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

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

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

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

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

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

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

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

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

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

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

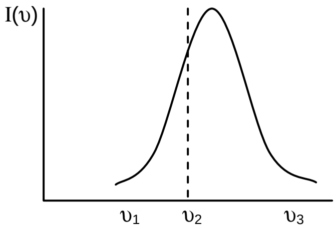
$= \frac{2\pi mv}{nqB}$

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

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

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

Ans :

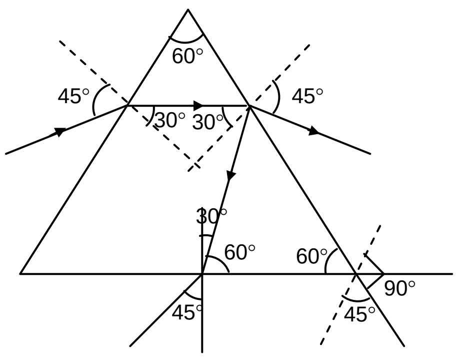


Sol: As the listener moves towards the source apparent frequency increases. Intensity remains the same.

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

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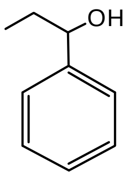
Sol: H_3PO_2 is a monobasic acid as there is only one –OH group in it.

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

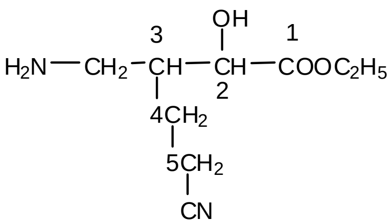
Ans :

$$\left[HN-CH_2-\overset{O}{\overset{\|}{C}}-NH-(CH_2)_5-\overset{O}{\overset{\|}{C}} \right]_n$$

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

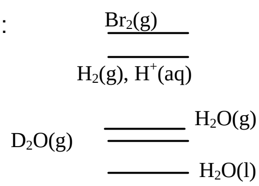
21. The correct IUPAC nomenclature of the given compound is

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: ΔH_f^o – $H_{2(g)}$ = 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: $E_{cell} = E^0_{cell} + \frac{0.06}{2}\log\frac{(Ag^+)^2}{(Mg^{2+})}$

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

$= 3.04$ V

$\Delta G° = –nFE°$

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

$= –611.81$ 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: $S = 1 + 3r + 5r^2 + 7r^3 \ldots$
$S_r = r + 3r^2 + 7r^3 ..$

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

$S(1 – r) = 1 + \frac{2r}{1-r}$

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

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

28. A group of 47 students received 27 …

Ans:18

Sol: n(F) = 27 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} — (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: $\int_0^{3/2}\left(\left[x^2\right]-[x]^2\right)dx$

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

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

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

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

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

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

Ans: 1

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

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

$= e^0 = 1$

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

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

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

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

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

$2h=10\sqrt{3}$

$h=5\sqrt{3}$

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 20 $\to$ 1 way

3E 10 $\to$ 3 ways

40 $\to$ 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

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

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

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

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

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