# 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: $\bar{m} \times \bar{B} = -\left(\bar{p} \times \bar{E}\right)$

$m\left(-\hat{k}\right) \times B\left(\hat{j}\right) = -\left[p\left(\hat{j}\right) \times \bar{E}\right]$

$\bar{E} = E\left(-\hat{k}\right)$

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

Ans : $\bar{E}$ 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 : $\frac{q}{2\pi\varepsilon_0 a} \times \frac{s}{s+1}$

Sol: Potential at origin

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

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

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

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

$$= \frac{q}{2\pi\varepsilon_0 a} \times \frac{s}{s+1}$$

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 $\lambda = \frac{2\pi r}{n}$

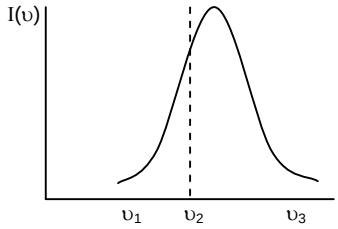
$= \frac{2\pi mv}{nqB}$

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

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

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

Ans :

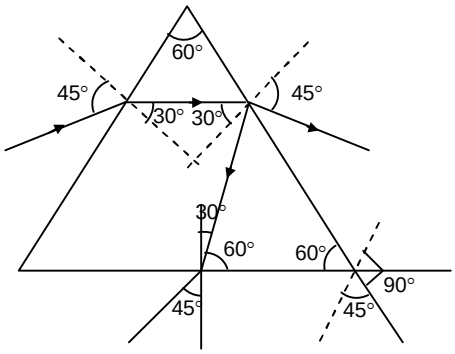



Sol: As the listener moves towards the source apparent frequency increases. Intensity remains the same.

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 ----------

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

Sol: $PV_1 = n_1 RT$

$PV_2 = n_2RT$

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

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

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

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 $\frac{\Delta x}{x} = \frac{\Delta y}{y} = \frac{-\upsilon \Delta z}{z}$

$\therefore$ relative change in volume

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

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

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 –OH group in it.

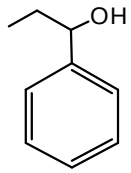
18. The best explosive among the following is

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

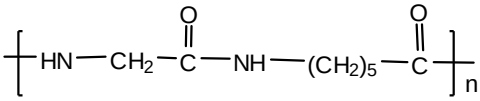
Ans :




Sol: Secondary alcohols are oxidized to ketones by chromic acid

20. Among the following, the homo polymer is

Ans :

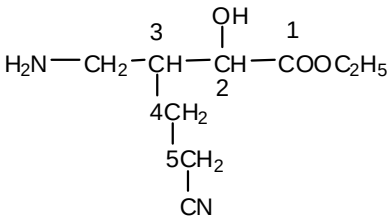



Sol: Structure (b), (c) and (d) are copolymers

21. The correct IUPAC nomenclature of the given compound is

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

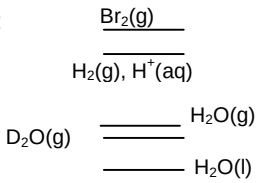
Sol:




ethyl – 3–aminomethyl–5–cyano–2–hydroy pentanoate

22. standard molar enthalpies of a several substances are summarised ….

Ans :




Sol: $\Delta H_f^\circ$ values are;

$H_{2(g)} = 0,\ H^+_{(aq)} = 0$

$Br_{2(g)}$ = 31 kJ

$H_2O(g)$ = –241.8 kJ

$D_2O(g)$ = –249.2 kJ

$H_2O(l)$ = –285.2 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, $Mg(s) + 2Ag^+(aq) \rightarrow Mg^{2+}(aq) + 2Ag(s)$, ….

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

Sol: $E_{cell} = E^0_{cell} + \frac{0.06}{2}\log\frac{\left(Ag^+\right)^2}{\left(Mg^{2+}\right)}$

$= 3.17 + 0.03 \log \frac{(0.001)^2}{0.02}$

$= 3.04$ V

$\Delta G^\circ = -nFE^\circ$

$= -2 \times 96500 \times 3.17$ J $mol^{-1}$

$= -611.81$ kJ $mol^{-1}$.

$\Delta G = \Delta G^\circ + RT\ \ell n\ Q$

$\log Q = \frac{0.127 \times 96500 \times 2}{2.303 \times 8.314 \times 298} = 4.3$

$Q = 20000$

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: $S = 1 + 3r + 5r^2 + 7r^3 \ldots$

$S_r = r + 3r^2 + 7r^3 \ldots$

$S(1-r) = 1 + 2r + 2r^2 + 2r^3 \ldots$

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

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

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

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

Ans : e

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

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

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

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

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

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: $\int_0^{3/2} \left([x^2] - [x]^2\right)dx$

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

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

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

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

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

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

Ans: e

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

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

$= e$

**Aliter**

$\ell = \lim_{x\to\alpha} \left(e^x + x\right)^{1/x}$

$\log \ell = \lim_{x\to\alpha} \frac{\log\left(e^x + x\right)}{x}$ (using LH rule)

$= \lim_{x\to\alpha} \frac{e^x + 1}{e^x + n}$

$= \lim_{x\to\alpha} \frac{e^x}{e^x + 1}$

$\log \ell = \lim_{x\to\alpha} \frac{e^x}{e^x} = 1$

$\therefore \ell = e$

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: $\tan^{-1}\left(\frac{2}{11} + \tan^{-1}\left(\frac{2.\frac{1}{7}}{1-\frac{1}{49}}\right)\right)$

$\tan^{-1}\frac{\left(2.\frac{1}{7}.49\right)}{49-1}$

$\tan^{-1}\left(\frac{14}{48}\right) = \tan^{-1}\left(\frac{7}{24}\right)$

$\tan^{-1}\ \frac{2}{11} + \tan^{-1}\left(\frac{7}{24}\right)$

$= \tan^{-1}\left(\frac{\frac{2}{11}+\frac{7}{24}}{1-\frac{2}{11}\times\frac{7}{24}}\right)$

$= \tan^{-1}\left(\frac{48+77}{11\times 24-14}\right)$

$= \tan^{-1}\left(\frac{125}{250}\right) = \tan^{-1}\left(\frac{1}{2}\right)$

36. A traffic police reports that …

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

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

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

$\therefore$ there can be 9 inside state or 10 inside state vehicles.
Required probability

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

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

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

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

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

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

38. Let an object be placed at …

Ans: $5\sqrt{3}$

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

$10 + x = \sqrt{3}\,h$

$10 + \frac{h}{\sqrt{3}} = \sqrt{3}\,h$

$10\sqrt{3} + h = 3h$

$2h = 10\sqrt{3}$

$h = 5\sqrt{3}$

39. An unbiased die is rolled ….

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

Sol: $5^{th}$ and $6^{th}$ trials will have even numbered faces _ _ _ _ E E
The remaining 4 trials can be filled only as follows :
2E 20 $\rightarrow$ 1 way
3E 10 $\rightarrow$ 3 ways
40 $\rightarrow$ 1 ways
5 ways to fill and P(E) = P(O) = $\frac{1}{2}$

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

40. A student is allowed to select ….

Ans:3

Sol: Atleast one book and Atmost n

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

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

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

$\therefore\ 2[{}^{2n+1}C_1 + \ldots + {}^{2n+1}C_n] = 2^{2n+1} - 2$

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

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