

SOLUTION & ANSWER FOR ISAT-2010 – PAPER - II

VERSION – A

[PHYSICS, CHEMISTRY & MATHEMATICS]

PART A – PHYSICS

1. The pseudo force on the object as seen -----

Ans : 2 mg upwards

Sol: When the rectangular box falls with acceleration 2 g, the pseudo force acting on the mass m attached to the box is 2 mg upwards.

2. The net force (pseudo force + all real forces) on -

Ans : 0

Sol: The mass is at rest with respect to the box. Hence the net force is zero.

3. Now the robot releases the object -----

Ans : CD in time square root of H/g

Sol: When released, the relative acceleration of the mass is (2 g – g) = g upwards.

Assuming the mass is the centre ($\frac{H}{2}$ from

CD), time required to hit CD is given by

$$\frac{1}{2}gt^2 = \frac{H}{2}$$

$$\Rightarrow t = \sqrt{\frac{H}{g}}$$

4. A square loop and an electric dipole \vec{p} are fixed on a light plastic plate-----

Ans : Along negative z direction

Sol: $\vec{m} \times \vec{B} = -(\vec{p} \times \vec{E})$
 $m(-\hat{k}) \times B(\hat{j}) = -[p(\hat{j}) \times \vec{E}]$
 $\vec{E} = E(-\hat{k})$

5. Positive electric charge is distributed uniformly on the surface of a thin spherical -----

Ans : \vec{E} is normal to the plane of the rim, pointing upwards.

Sol: By symmetry, all the field components in the plane of the rim of the bottom hemisphere will add up to zero. The normal component at P points upwards.

6. Two equal positive charges A and B are kept fixed at the -----

Ans : $\frac{\pi}{2}$, $\sin^{-1}(3/4)$

Sol: For the released charge to move along Y-axis, the forces along X-axis must balance.

$$\therefore \frac{Kq}{10^2} \sin \theta = \frac{Kq}{15^2}$$

$$\therefore \sin \theta = \frac{10^2}{15^2} = \frac{4}{9}$$

The only choice is (b) which meets condition for motion along x.

7. An electric charge +q is located at each of the points -----

Ans : $\frac{q}{2\pi\epsilon_0 a} \times \frac{s}{s+1}$

Sol: Potential at origin

$$= 2 \frac{kq}{a} \left[1 + \frac{1}{s^2} + \frac{1}{s^4} + \dots \right] - \frac{2kq}{a} \left[\frac{1}{s} + \frac{1}{s^3} + \dots \right]$$

$$= \frac{2kq}{a} \left[\frac{1}{1 - \frac{1}{s^2}} \right] - \frac{2kq}{as} \left[\frac{1}{1 - \frac{1}{s^2}} \right]$$

$$= \frac{2kq}{a} \left[\frac{s^2}{(s^2 - 1)} \right] \left[1 - \frac{1}{s} \right]$$

$$= \frac{2kq}{a} \left[\frac{s^2}{s^2 - 1} \right] \times \frac{s-1}{s}$$

$$= \frac{q}{2\pi\epsilon_0 a} \times \frac{s}{s+1}$$

8. An electron (magnitude of charge e, mass m) is moving in a circular orbit -----

Ans : $n \left(\frac{heB}{4\pi m} \right)$

Sol: Radius of orbit = $\frac{mv}{qB}$

de-Broglie wavelength $\lambda = \frac{2\pi r}{n}$

$$= \frac{2\pi mv}{nqB}$$

$$\Rightarrow \frac{h}{mv} = \frac{2\pi mv}{nqB}$$

$$\therefore \frac{1}{2}mv^2 = \frac{qB}{4\pi m} \cdot nh$$

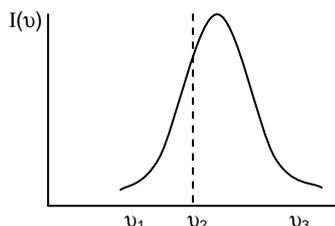
Ans : $\frac{1}{10}$

Sol: $PV_1 = n_1 RT$
 $PV_2 = n_2 RT$

$$\frac{V_1}{V_2} = \frac{n_1}{n_2} = \frac{L_1}{L_2} = \frac{\frac{m_1}{M_1}}{\frac{m_2}{M_2}} = \frac{\frac{14}{28}}{\frac{20}{4}} = \frac{1}{10}$$

9. A source emits sound having a range of frequencies, the -----

Ans :

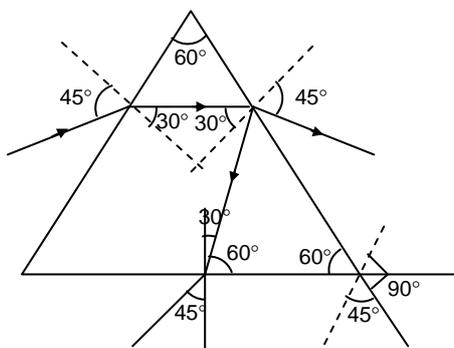


Sol: As the listener moves towards the source apparent frequency increases. Intensity remains the same.

10. An equilateral prism ABC is made of a material of refractive index -----

Ans : 90°

Sol:



11. An ideal gas undergoes two successive processes A and B, in the process A, the -----

Ans : Process A is adiabatic, process B is isothermal.

Sol: Theoretical.

12. A thermally conducting piston can move freely in a thermally insulated cylindrical vessel, separating -----

13. A solid rectangular parallelepiped has sides of lengths x, y and z, respectively

Ans : $\frac{\Delta z}{z} (1 - 2 \nu)$

Sol: Original volume = $xyz = V$

relative change in volume = $\frac{dV}{V}$

$$= \frac{\Delta x(yz) + \Delta y(zx) + \Delta z(xy)}{xyz}$$

$$= \frac{\Delta x}{x} + \frac{\Delta y}{y} + \frac{\Delta z}{z}$$

Given $\frac{\Delta x}{x} = \frac{\Delta y}{y} = \frac{-\nu \Delta z}{z}$

\therefore relative change in volume

$$= \frac{-\nu \Delta z}{z} - \frac{\nu \Delta z}{z} + \frac{\Delta z}{z}$$

$$= \frac{\Delta z}{z} (1 - 2 \nu)$$

14.which does not contain a neutral oxide.....

Ans : CO_2, SO_3, CaO, XeO_3

Sol: CO_2, SO_3, XeO_3 – acidic (non metallic oxides). CaO –basic (metallic oxide)

15. The X–E –X bond angle in EX_3 is

Ans : 90°

Sol: 3p orbitals are mutually perpendicular to each other.

16. The species with metal ion having d^5 configuration is

Ans : $K_4[Mn(CN)_6]$

Sol: Mn is in +2 oxidation state and has d^5 configuration

17. The monobasic acid among the following is

Ans : H_3PO_2

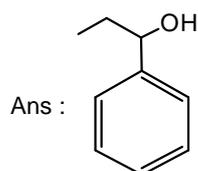
Sol: H_3PO_2 is a monobasic acid as there is only one $-\text{OH}$ group in it.

18. The best explosive among the following is

Ans : d

Sol: The most unstable structure.

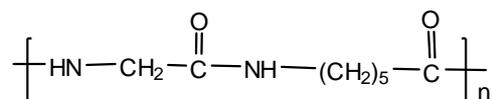
19. An organic compound on treatment with chromic acid/ H_2SO_4 gave a clear orange solution which turned greenish and opaque immediately. The compound is



Sol: Secondary alcohols are oxidized to ketones by chromic acid

20. Among the following, the homo polymer is

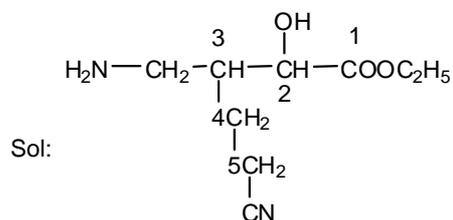
Ans :



Sol: Structure (b), (c) and (d) are copolymers

21. The correct IUPAC nomenclature of the given compound is

Ans : ethyl - 3-aminomethyl-5-cyano-2-hydroxy pentanoate



ethyl - 3-aminomethyl-5-cyano-2-hydroxy pentanoate

22. standard molar enthalpies of a several substances are summarised

Ans : $\frac{\text{Br}_2(\text{g})}{\text{H}_2(\text{g}), \text{H}^+(\text{aq})}$

$\frac{\text{H}_2\text{O}(\text{g})}{\text{D}_2\text{O}(\text{g})}$
 $\frac{\text{H}_2\text{O}(\text{l})}{\text{H}_2\text{O}(\text{l})}$

Sol: $\Delta H_f^\circ - \text{H}_2(\text{g}) = 0, \text{H}^+(\text{aq}) = 0$

$\text{Br}_2(\text{g}) = 31 \text{ kJ}$
 $\text{H}_2\text{O}(\text{g}) = -241.8 \text{ kJ}$
 $\text{D}_2\text{O}(\text{g}) = -249.2 \text{ kJ}$
 $\text{H}_2\text{O}(\text{l}) = -285.2 \text{ kJ}$

23. The observed rate of a chemical reaction is substantially lower than the collision frequency....

Ans : A, B, & D

Sol: A, B, & D

24. The correct statement(s) for alkali halides is /are

Ans : A, B, & D

Sol: Metal excess defect makes NaCl -yellow, LiCl -red and KCl -violet.

25. For the cell reaction, $\text{Mg}(\text{s}) + 2\text{Ag}^+(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + 2\text{Ag}(\text{s}), \dots$

Ans : 3.04 V, $-611.8 \text{ kJ mol}^{-1}$, 20000

Sol: $E_{\text{cell}} = E_{\text{cell}}^\circ + \frac{0.06}{2} \log \frac{(\text{Ag}^+)^2}{(\text{Mg}^{2+})}$
 $= 3.17 + 0.03 \log \frac{(0.001)^2}{0.02}$
 $= 3.04 \text{ V}$
 $\Delta G^\circ = -nFE^\circ$
 $= -2 \times 96500 \times 3.17 \text{ J mol}^{-1}$
 $= -611.81 \text{ kJ mol}^{-1}$.

26. The most thermally stable polymer is

Ans : Polyethylene

Sol: Linear chain and hence effective packing.

27. The sum of the series ...

Ans : $\frac{2}{9}$

Sol: $S = 1 + 3r + 5r^2 + 7r^3 \dots$
 $S_r = r + 3r^2 + 7r^3 \dots$

$S(1-r) = 1 + 2r + 2r^2 + 2r^3 \dots$
 $S(1-r) = 1 + \frac{2r}{1-r}$

$$\therefore S \left(1 + \frac{1}{2}\right) = 1 + \frac{2 \times \frac{-1}{2}}{3} = 1 - \frac{2}{3} = \frac{1}{3}$$

$$S \times \frac{3}{2} = \frac{1}{3} \Rightarrow S = \frac{2}{9}$$

28. A group of 47 students received 27 ...

Ans: 18

Sol: $n(F) = 27 \quad n(B) = 26$

$n(C) = 28$

$n(F \cap B \cap C) = 8$

$n(F \cup B \cup C) = n(F) + n(B) + n(C)$

$- n(A \cap B) - n(B \cap C)$

$- n(F \cap C) + n(A \cap B \cap C)$

$47 = 27 + 26 + 28 - () + 8$

$\therefore n(F \cap B) + n(B \cap C) + n(E \cap C) = 42$

\therefore No student received exactly two events

$= 42 - 3n(A \cap B \cap C) = 42 - 24$

$= 18$

29. Let $f(x) = 3 \int_0^x t^2 f(t) dt + 1, \dots$

Ans : e

Sol: $f'(x) = 3x^2 f(x)$

$\frac{f'(x)}{f(x)} = 3x^2 \Rightarrow \log f(x) = x^3 + C$

$\therefore f(x) = Ce^{x^3} \dots (1)$

$f(0) = 3 \int_0^0 f^2(x) + 1 = 1 \Rightarrow C = 1$

$\therefore f(x) = e^{x^3} \Rightarrow f(1) = e$

30. The general solution of the

Ans: $y^4 = C \left(\frac{x-2}{x+2}\right)$

Sol: $\frac{dx}{x^2-4} = \frac{dy}{y} \Rightarrow \log y = \frac{1}{4} \log \left(\frac{x-2}{x+2}\right)$

$\Rightarrow y^4 = C \left(\frac{x-2}{x+2}\right)$

31. If $f(x) = [x]$ denotes the greatest

Ans: $\frac{3}{2} - \sqrt{2}$

Sol: $\int_0^{\frac{3}{2}} ([x^2] - [x]^2) dx$

$= \int_0^{\frac{3}{2}} [x^2] dx - \int_0^{\frac{3}{2}} [x]^2 dx$

$= \int_0^1 [x^2] dx - \int_1^{\sqrt{2}} [x]^2 dx + \int_0^{\frac{3}{2}} [x^2] dx$

$- \left(\int_0^1 [x]^2 dx + \int_1^{\frac{3}{2}} [x]^2 dx \right)$

$= 0 + (\sqrt{2} - 1) + 2 \left(\frac{3}{2} - \sqrt{2} \right) - \left[\left(\frac{3}{2} - 1 \right) \right]$

$= \frac{3 - 2\sqrt{2}}{2} = \frac{3}{2} - \sqrt{2}$

32. The value of $\lim_{x \rightarrow \infty} (e^x + x)^{1/x}$ is

Ans: 1

Sol: $\lim_{x \rightarrow \infty} \left(\left(1 + \frac{x}{e^x} \right)^{e^x/x} \right)^{1/e^x}$

$= \lim_{x \rightarrow \infty} \left(\left(1 + \frac{x}{e^x} \right)^{e^x/x} \right)^{1/e^x}$

$= e^0 = 1$

33. Let z_1, z_2, z_3 be complex numbers

Ans: $z_2 + z_3 = 0$

Sol: Put $z_2 = -z_3$

$|z_1 + z_3|^2 + |z_1 - z_3|^2 = 4$

Indeed $2 \times |z_1|^2 + |z_2|^2 = 4$

$\therefore z_2 + z_3 = 0$

34. The number of ways in which 7 balls ...

Ans: $7^7 - 7$

Sol: 7 balls in 7 bags; Atmost 5 bags empty

Total number of ways $= 7^7$

Let 6 bags be empty

$\Rightarrow {}^7C_1 = 7$

\therefore Atmost 5 bags empty is possible in

$(7^7 - 7)$ ways

35. $\tan^{-1} \frac{2}{11} + 2 \tan^{-1} \frac{1}{7}$ is

Ans: $\tan^{-1} \left(\frac{1}{2} \right)$

Sol: $\tan^{-1} \left(\frac{2}{11} + \tan^{-1} \left(\frac{2 \cdot \frac{1}{7}}{1 - \frac{1}{49}} \right) \right)$
 $\tan^{-1} \left(\frac{2 \cdot \frac{1}{7} \cdot 49}{49 - 1} \right)$
 $\tan^{-1} \left(\frac{14}{48} \right) = \tan^{-1} \left(\frac{7}{24} \right)$
 $\tan^{-1} \frac{2}{11} + \tan^{-1} \left(\frac{7}{24} \right)$
 $= \tan^{-1} \left(\frac{\frac{2}{11} + \frac{7}{24}}{1 - \frac{2}{11} \times \frac{7}{24}} \right)$
 $= \tan^{-1} \left(\frac{48 + 77}{11 \times 24 - 14} \right)$
 $= \tan^{-1} \left(\frac{125}{250} \right) = \tan^{-1} \left(\frac{1}{2} \right)$

36. A traffic police reports that ...

Ans: $\frac{14}{5} \left(\frac{4}{5} \right)^9$

Sol: $P(\text{outside the state}) = \frac{1}{5}$

$P(\text{inside the state}) = 1 - \frac{1}{5} = \frac{4}{5}$

∴ there can be 9 inside state or 10 inside state vehicles.

Required probability

$$= {}^{10}C_9 \cdot \left(\frac{4}{5} \right)^9 \cdot \frac{1}{5} + {}^{10}C_{10} \left(\frac{4}{5} \right)^{10}$$

$$= \frac{4^9}{5^{10}} (10 + 4) = \frac{14 \times 4^9}{5^{10}}$$

37. Let a, b, c be three non-zero vectors

Ans: $\left(\frac{\bar{a} \cdot \bar{c}}{b \cdot c} \right) (\bar{a} \times \bar{b})$

Sol: $\bar{c} \times (\bar{r} \times \bar{b}) = \bar{c} \times (\bar{a} \times \bar{b})$
 $(\bar{c} \cdot \bar{b}) \bar{r} - (\bar{c} \cdot \bar{r}) \bar{b} = (\bar{c} \cdot \bar{b}) \bar{a} - (\bar{c} \cdot \bar{a}) \bar{b}$
 $\therefore (\bar{c} \cdot \bar{b}) \bar{r} = (\bar{c} \cdot \bar{b}) \bar{a} - (\bar{c} \cdot \bar{a}) \bar{b}$
 Since $\bar{c} \cdot \bar{r} = 0$

$$\therefore (\bar{c} \cdot \bar{b}) (\bar{r} \times \bar{a}) = (\bar{c} \cdot \bar{b}) \bar{a} \times \bar{a} - (\bar{c} \cdot \bar{a}) (\bar{b} \times \bar{a})$$

$$\therefore \bar{r} \times \bar{a} = \left(\frac{\bar{c} \cdot \bar{a}}{b \cdot c} \right) (\bar{a} \times \bar{b})$$

$$= \left(\frac{\bar{a} \cdot \bar{c}}{b \cdot c} \right) (\bar{a} \times \bar{b})$$

38. Let an object be placed at ...

Ans: $5\sqrt{3}$

Sol: $\tan 30 = \frac{n}{10+x} = \frac{1}{\sqrt{3}} = \frac{n}{10+x}$
 $10+x = \sqrt{3}h$
 $10 + \frac{h}{\sqrt{3}} = \sqrt{3}h$
 $10\sqrt{3} + h = 3h$
 $2h = 10\sqrt{3}$
 $h = 5\sqrt{3}$

39. An unbiased die is rolled

Ans: $5 \left(\frac{1}{2} \right)^6$

Sol: 5th and 6th trials will have even numbered faces _ _ _ _ E E

The remaining 4 trials can be filled only as follows :

2E 2O → 1 way

3E 1O → 3 ways

4O → 1 way

5 ways to fill and $P(E) P(O) = \frac{1}{2}$

∴ $5 \left(\frac{1}{2} \right)^6$

40. A student is allowed to select

Ans: 3

Sol: Atleast one book and Atmost n

$\Rightarrow {}^{2n+1}C_1 + {}^{2n+2}C_2 + \dots + {}^{2n+1}C_n = 63$

But $\sum_{r=0}^{2n+1} {}^{2n+1}C_r = 2^{2n+1}$ and

${}^{2n+1}C_r = {}^{2n+1}C_{2n+1-r}$

∴ $2[{}^{2n+1}C_1 + \dots + {}^{2n+1}C_n] = 2^{2n+1} - 2$

$\Rightarrow 2(63) = 2^{2n+1} - 2$

$\Rightarrow 2n = 6 \Rightarrow n = 3$