. The value of

$$\begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & \omega^3 \\ \omega^2 & \omega^3 & \omega^4 \end{vmatrix} + \begin{vmatrix} 1 & \omega & -\omega \\ 0 & 0 & \omega^2 \\ 0 & 0 & 1 \end{vmatrix}$$ is

(a) 0 (b) 1
(c) $-1$ (d) none of these.

129. The value of the parameter $\alpha$, for which the function $f(x) = 1 + \alpha x$, $\alpha \neq 0$ is the inverse of itself, is

(a) $-2$ (b) $-1$
(c) 1 (d) 2.

130. $\lim_{x\to\infty} \frac{\sqrt{x+\sin x}}{\sqrt{x-\cos x}} =$

(a) 0 (b) 1
(c) $-1$ (d) none of these.

131. The value of $\lambda$, for which the function

$$f(x)=\begin{cases}\lambda+(x^2-2x) & \text{if } x\le 0\\ 4x+1 & \text{if } x>0\end{cases}$$

is continuous at $x = 0$, is

(a) 1 (b) $-1$
(c) 0 (d) none of these.

132. Given $y = a^{x^{a^{x^{a^{x}}}}}$. The value of $\frac{dy}{dx}$ is

(a) $\frac{2}{x(1-y\log x)}$ (b) $\frac{y^2\log y}{x(1-y\log x)}$
(c) $\frac{y^2\log y}{x(1-y\log x\log y)}$
(d) $\frac{y^2\log y}{x(1+y\log x\log y)}$

133. If $x^y = e^{x-y}$, then $\frac{dy}{dx} =$

(a) $(1 + \log x)^{-1}$ (b) $(1 + \log x)^{-2}$
(c) $\log x(1 + \log x)^{-2}$ (d) none of these.

134. If $y^2 = P(x)$, where $P(x)$ is a polynomial of degree 3, then $2\frac{d}{dx}\left[y^3\frac{d^2y}{dx^2}\right]$ is equal to

(a) $P(x) + P''(x)$ (b) $P(x)$
(c) $P(x)\,P'''(x)$ (d) a constant.

135. The curve $y - e^{xy} + x = 0$ has a vertical tangent at the point

(a) (1, 1) (b) at no point
(c) (0, 1) (d) (1, 0).

136. If $a < 0$, the function $f(x) = e^{ax} + e^{-ax}$ is a monotonically decreasing function for values of $x$ given by

(a) $x > 0$ (b) $x < 0$
(c) $x > 1$ (d) $x < 1$.

137. The maximum value of $xy$ subject to $x + y = 16$ is

(a) 8 (b) 64
(c) 16 (d) 32.

138. $\int f'(ax+b)[f(ax+b)]^n\,dx$ is equal to

(a) $\frac{1}{n+1}[f(ax+b)]^{n+1}+c$ for every $n \neq -1$

(b) $\frac{1}{n+1}[f(ax+b)]^{n+1}+c$ for every $n$,

(c) $\frac{1}{a(n+1)}[f(ax+b)]^{n+1}+c$ for every $n \neq -1$

(d) $\frac{1}{a(n+1)}[f(ax+b)]^{n+1}+c$ for every $n$

**139.** If $\int \frac{x\tan^{-1}x}{\sqrt{1+x^2}}dx = \sqrt{1+x^2}f(x) + A\log(x+\sqrt{1+x^2})+c$, then

(a) $f(x)=\tan^{-1}x,\ A=-1$

(b) $f(x)=\tan^{-1}x,\ A=1$

(c) $f(x)=2\tan^{-1}x,\ A=-1$

(d) $f(x)=2\tan^{-1}x,\ A=1$.

**140.** If $\int \frac{2x^2+3}{(x^2-1)(x^2+4)}dx = a\log\left(\frac{x+1}{x-1}\right)+b\tan^{-1}\frac{x}{2}+c$, then

(a) $a=-\frac{1}{2},\ b=\frac{1}{2}$ (b) $a=\frac{1}{2},\ b=\frac{1}{2}$

(c) $a=-1,\ b=1$ (d) $a=1,\ b=-1$.

**141.** If $f(x)=A\sin\left(\frac{\pi x}{2}\right)+B,\ f'\left(\frac{1}{2}\right)=\sqrt{2}$ and $\int_0^1 f(x)dx=\left(\frac{2A}{\pi}\right)$, then the constants $A$ and $B$ are respectively

(a) $\frac{\pi}{2}$ and $\frac{\pi}{2}$ (b) $\frac{2}{\pi}$ and $\frac{3}{\pi}$

(c) 0 and $-\frac{4}{\pi}$ (d) $\frac{4}{\pi}$ and 0.

**142.** $\int_0^{2a}\frac{f(x)}{f(x)+f(2a-x)}dx$ is equal to

(a) $a$ (b) $4a$

(c) 0 (d) none of these.

**143.** The value of $\int_{-\pi}^{\pi}(1-x^2)\sin x\cos^2 x\,dx$ is

(a) 0 (b) $\pi-\frac{\pi^3}{3}$

(c) $2\pi-\pi^3$ (d) $\frac{\pi}{2}-2\pi^3$

**144.** The order of the differential equation whose general solution is given by

$$y = c_1e^x + c_2e^x + (c_3+c_4)e^{3x+5} + c_5e^{2x}$$

where $c_1, c_2, c_3, c_4$ and $c_5$ are arbitrary constants, is

(a) 5 (b) 4

(c) 3 (d) 2.

**145.** A solution of the differential equation $\left(\frac{dy}{dx}\right)^2 - x\frac{dy}{dx}+y=0$ is

(a) $y=2$ (b) $y=2x$

(c) $y=2x-4$ (d) $y=2x^2-4$.

**146.** The differential equation $y\frac{dy}{dx}+x=a$ ($a$ is a constant) represents

(a) a set of circles having centre on the y-axis

(b) a set of circles having centre on the x-axis

(c) a set of ellipses (d) none of these.

**147.** Consider Max $z=-2x-3y$

subject to $\frac{x}{2}+\frac{y}{3}\le 1$

$\frac{x}{3}+\frac{y}{2}\le 1$

$x, y \ge 0$

The max. value of $z$ is

(a) 0 (b) 4

(c) 9 (d) 6.

**148.** Consider

Minimize $z = 3x+2y$

subject to $x+y\ge 8$

$3x+5y\le 15$

$x, y \ge 0$

It has

(a) infinite feasible solutions

(b) unique feasible solutions

(c) no feasible solution

(d) none of these.

**149.** Let $z$ and $\omega$ be two non-zero complex numbers such that $|z|=|\omega|$ and $\arg(z)+\arg(\omega)=\pi$, then $z$ equals

(a) $\omega$ (b) $-\omega$

(c) $\bar{\omega}$ (d) $-\bar{\omega}$.

**150.** Two events $A$ and $B$ have probabilities 0.25 and 0.50 respectively. The probability that both $A$ and $B$ occur is 0.14. Then the probability that neither $A$ nor $B$ occur is

(a) 0.39 (b) 0.25

(c) 0.11 (d) none of these

# A.M.U. (ENGINEERING)

# Solved Paper 2007

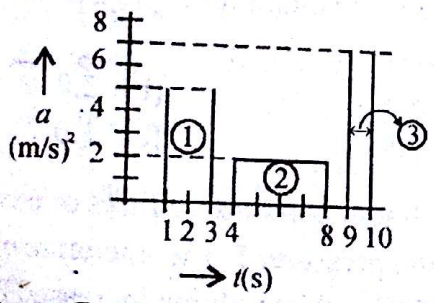
## PHYSICS

1. Which of the following statement is wrong ?
(a) In an adiabatic process $\Delta E_{int} = -W$
(b) In a constant volume process $\Delta E_{int} = Q$
(c) In a cyclic process $\Delta E_{int} = 0$
(d) For adiabatic expansion of an ideal gas $TV^{\gamma}$ = constant

2. The position $x$ (in meters) of a particle on the $x$-axis is given by
$$x = 5t^3 + 3t^2 - 9,$$
where $t$ is the time in seconds. What is the acceleration of the particle at $t = 2$ seconds (in m/s$^2$)?
(a) 31 (b) 66
(c) 29 (d) 75

3. A ball is thrown vertically up with a velocity of 4.9 m/s. The ball is then collected by the person on ground after a time interval of
(a) 3.0 s (b) 2.0 s
(c) 1.0 s (d) 0.5 s

4. The figure shows a particle moving along $x$-axis subjected to three periods of acceleration ($a$). Rank the periods according to the increase they produce in the particle velocity, greatest first




(a) ② > ① > ③
(b) ② > ③ > ①
(c) ① > ③ > ②
(d) ① > ② > ③

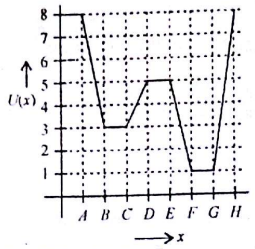
5. An object falls from a bridge 45 m above the water level in a river. It falls directly into a boat moving with constant speed. The boat was 18 m away from the point of impact. What is the speed of the boat (in m/s) ?
(a) 6 (b) 9
(c) 12 (d) 15

6. A projectile is thrown from the surface of ground on Earth with velocity 16 m/s at an angle of 75° from the vertical. The projectile would be able to cover, approximately a horizontal distance (in meters)
(a) 13 (b) 17
(c) 15 (d) 21

7. A bat and an insect are flying with velocities $\vec{v}_{BG}$ $\vec{v}_{IG}$ with respect to ground (in unit vector $\hat{i}$, $\hat{j}$ notation)
$\vec{v}_{BG} = 3.5\hat{i} + 9.2\hat{j}$, $\vec{v}_{IG} = -2.5\hat{i} + 1.8\hat{j}$
Calculate the velocity of the insect with respect to bat
(a) $1.5\hat{i} + 11.0\hat{j}$ (b) $-6\hat{i} - 7.4\hat{j}$
(c) $+6\hat{i} - 11.0\hat{j}$ (d) $1.0\hat{i} + 7.4\hat{j}$

8. A 5 N force acts on a 15 kg body initially at rest. The work done by the force in the third second of its motion is (in joules) approximately equal to
(a) 9 (b) 15
(c) 4 (d) 20

9. Solid line in the figure shows the potential energy $U(x)$ as a function of $x$ of a particle confined to move along $x$-axis. Regions $AB$, $BC$, $CD$, $EF$, $FG$ and $GH$ are of equal distance. Rank the regions $AB$, $BC$, $CD$ and $EF$ according to the magnitude of the force on the particle, greatest first.




(a) $AB > EF > CD > BC$
(b) $CD > AB > EF > BC$
(c) $AB > EF > BC > CD$
(d) $BC > EF > AB > CD$

**10.** The work done required to increase the separation distance from $x_1$ to $x_1 + d$ between two masses $m_1$ and $m_2$ is
(a) $-G m_1 m_2 [d^3 - 3x_1 d(x_1 + d)] / [d(x_1 + d)]^3$
(b) $-G m_1 m_2 [x_1^2 - 2x_1 d(x_1 + d)] / [x_1 (x_1 + d)]^2$
(c) $+G m_1 m_2 [x_1^3 + 3x_1 d(x_1 + d)] / [d(x_1 + d)]^3$
(d) $+G m_1 m_2 [d^3 + 3x_1 d(x_1 + d)] / [x_1 (x_1 + d)]^3$

**11.** An 80 kg man is riding on a small 40 kg cart at a speed of 4 m/s. He jumps off the cart with zero horizontal speed. What is the resulting changes in the speed of the cart (in m/s) ?
(a) 4 (b) 8
(c) 12 (d) 0

**12.** The angular acceleration $\alpha$ of a spinning top as a function of $t$ is : $\alpha = 3t^2 + 5t$. At $t = 0$, the angular velocity $\omega_0 = 10$ rad/s and angular position $\theta_0 = 8$ rad. The angular position as a function of time $t$ is given by which of the following expression?
(a) $\frac{1}{4}t^4 + \frac{5}{6}t^3 + 10t + 8$
(b) $\frac{5}{6}t^4 + \frac{1}{4}t^3 + \frac{2}{5}t + 8$
(c) $2t^4 + 3t^3 + 5t + 8$
(d) $\frac{1}{4}t^4 + \frac{3}{5}t^3 + 6t^2 + 8$

**13.** A uniform solid sphere of radius $R$ produces a gravitational acceleration $a_g$ on its surface. At what two distances from the centre of the sphere the acceleration due to gravity is $a_g/4$ ?
(a) $4R$, $0.50R$ (b) $2R$, $0.25R$
(c) $3R$, $0.33R$ (d) $2R$, $0.50R$

**14.** About one-third of the body of a physicist swimming in the Dead sea is above the water line. Assuming that density of a human being is about 0.98 gm/cm$^3$. What is the density of water in the Dead sea (answer in gm/cm$^3$) ?
(a) 1.5 (b) 1.7
(c) 1.9 (d) 2.1

**15.** A 25 N weight is hung from the bottom of a vertical spring causing it to stretch by 5 cm. The spring is then placed horizontally on a frictionless table. One end of the spring is held fixed and a body of 5 kg weight is attached to the free end of the spring. The spring is stretched and allowed to vibrate. What is the time period of its vibration?
(a) 0.72 s (b) 0.65 s
(c) 0.43 s (d) 0.21 s

**16.** What phase difference between two identical travelling waves moving in the same direction would produce a combined wave having an amplitude $\sqrt{3}$ times the amplitude of the original waves ?
(a) 30° (b) 45°
(c) 60° (d) 75°

**17.** A block of mass 0.1 kg oscillates on a frictionless horizontal surface. If the displacement from the origin is given by
$x = 10$ cm cos $[(10$ rad/s$)t + \pi/3$ rad$]$
What is the maximum speed of the block ? (answer in m/s)
(a) 3.5 (b) 2.0
(c) 1.5 (d) 1.0

**18.** A cylinder contains 12 litres of oxygen at 20°C and 15 atm pressure. The temperature of the gas is raised to 35°C and its volume increased to 17 litres. What is the final pressure of the gas (in atm) ?
(a) 9 (b) 11
(c) 15 (d) 17

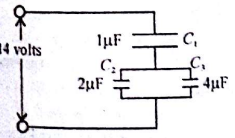
**19.** The root mean square speed of Hydrogen molecule at 300 K is 1920 m/s. What is the rms speed of oxygen gas molecules at the same temperature ? (answer in MKS units).
(a) 480 (b) 560
(c) 940 (d) 860

**20.** A man of mass $m = 55$ kg is climbing inside a wide vertical hollow pipe. After reaching some height he takes rest by pressing his shoulder and feet on the opposite sides of the pipe. If the two coefficients of static frictions are 1.1 and 0.7, what is the minimum horizontal push so that he does not fall ?
(a) 670 N (b) 550 N
(c) 300 N (d) 250 N

**21.** A certain charge $Q$ is divided into two parts $q$ and $Q - q$, which are then separated by a distance $d$. Calculate the maximum electrostatic repulsion possible for some value of $q$, when the distance $d$ is kept fixed.
(a) $\frac{4\pi}{\varepsilon_0} \cdot \frac{Q^2}{d^2}$ (b) $\frac{1}{\pi\varepsilon_0} \cdot \frac{Q^2}{d^2}$
(c) $\frac{1}{16\pi\varepsilon_0} \cdot \frac{Q^2}{d^2}$ (d) $\frac{1}{4\pi\varepsilon_0} \cdot \frac{Q^2}{d^2}$

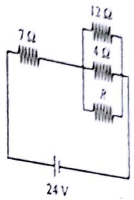
**22.** A neutral water molecule (dipole moment $6.0 \times 10^{-30}$ C - m) is placed in a uniform electric field $E = 1.5 \times 10^4$ N/C at an angle of 30°. What is the torque (in N - m) acting on the water molecule ?
(a) $4.5 \times 10^{-26}$ (b) $7.5 \times 10^{-26}$
(c) $9.0 \times 10^{-26}$ (d) $12.0 \times 10^{-26}$

**23.** Three capacitors $C_1$, $C_2$, and $C_3$ are connected as shown in the figure. A potential difference of 14 volts is applied to the input terminals. What is the charge on $C_3$ (in μC) ?




(a) 8 (b) 4
(c) 2 (d) 10

**24.** In the circuit shown, for what value of $R$, will the ideal battery transfer energy at the rate of 60 W?




(a) 12.5 (b) 15.5
(c) 17.5 (d) 19.5

**25.** An electron charge $-e$, mass $m$, enters a uniform magnetic field $\vec{B} = B\hat{i}$ with an initial velocity $\vec{v} = v_x\hat{i} + v_y\hat{j}$. What is the velocity of the electron after a time interval of $t$ seconds ?
(a) $v_x\hat{i} + v_y\hat{j} + \frac{e}{m}v_y Bt\,\hat{k}$
(b) $v_x\hat{i} + v_y\hat{j} - \frac{e}{m}v_y Bt\,\hat{k}$
(c) $v_x\hat{i} + (v_y + \frac{e}{m}v_y Bt)\hat{j}$
(d) $(v_x + \frac{e}{m}v_y Bt)\hat{i} + v_y\hat{j}$

**26.** A galvanometer has resistance of 75 Ω and experiences a full scale deflection for 0.5 mA current. What is the value of resistance to be connected to it in order to convert it into a voltmeter to read upto 1 volt potential difference?
(a) 1525 (b) 1075
(c) 1925 (d) 2075

**27.** A parallel plate capacitor of plate area $A$ and plates separation distance $d$ is charged by applying a potential $V_0$ between the plates. The dielectric constant of the medium between the plates is $K$. What is the uniform electric field $E$ between the plates of the capacitor ?
(a) $E = \varepsilon_0 CV_0 / KA$ (b) $E = V_0 / Kd$
(c) $E = V_0 / KA$ (d) $E = K V_0 d / \varepsilon_0 A$

**28.** Specific heat of Aluminium metal is 24.4 J/ mole-K. Express the specific heat in J/kg-K.
(a) 500 (b) 600
(c) 900 (d) 1200

**29.** A cyclotron is operated at an oscillator frequency of 24 MHz and has a dee radius $R = 60$ cm. What

is magnitude of the magnetic field $B$ (in tesla) to accelerate deuterons (mass = $3.34 \times 10^{-27}$ kg) ?
(a) 9.5 (b) 7.2
(c) 5.0 (d) 3.2

**30.** A coil has an inductance of 50 mH and an ohmic resistance of 0.5 Ω. A 5 V emf is applied across the coil. How much energy (in joules) is stored in the magnetic field after the current through the coil has built to its steady state value ?
(a) 2.5 (b) 5.0
(c) 0.5 (d) 10.0

**31.** Which one of the following is not true ?
(a) Ampere's law is : $\oint \vec{B}.d\vec{s} = \mu_0 i_{enc}$
(b) Faraday's law is : $\varepsilon = -\varepsilon_0 \frac{d\phi_B}{dt}$
(c) Biot-Savart law is : $d\vec{B} = \frac{\mu_0 i\, d\vec{s} \times \vec{r}}{4\pi\ \ r^3}$
(d) Gauss's law is : $\varepsilon_0 \oint \vec{E}.d\vec{A} = q$

**32.** If the magnetic field $B$ of a polarised electromagnetic wave oscillates parallel to $y$-axis and is given by : $B_y = B_m \sin(kz - \omega t)$. What is the direction of propagation of the electromagnetic wave and parallel to which axis does the associated electric field oscillates ?
(a) + ve $y$-axis, $x$-axis
(b) – ve $z$-axis, $y$-axis
(c) + ve $z$-axis, $x$-axis
(d) + ve $x$-axis, $z$-axis

**33.** Using the data given below calculate the kinetic energy of the α-particle and proton coming from the possible decay $U^{238}$ respectively.
$^{238}U$ = 238.0508 u $^{4}He$ = 4.0026 u
$^{234}U$ = 234.0436 u $^{1}H$ = 1.0078 u
$^{237}U$ = 237.0512 u
(a) 4.25 MeV, negative
(b) 3.25 MeV, 7.55 MeV
(c) negative, 4.37 MeV
(d) negative, 5.42 MeV

**34.** A beam of Beryllium nucleus ($z$ = 4) of kinetic energy 5.3 MeV is headed towards the nucleus of Gold atom ($z$ = 79). What is the distance of closest approach ?
(a) $10.32 \times 10^{-14}$ m (b) $8.58 \times 10^{-14}$ m
(c) $3.56 \times 10^{-14}$ m (d) $1.25 \times 10^{-14}$ m

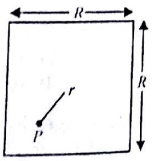
**35.** What is the maximum wavelength of photon that would excite an electron in the valence band of diamond to the conduction band ? The energy gap for diamond is 5.5 eV.
(a) 169 nm (b) 205 nm
(c) 226 nm (d) 350 nm

**36.** What is the wavelength of the most energetic photon emitted in the Balmer series of the Hydrogen atom ?
(a) 645 nm (b) 580 nm
(c) 435 nm (d) 365 nm

**37.** Two thin double convex lenses of focal lengths $f_1$ = 24 cm, $f_2$ = 11 cm are placed apart by a distance of 10 cm. An object is placed in front of $f_1$ at a distance of $O_1$ = 8 cm on the axis of the lens combination. What is the nature and distance from $f_2$ of the final image ?
(a) virtual, 12 cm (b) real, 22 cm
(c) virtual, 11 cm (d) real, 18 cm

**38.** An unpolarised beam of light is incident on a plane surface separating air and glass at an angle equal to the Brewster angle. Then
(a) the reflected light has electric component only perpendicular to the incident plane.
(b) the reflected light has electric component only in the plane of incidence.
(c) the electric component parallel to the plane of incidence in refracted ray completely disappear.
(d) the magnetic component of the refracted light completely disappear.

**39.** The figure shows only the cross-sectional area of a long piece of wire in which a uniform current $i$ is flowing. What is the magnitude of the magnetic field produced at a point $P$ which is $r$ distance away from the centre of the cross-section as shown in the figure ?






(a) $\mu_0 ir/(2R^2)$ (b) $\mu_0 ir/(2\pi R^2)$
(c) $2\pi/(\mu_0 iR)$ (d) $2\pi r/(\mu_0 iR^2)$

A $U^{235}$ atom undergoes fission by thermal neutrons according to the following reaction

$$U^{235} + n \rightarrow {}^{140}_{54}Xe + {}^{94}_{38}Sr + 2n$$

Then Xenon undergoes four and Strontium undergoes two consecutive β decays and six electrons are detected. What is the atomic number of the two decay products of Xenon and Strontium?
(a) 50, 36 (b) 58, 40
(c) 56, 42 (d) 57, 41

## CHEMISTRY

200 g of hydrogen reacts with nitrogen according to equation $3H_{2(g)} + N_{2(g)} \rightarrow 2NH_{3(g)}$, to produce
(a) 11.322 g of ammonia
(b) 113.22 g of ammonia
(c) 1132.2 g of ammonia
(d) 11322 g of ammonia

The mass of $KClO_3$ required to produce 2.4 mol of oxygen by catalytic decomposition will be
(a) 19.6 g (b) 196.0 g
(c) 122.5 g (d) 245.0 g
[Given that : $2KClO_{3(S)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$; molar mass of $KClO_3$ = 122.5 g]

A 2.5 litre flask contains 0.25 mol each of sulphur dioxide and nitrogen gas at 27°C. The total pressure exerted by the mixture of the two gases will be
(a) $4.98 \times 10^5$ Pa (b) $2.49 \times 10^5$ Pa
(c) $4.98 \times 10^{10}$ Pa (d) $2.49 \times 10^{10}$ Pa
[Given : $R = 8.314\ JK^{-1}\ mol^{-1}$]

Sodium chloride molecules are held together by
(a) electron sharing (b) coulombic forces
(c) metallic bonds (d) hydrogen bonds

The energy of one mole of photons of radiation whose frequency is $5 \times 10^{14}$ Hz will be
(a) 19.951 kJ $mol^{-1}$ (b) 199.51 $mol^{-1}$
(c) 39.90 kJ $mol^{-1}$ (d) 399.0 kJ $mol^{-1}$

The shape of $SF_6$ is
(a) octahedral (b) trigonal bipyramidal
(c) tetrahedral (d) trigonal planar

**47.** The order of stability of $O_2$ and its various ionic species follows the sequence
(a) $O_2^{2-} > O_2 > O_2^{+} > O_2^{-}$
(b) $O_2 > O_2^{-} > O_2^{+} > O_2^{2-}$
(c) $O_2^{-} > O_2^{+} > O_2 > O_2^{2-}$
(d) $O_2^{+} > O_2^{-} > O_2 > O_2^{2-}$

**48.** The metallic character of Be, Mg, Na, P and Si follows the order
(a) Na < Mg < Be < Si < P
(b) Na < Mg < Be < P< Si
(c) Mg < Be < P < Na < Si
(d) P < Si < Be < Mg < Na

**49.** Which of the following metal hydroxides is strong base ?
(a) $Mg(OH)_2$ (b) $Ca(OH)_2$
(c) $Sr(OH)_2$ (d) $Ba(OH)_2$

**50.** The reducing power of Al, Ga, In and Tl follows the sequence
(a) Al > Ga > In > Tl
(b) Tl > In > Ga > Al
(c) Al > In > Ga > Tl
(d) In > Ga > Al > Tl

**51.** The electronic configuration of cerium is
(a) [Xe] $4f^1, 5d^1, 6s^2$
(b) [Xe] $4f^2, 5d^0, 6s^2$
(c) [Xe] $4f^4, 5d^0, 6s^2$
(d) [Xe] $4f^5, 5d^0, 6s^2$

**52.** Which of the following coordination entities is paramagnetic ?
(a) $[Ni(CN)_4]^{2-}$ (b) $[NiCl_4]^{2-}$
(c) $[Fe(CN)_6]^{4-}$ (d) $[Co(NH_3)_6]^{3+}$

**53.** The type of isomerism in coordination compounds $[Cu(NH_3)_4]$ $[PtCl_4]$ and $[Pt(NH_3)_4]$ $[CuCl_4]$ is
(a) coordination isomerism
(b) geometrical isomerism
(c) ionization isomerism
(d) linkage isomerism

**54.** The equilibrium constant of the following reaction is $K$

$$aA + bB \rightleftharpoons cC + dD$$

the equilibrium constant of the reaction

$$ncC + ndD \rightleftharpoons naA + naB,$$ will be

(a) $K^n$ (b) $\frac{n}{K}$

(c) $n.K$ (d) $\frac{1}{K^n}$

**55.** The molar solubility (s) of the equilibrium, $A_x B_y$ (solid) $\rightleftharpoons x A^{y+}_{(aq)} + y B^{x-}_{(aq)}$, in terms of the solubility product ($K_{sp}$) will be

(a) $S=\left(\frac{K_{sp}}{X^x y^y}\right)^{1/x+y}$ (b) $S=\left(\frac{K_{sp}}{X^x - y^y}\right)^{x+y}$

(c) $S=\left(\frac{K_{sp}}{X.Y}\right)^{x+y}$ (d) $S=\left(\frac{K_{sp}}{X.Y}\right)^{1/x+y}$

**56.** The oxidant in the following reaction is

$I_{2(g)} + H_2S_{(g)} \rightarrow 2HI_{(g)} + S_{(s)}$

(a) $I_2$ (b) $H_2S$

(c) HI (d) S

**57.** A cubic close packed (*ccp*) structure contains 'N' atoms. The tetrahedral and octahedral voids, respectively, will be

(a) N and N (b) 2N and 2N

(c) 2N and N (d) N and 2N

**58.** Which of the following is not a colligative property ?

(a) Osmotic pressure

(b) Lowering of vapour pressure

(c) Optical activity

(d) Elevation of boiling point

**59.** The enthalpy change when 2.63 g of phosphorus reacts with an excess of bromine according to the equation :

$2P_{(s)} + 3Br_{2(l)} \rightarrow 2\ PBr_{3\ (g)}$; $\Delta_f H^0 = -243$ kJ mol$^{-1}$ will be

(a) 103 kJ (b) 10.3 kJ

(c) 20.6 kJ (d) 24.3 kJ

[Given: Molar mass of phosphorus = 30.97 g mol$^{-1}$]

**60.** A reaction is spontaneous at high temperatures if

(a) $\Delta H$ and $\Delta S$ both are negative

(b) $\Delta H$ and $\Delta S$ both are positive

(c) $\Delta H$ is negative and $\Delta S$ is positive

(d) $\Delta H$ is positive and $\Delta S$ is negative

**61.** Which of the following is an example of associated colloid ?

(a) Sulphur sol (b) Cellulose

(c) Sodium stearate (d) Polystyrene

**62.** The equilibrium constant of the reaction $Cu_{(s)} + 2Ag^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + Ag_{(s)}$ [Given : $E^0 = 0.46$ V] will be

(a) $4 \times 10^{15}$ (b) $4 \times 10^{14}$

(c) $14 \times 10^{14}$ (d) $15.6 \times 10^{1}$

**63.** The rate constant of a reaction is 3.0 $\times$ mol$^{-1}$ sec$^{-1}$. The order of this reaction will

(a) zero (b) first

(c) second (d) third

**64.** In the following nuclear equation :

$^{239}_{94}Pu + {}^{\prime}X^{\prime} \rightarrow {}^{242}_{96}Cm + {}^{1}_{0}n$

the '*X*' is a

(a) proton (b) deuteron

(c) γ-particle (d) α-particle

**65.** Which of the following is (*D*, α) type of transmutation ?

(a) $^7_3Li + {}^1_1H \rightarrow {}^4_2He + {}^4_2He$

(b) $^{23}_{11}Na + {}^1_0n \rightarrow {}^{24}_{11}Na + \gamma$

(c) $^{16}_8O + {}^2_1H \rightarrow {}^{14}_7N + {}^4_2He$

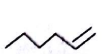
(d) $^9_4Be + {}^4_2He \rightarrow {}^{12}_6C + {}^1_0n$

**66.** The number of isomeric alkenes with molecular formula $C_5H_{10}$ are

(a) 4 (b) 5

(c) 6 (d) 8

**67.** Which of the following alkenes will give propanone and propanal on ozonolysis followed by reduction of ozonide with Zn/ $H_2O$ ?

(a)  (b) 

(c)  (d) 

**68.** The compound that forms racemic product on reaction with aqueous KOH is

(a) 3, 4-dimethyl-1-iodopentane

(b) 2, 3-dimethyl-3-iodopentane

(c) 1-iodo-3-methylpentane

(d) 1-iodo-4-methylpentane



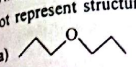


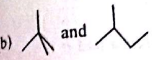
**69.** Which of the following haloalkanes is most reactive towards elimination reaction (E2) ?

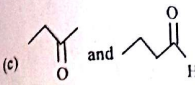
(a)  (b) 

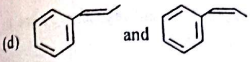
(c)  (d) 

**70.** Which of the following pairs of compounds does not represent structural isomers ?

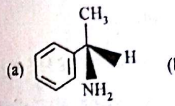
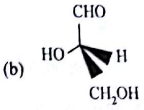
(a) 

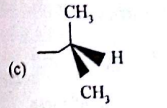
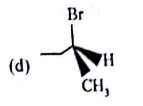
(b) 

(c) 

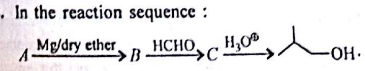
(d) 

**71.** Which one of the following compounds is achiral?

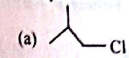
(a)  (b) 

(c)  (d) 

**72.** In the reaction sequence :



Compound '*A*' is

(a)  (b) 

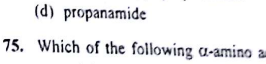
(c)  (d) 

**73.** Which of the following compounds will give 2, 2-dimethyl cyclohexanol by reduction with $LiAlH_4$?

(a)  (b) 

(c)  (d) 

**74.** In the sequence of reactions



the compound '*Y*' is

(a) propanamine

(b) N-methyl propanamine

(c) N, N-dimethyl propanamine

(d) propanamide

**75.** Which of the following α-amino acids is not an essential amino acid ?

(a) Arginine (b) Phenylalanine

(c) Tryptophan (d) Tyrosine

**76.** Which of the following is an azo dye ?

(a) Alizarin (b) Martius yellow

(c) Magenta (d) Congo red

**77.** The antioxidant commonly used as food additive is

(a) sodium benzoate

(b) butylated hydroxytoluene

(c) sodium alkyl benzene sulponates

(d) saccharin

**78.** Which of the following is a female sex hormone?

(a) Testosterone (b) Corticosterone

(c) Aldosterone (d) Progesterone

**79.** Which of the following enzymes breaks proteins into smaller peptides ?

(a) Trypsin (b) Invertase

(c) Lipase (d) Amylase

**80.** If one strand of DNA has the sequence C G A T G A T, the sequence in the complementary strand would be :

(a) C G T A G A T (b) T A G C A T A

(c) G C A T C T A (d) C G A T C A T

## MATHEMATICS

81. If $f(x)=\frac{x^2-1}{x^2+1}$ for every real number $x$, then the minimum value of $f$ is
(a) does not exist (b) 1
(c) $-1$ (d) 2

82. If $f(x) = x^2 + 2bx + 2c^2$ and $g(x) = -x^2 - 2cx + b^2$ are such that min $f(x) >$ max $g(x)$, then the relation between $b$ and $c$ is
(a) no relation (b) $0 < c < b/2$
(c) $|c| < |b|\sqrt{2}$ (d) $|c| < |b|\sqrt{2}$

83. The sum of the divisors of $2^3 3^4 5^2$ is
(a) $3^2 \cdot 7^1 \cdot 11^2$ (b) $3^2 \cdot 7^1 \cdot 11^2 \cdot 31$
(c) $3 \cdot 7 \cdot 11 \cdot 31$ (d) none of these

84. If $f(x) = \cos(\log_e x)$, then $f(x)f(y) - \frac{1}{2}[f(xy) + f(x/y)]$ is equal to
(a) 0 (b) $\frac{1}{2}f(x)f(y)$
(c) $f(x + y)$ (d) none of these

85. The function $f(x) = \log(x+\sqrt{x^2+1})$ is
(a) an even function (b) an odd function
(c) periodic function (d) none of these

86. If $f : (0, \infty) \to (0, \infty)$ and $f(x) = \frac{x}{1+x}$, then the function $f$ is
(a) one-one and onto
(b) one-one but not onto
(c) onto but not one-one
(d) neither one-one nor onto

87. The equation $e^{\sin x} - e^{-\sin x} - 4 = 0$ has
(a) no real roots
(b) exactly one real root
(c) exactly four real roots
(d) infinite real roots

88. The number of solutions of $\log_e(x-1) = \log_e(x-3)$ is
(a) 3 (b) 1 (c) 2 (d) 0

89. If the equations $k(6x^2 + 3) + rx + 2x^2 - 1 = 0$ and $6k(2x^2 + 1) + px + 4x^2 - 2 = 0$ have both roots common, then the value of $(2r - p)$ is
(a) 0 (b) 1/2
(c) 1 (d) none of these

90. If $x^2 - 3x + 2$ is a factor of $x^4 - px^2 + q$, then the values $p$ and $q$ are
(a) 5, – 4 (b) 5, 4
(c) – 5, 4 (d) – 5, – 4

91. The equation $k \sin x + \cos 2x = 2k - 7$ possesses a solution if
(a) $k > 6$ (b) $2 \le k \le 6$
(c) $k > 2$ (d) none of these

92. The value of $n$ so that $\frac{a^{n+1}+b^{n+1}}{a^n+b^n}$ may be the geometric mean between $a$ and $b$ is
(a) $-\frac{1}{2}$ (b) $\frac{1}{2}$
(c) 0 (d) 1

93. If $\log 2$, $\log(2^x - 1)$ and $\log(2^x + 3)$ are in A.P., then $x$ is equal to
(a) $\frac{5}{2}$ (b) $\log_2 5$
(c) $\log_3 2$ (d) $\frac{3}{2}$

94. If the sun of an infinitely decreasing G.P. is 3 and the sum of the squares of its terms is $\frac{9}{2}$, then the sum of the cubes of the terms is
(a) $\frac{105}{13}$ (b) $\frac{108}{13}$
(c) $\frac{729}{8}$ (d) none of these

95. If $(1 + 3 + 5 + \ldots + p) + (1 + 3 + 5 + \ldots + q) = (1 + 3 + 5 + \ldots + r)$ where each set of parentheses contains the sum of odd integers, the smallest possible value of $p + q + r$ (where $p > 6$) is
(a) 12 (b) 21
(c) 45 (d) 54

96. If the first two terms of a H.P. are $\frac{2}{5}$ and $\frac{12}{13}$ respectively, then the largest term is
(a) 2nd term (b) 3rd term
(c) 4th term (d) 6th term



97. If $a, b, c$ are in G.P., then the equation $ax^2 + 2bx + c = 0$ and $dx^2 + 2ex + f = 0$ have a common root if $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in
(a) A.P. (b) G.P.
(c) H.P. (d) none of these

98. The sum to $n$ terms of the series $\frac{3}{1^2 \cdot 2^2} + \frac{5}{2^2 \cdot 3^2} + \frac{7}{3^2 \cdot 4^2} + \ldots$ is
(a) $\frac{n^2+n}{(n+1)^2}$ (b) $\frac{(n^2+2n)}{(n+1)^2}$
(c) $\frac{n^2}{n+1}$ (d) $n$

99. If $\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\ldots$ to $\infty = \frac{\pi^2}{6}$, then $\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\ldots$ equals
(a) $\frac{\pi^2}{8}$ (b) $\frac{\pi^2}{12}$
(c) $\frac{\pi^2}{3}$ (d) $\frac{\pi^2}{2}$

100. $e^{x-1-\frac{1}{2}(x-1)^2+\frac{1}{3}(x-1)^3-\frac{1}{4}(x-1)^4+\ldots}$ is equal to
(a) $\log(x - 1)$ (b) $\log x$
(c) $x$ (d) none of these

101. Let $T_n$ denote the number of triangles which can be formed by using the vertices of a regular polygon of $n$ sides. If $T_{n+1} - T_n = 21$, then $n$ equals
(a) 5 (b) 7
(c) 6 (d) 4

102. The range of the function $f(x) = {}^{7-x}P_{x-3}$ is
(a) {1, 2, 3, 4} (b) {1, 2, 3, 4, 5}
(c) {1, 2, 3} (d) {1, 2, 3, 4, 5, 6}

103. If $a$ and $b$ are the greatest values of ${}^{2n}C_r$ and ${}^{2n-1}C_r$ respectively, then
(a) $a = 2b$ (b) $b = 2a$
(c) $a = b$ (d) none of these

104. The number of integral solutions of $x + y + z = 0$ with $x \ge -5$, $y \ge -5$, $z \ge -5$ is
(a) 135 (b) 136
(c) 455 (d) 105



105. If $n > 1$, then $(1 + x)^n - nx - 1$ is divisible by
(a) $x^2$ (b) $x^3$
(c) $x^4$ (d) $x^5$

106. The coefficient of $x^4$ in the expansion of $A = 1 + (1 + x) + (1 + x)^2 + \ldots + (1 + x)^n$ is
(a) ${}^nC_4$ (b) ${}^{n+1}C_4$
(c) ${}^{n+1}C_{n+1}$ (d) none of these

107. The inverse of a skew-symmetric matrix of odd order is
(a) a symmetric matrix
(b) a skew-symmetric matrix
(c) diagonal matrix
(d) does not exist

108. If $A = \begin{bmatrix} i & -i \\ -i & i \end{bmatrix}$ and $B = \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$, then $A^8$ equals
(a) 4 $B$ (b) 128 $B$
(c) – 128 $B$ (d) – 64 $B$

109. Let $f(x) = \begin{vmatrix} 1+\sin^2 x & \cos^2 x & 4\sin 2x \\ \sin^2 x & 1+\cos^2 x & 4\sin 2x \\ \sin^2 x & \cos^2 x & 1+4\sin 2x \end{vmatrix}$. Then the maximum value of $f(x)$ is
(a) 2 (b) 3 (c) 4 (d) 6

110. The value of determinant $\begin{vmatrix} 1 & 1 & 1 \\ {}^nC_1 & {}^{n+1}C_1 & {}^{n+2}C_1 \\ {}^nC_2 & {}^{n+1}C_2 & {}^{n+2}C_2 \end{vmatrix}$ is equal to
(a) 1 (b) –1
(c) 0 (d) none of these

111. A drawer contain 5 brown socks and 4 blue socks well mixed. A man reaches the drawer and pulls out 2 socks at random. The probability that match is
(a) $\frac{4}{9}$ (b) $\frac{5}{8}$
(c) $\frac{5}{9}$ (d) $\frac{7}{12}$

112. Three different integers are chosen at random from the first 20 integers. The probability that their product is even is
(a) $\frac{2}{19}$ (b) $\frac{2}{19}$

(c) $\frac{17}{19}$ (d) $\frac{4}{29}$

**113.** The value of $\tan 9° - \tan 27° - \tan 63° + \tan 81°$ is
(a) 2 (b) 3
(c) 4 (d) none of these

**114.** In a triangle $ABC$, if $\frac{1}{a+c}+\frac{1}{b+c}=\frac{3}{a+b+c}$, then $C$ is equal to
(a) 30° (b) 45°
(c) 60° (d) 90°

**115.** The value of $\lim_{x\to 1}\frac{x+x^2+x^3+.....+x^n-n}{x-1}$ is
(a) $n$ (b) $\frac{n+1}{2}$
(c) $\left(\frac{n+1}{2}\right)n$ (d) $\frac{n(n-1)}{2}$

**116.** The value of $\lim_{x\to 0}\frac{\int_{\pi}^{x^2}\cos t^2\,dt}{x\sin x}$ is
(a) $\frac{3}{2}$ (b) 1
(c) $-1$ (d) none of these

**117.** If $f(x)\begin{cases}\frac{\log(1+ax)-\log(1-bx)}{x}, & x\neq 0\\ k, & x=0\end{cases}$
and $f(x)$ is continuous at $x = 0$, then the value of $k$ is
(a) $a - b$ (b) $a + b$
(c) $\log a + \log b$ (d) none of these

**118.** The set of all points of discontinuity of the function $f(x) = \frac{1+\cos 5x}{1-\cos 4x}$ is
(a) $\{0, \pi/2, \pi/4\}$ (b) $\{0, \pi/2, \pi/6\}$
(c) $\{0, \pi/2, \pi\}$ (d) $\{0, \pi/2, \}$

**119.** If $a + b + c = 0$, then the quadratic equation $3ax^2 + 2bx + c = 0$ has
(a) at least one root in (0, 1)
(b) one root in (2, 3) and other in (−2, −1)
(c) imaginary roots
(d) none of these

**120.** If $x = \int_0^y \frac{1}{\sqrt{1+4t^2}}dt$, then $\frac{d^2y}{dx^2}$ is
(a) $2y$ (b) $4y$
(c) $8y$ (d) $6y$

**121.** Let $f(x + y) = f(x) f(y)$ for all $x$ and $y$. If $f(1) = 2$ and $f'(0) = 3$, then $f'(5)$ is equal to
(a) 5 (b) 6
(c) 0 (d) none of these

**122.** If the normal at the curve $y = f(x)$ at the point (3, 4) makes an angle $3\pi/4$ with positive x-axis, then $f'(3)$ is equal to
(a) −1 (b) −3/4
(c) 4/3 (d) 1

**123.** If $y = \cos^{-1}(\cos x)$, then $y'(x)$ is equal to
(a) 1 for all $x$
(b) − 1 for all $x$
(c) 1 in 2nd and 3rd quadrants
(d) −1 in 3rd and 4th quadrants

**124.** If $F(x) = \frac{1}{x^2}\int_{x^2}^{x}(4t^2-2F(t))dt$, then $F'(4)$ equals
(a) $\frac{32}{9}$ (b) $\frac{64}{3}$
(c) $\frac{64}{9}$ (d) none of these

**125.** If $\int_0^{2\pi} f(\cos^2 x)dx = k\int_0^{\pi} f(\cos^2 x)dx$, then the value of $k$ is
(a) 1 (b) $n$
(c) $\frac{n}{2}$ (d) none of these

**126.** The value of the integral $\int_a^b \frac{f(x)}{f(x)+f(a+b-x)}dx$ is
(a) $a - b$ (b) $\frac{a-b}{2}$
(c) $\frac{b-a}{2}$ (d) $b - a$





If $f: R \to R$, $g: R \to R$ are continuous functions, then the value of the integral $\int_{-\pi/2}^{\pi/2}(f(x)+f(-x)(g(x)-g(-x))dx$ is
(a) $\pi$ (b) 1
(c) −1 (d) 0

If $f(x)=\begin{vmatrix}\sin x+2x+\sin 3x & \sin 2x & \sin 3x\\ 3+4\sin x & 3 & 4\sin x\\ 1+\sin x & \sin x & 1\end{vmatrix}$,
then the value of $\int_0^{\pi/2} f(x)dx$ is
(a) 3 (b) 2/3
(c) 1/3 (d) 0

The area bounded by the curves $y = xe^x$, $y = xe^{-x}$ and the line $x = 1$, is
(a) $\frac{2}{e}$ (b) $1+\frac{2}{e}$
(c) $\frac{1}{e}$ (d) $1+\frac{1}{e}$

The slope of a curve at any point is the reciprocal of twice the ordinate at the point and it passes through the points (4, 3). The equation of the curve is
(a) $x^2 = y + 5$ (b) $y^2 = x + -5$
(c) $y^2 = x + 5$ (d) $x^2 = y - 5$

If $f(x)$, $g(x)$ be twice differentiable functions on [0, 2] satisfying $f''(x) = g''(x)$, $f'(1) = 2g'(1) = 4$ and $f(2) = 3g(2) = 9$, then $f(x) - g(x)$ at $x = 4$ equals
(a) 0 (b) 10
(c) 8 (d) 2

The general solution of the differential equation $(1 + y^2)\,dx + (1 + x^2)\,dy = 0$ is
(a) $x - y = c(1 - xy)$
(b) $x - y = c(1 - xy)$
(c) $x + y = c(1 - xy)$
(d) $x + y = c(1 + xy)$

The order of the differential equation of all tangents to the parabola $y = x^2$ is
(a) 1 (b) 2
(c) 3 (d) 4

The straight lines $x + 2y - 9 = 0$, $3x + 5y - 5 = 0$ and $ax + by = 1$ are concurrent if the straight line $35x - 22y + 1 = 0$ passes through
(a) $(a, b)$ (b) $(b, a)$
(c) $(a, -b)$ (d) $(-a, b)$

**135.** The points $A$ (2, 3), $B$ (3, 5), $C$ (7, 7) and $D$ (4, 5) are such that
(a) $ABC$ is a parallelogram
(b) $A$, $B$ $C$ and $D$ are collinear
(c) $D$ lies inside the triangle $ABC$
(d) $d$ lies on the boundary of the triangle $ABC$

**136.** If the algebraic sum of distances of a variable line from points (2, 0), (0, 2) and (−2, −2) is zero, then the line passes through the fixed point
(a) (−1, −1) (b) (0, 0)
(c) (1, 1) (d) (2, 2)

**137.** The equation of a circle with origin as centre and passing through the vertices of an equilateral triangle whose median is of length $3a$, is
(a) $x^2 + y^2 = 9a^2$ (b) $x^2 + y^2 = 6a^2$
(c) $x^2 + y^2 = 4a^2$ (d) $x^2 + y^2 = a^2$

**138.** If the tangent at the point $P$ on the circle $x^2 + y^2 + 6x + 6y = 2$ meets the straight line $5x - 2y + 6 = 0$ at a point $Q$ on the $y$-axis, then the length $PQ$ is
(a) 4 (b) $2\sqrt{5}$
(c) 5 (d) $3\sqrt{5}$

**139.** A parallelopiped is formed by planes drawn through the points (2, 3, 5) and (5, 9, 7), parallel to co-ordinate planes. The length of a diagonal of the parallelopiped is
(a) 7 (b) $\sqrt{38}$
(c) $\sqrt{155}$ (d) none of these

**140.** If the $x$-coordinate of a point $P$ on the join of $Q$ (2, 2, 1) and $R$ (5, 1, −2) is 4, then its $z$-coordinate is
(a) 2 (b) 1
(c) −1 (d) −2

**141.** The equation of the plane through the points (2, 2, 1) and (9, 3, 6) and perpendicular to the plane $2x + 6y + 6z - 1 = 0$ is
(a) $3x + 4y + 5z = 9$
(b) $3x + 4y - 5z = 9$
(c) $3x + 4y - 5z + 9 = 0$

(d) none of these

**142.** The value of a for which the volume of the parallelopiped formed by the vectors $\hat{i}+a\hat{j}+\hat{k}, \hat{j}+a\hat{k}$ and $a\hat{i}+\hat{k}$

(a) $-3$ (b) $3$

(c) $\frac{1}{\sqrt{3}}$ (d) $-\sqrt{3}$

**143.** Let $\vec{a}=\hat{i}-\hat{k}, \vec{b}=x\hat{i}+\hat{j}+(1-x)\hat{k}$ and $\vec{c}=y\hat{i}+x\hat{j}+(1+x-y)\hat{k}$, then $[\vec{a}\ \vec{b}\ \vec{c}]$ depends on

(a) only $x$ (b) only $y$

(c) neither $x$ nor $y$ (d) both $x$ and $y$

**144.** A vector $\vec{a}$ has components $2p$ and 1 with respect to a rectangular Cartesian system. The system is rotated through a certain angle about the origin in the counter clockwise sense. If $\vec{a}$ has components $p+1$ and 1 with respect to the new system, then

(a) $p = 0$ (b) $p = 1$ or $= -\frac{1}{3}$

(c) $p = -1$ or $p = 2$ (d) $p = 1$ or $p = -1$

**145.** Let $a, b, c$ be distance non-negative numbers. If the vectors $a\hat{i}+a\hat{j}+c\hat{k}, \hat{i}+\hat{k}$ and $c\hat{i}+c\hat{j}+b\hat{k}$ lie in $a$ plane, then $c$ is

(a) the arithmetic mean of $a$ and $b$

(b) the geometric mean of $a$ and $b$

(c) the harmonic mean of $a$ and $b$

(d) equal to zero

**146.** The distance of the point $B$ with position $\hat{i}+2\hat{j}+3\hat{k}$ from the line passing through the $A$ whose position vector is $4\hat{i}+2\hat{j}+2\hat{k}$ and with the vector $2\hat{i}+3\hat{j}+6\hat{k}$ is

(a) $\sqrt{10}$ (b) $\sqrt{5}$

(c) $\sqrt{6}$ (d) $\sqrt{11}$

**147.** A force is resolved into components $P$ and $Q$ inclined to it, then

(a) $P = 2Q$ (b) $2P = Q$

(c) $P = Q$ (d) none of these

**148.** A particle is acted upon by three forces $P, Q$ $R$. It cannot be in equilibrium, if $P : Q : R =$

(a) 1 : 3 : 5 (b) 3 : 5 : 7

(c) 5 : 7 : 9 (d) 7 : 9 : 11

**149.** $O$ is the circumcenter of $\Delta ABC$. If forces $P, Q$ $R$ acting along $OA$, $OB$, $OC$ are in equilib then $P : Q : R$ is

(a) $\sin A : \sin B : \sin C$

(b) $\cos A : \cos B : \cos C$

(c) $a \cos A : b \cos B : c \cos C$

(d) $a \sec A : b \sec B : c \sec C$

**150.** If a cricketer can throw a ball 49 m vertically can throw it on a level field

(a) 24. 5 m (b) 49 m

(c) 98 m (d) none of these