JEE MAIN 2014

Detailed Solution - Offline 6th April

F
CODE

CHEMISTRY

Solution
Q.1 (4)

All solutions have same osmotic pressure because they have same number of particles in the solution.

$0.5\,M\,C_2H_5OH$ (Non electrolyte)

$0.1\,M\ Mg_3(PO_4)_2 \equiv 0.1 \times 5 = 0.5\,M$

$0.25\,M\ KBr \equiv 0.25 \times 2 = 0.5\,M$

$0.125\,M\ Na_3PO_4 \equiv 0.125 \times 4 = 0.5\,M$

Solution
Q.2 (4)

DNA contains
1) Adenine
2) Guanine
3) Thymine
4) Cytosine
Quinoline doesn't present in DNA

Solution
Q.3 (4)

Basic strength $\alpha K_b \alpha \frac{1}{p^{k_b}}$

Basic strength of amines in H_2O

$(CH_3)_2\,NH > CH_3 - NH_2 > (CH_3)_3\,N > Ph - NH_2$

Solution
Q.4 (1)

Alkali and Alkaline earth metals can be extracted only in molten state.

Solution
Q.5 (3)

$$R - CH_2 - NH_2 \xrightarrow[C_2H_5O\ Na^{\oplus}]{CHCl_3} R - CH_2 - NC$$

Aliphatic
1° amine

Isocyanide

Solution
Q.6 (1)

$K_p = K_c\,(RT)^{\Delta n_g}$

$\Delta n_g = x = -\frac{1}{2}$

Solution
Q.7 **(4)**

$$E^o_{cell} = \underset{\text{Cathod}}{E^o_{R.P}} + \underset{\text{Anode}}{E^o_{O.P}}$$

$$= -1.18 - 1.51$$

$$= -2.69$$

Since E^o_{cell} is negative the reaction will not occur.

Solution
Q.8 (1)

van der Waal equation

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

for 1 mole at low pressure b can be neglected

$$\left(P + \frac{a}{V^2}\right)V = RT$$

$$PV = RT - \frac{a}{V}$$

$$\frac{PV}{RT} = 1 - \frac{a}{VRT}$$

$$Z = 1 - \frac{a}{VRT}$$

Solution
Q.9 (2)

$$CH_3COOH \xrightarrow{LiAlH_4} \underset{(A)}{CH_3CH_2OH} \xrightarrow{PCl_5} \underset{(B)}{CH_3CH_2Cl}$$

$$\downarrow \text{Alc KOH}$$

$$CH_2 = CH_2$$

(C) Ethylene

Solution
Q.10 (2)

The strength of acidic character of an oxyacid is directly proportional to the oxidation state of central atom.

Solution
Q.11 (1)

Let mass of $O_2 = W$ g

mass of $N_2 = 4W$ g

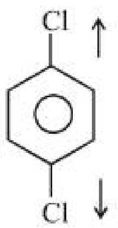
so moles ratio = molecules ratio $= \dfrac{\text{moles of } O_2}{\text{moles of } N_2}$

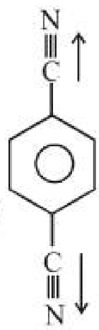
$$= \frac{W \times 28}{32 \times 4W}$$
$$= \frac{7}{32}$$

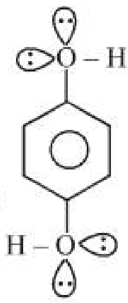
Solution
Q.12 (4)
NO is paramagnetic with 1 unpaired electron.

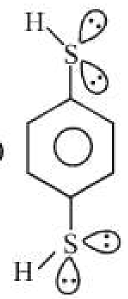
Solution
Q.13 (3)
$$Fe \xrightarrow{O_2,\text{Heat}} Fe_3O_4 \xrightarrow{CO,\,600^\circ C} FeO \xrightarrow{CO,\,700^\circ C} Fe$$
Carbon monoxide reduces Iron oxide.

Solution
Q.14 (3)
For symmetrycally substituted molecules $\mu = 0$ when it is symmetrical

(a)  $\mu = 0$

(b)  $\mu = 0$

(c)  unsymmetrical $\therefore \mu \neq 0$

(d)  unsymmetrical $\therefore \mu \neq 0$

Solution
Q.15 (2)
For CsCl the crystalline structure is bodycentred.

$$2r^+ + 2r^- = a\sqrt{3}$$
$$r^+ + r^- = \frac{a\sqrt{3}}{2}$$

Solution

Q.16 (4)

Neopreone

1) $n\,CH_2=CH-\underset{\underset{Cl}{|}}{C}=CH_2 \xrightarrow{Add^n} \left(CH_2-CH=\underset{\underset{Cl}{|}}{C}-CH_2 \right)$

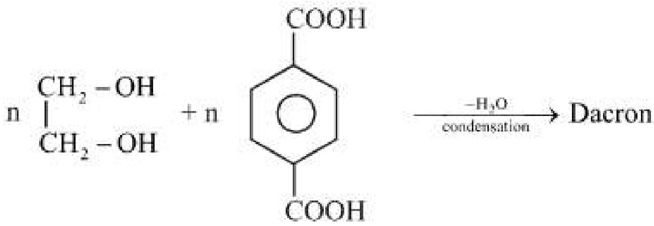
Neoprene

2) $n\,CF_2=CF_2 \xrightarrow{Add^n} \left(CF_2-CF_2 \right)_n$

Teflon

3) $CH_2=CH-C\equiv N \xrightarrow{Add^n} \left(CH_2-\underset{\underset{CN}{|}}{CH} \right)_n$

4) Dacron is condensation polymer



Solution

Q.17 (1)

$$\underset{(1.4\,g)}{\text{Organic compound}} \xrightarrow{\text{kjeldahl method}} NH_3 \xrightarrow{H_2SO_4\ (6\ \text{milli moles})} \text{Remaining } H_2SO_4$$

$$\text{So milli moles of } H_2SO_4 \text{ used with } NH_3 = 5 \xleftarrow[\text{2 milli moles}]{NaOH} \text{Remaining } H_2SO_4$$

So milli moles of $NH_3 = 5 \times 2$ (1 H_2SO_4 requires 2 NH_3)
$= 10$

So moles of $NH_3 = \dfrac{10}{1000}$

(same will be moles of N)

so mass of $N = \dfrac{14 \times 10}{1000} = 0.14\,g$

so % $N = \dfrac{0.14}{1.4} \times 100 = 10$

Solution
Q.18 (4)

$C_2H_5OH(l) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l)$

In bomb calorimeter heat liberated = 1364.47 kJ

So, $\Delta U = -1364.47$ kJ

$\Delta H = \Delta U + \Delta n_g RT$

$= -1364.47 + (-1) \times \frac{8.314}{1000} \times 298$

$= -1366.95$ kJ / mol.

Solution
Q.19 (1)

Strength of a ligand is directly proportional to energy and inversly proportional to wavelength of the radiation absorbed. $\left(E \propto \frac{1}{\lambda}\right)$

Solution
Q.20 (3)

$R-CH_2-OH \xrightarrow{K_2Cr_2O_7} R-COOH$

$R-CH_2-OH \xrightarrow{CrO_3} R-COOH + R-CHO$

$R-CH_2-OH \xrightarrow{PCC} R-CHO$ only

$R-CH_2-OH \xrightarrow{KMnO_4} R-COOH$

Solution
Q.21 (3)

In (b) and (d) oxidation number of oxygen is increasing from -1 to 0 i.e. oxidation of H_2O_2 is taking place. Therefore H_2O_2 is acting as reducing agent.

Solution
Q.22. (1)

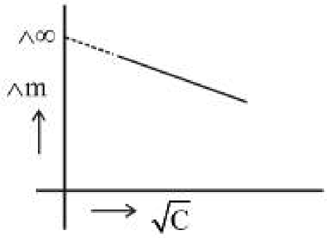
Cesium can form compounds only in +1 oxidation state and Iodine forms I_3^- with Iodide iron.

Solution
Q.23 (2)

$2CH_3-CCl_3 \xrightarrow[-6AgCl]{Ag} \underset{\text{2-Butyne}}{CH_3-C \equiv C-CH_3}$

Solution

Q.24 (2)



$$\wedge m = \wedge\infty - B\sqrt{C}$$

Solution

Q.25 (4)

$$G = \frac{k}{C} \qquad k = \text{specific conductance}$$

$$C = \text{conductance}\left(\frac{1}{R}\right)$$

$$\frac{k_1}{C_1} = \frac{k_2}{C_2}$$

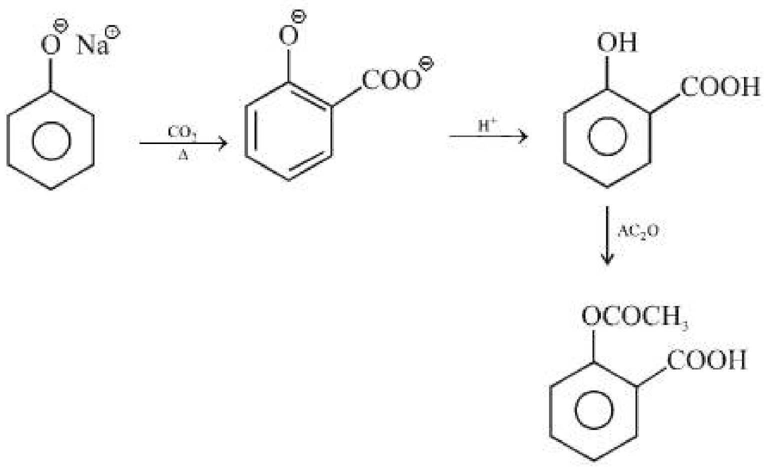
$$k_2 = \frac{1.4 \times 50}{280}$$

$$\wedge_m = \frac{10^{-3} \times k_2}{M}\ S\,m^2\,mol^{-1}$$

$$= \frac{10^{-3} \times 1.4 \times 50}{280 \times 0.5} = 5 \times 10^{-4}\ S\,m^2\,mol^{-1}$$

Solution

Q.26 (4)



'C'

Solution
Q.27 (1)
In acidic medium complex is unstable and decomposes.

Solution
Q.28 (4)
Electronic configuration of Cs $= [Xe]5s^1$
$\therefore$ valence electron comes in 5s orbital.

Solution
Q.29 (3)
From the given data it is clear that,
rate of reaction does not depend upon the concentration of B therefore order of reaction with respect to B will be 'zero'
While on doubling the concentration of A alone rate of reaction is also doubled therefore orders of reaction with respect to A will be 'one'
$\therefore r = k[A]$

Solution
Q.30 (1)
Rate of $SN^2 \; \alpha \dfrac{1}{\text{crowding}}$
$\therefore CH_3Cl > CH_3-CH_2-Cl > (CH_3)_2CH-Cl > (CH_3)_3C-Cl$

MATHEMATICS

Solution

Q. 31: (1)

$$\lim_{x\to 0}\frac{\sin(\pi\cos^2 x)}{x^2}, \frac{0}{0}\ form$$

$$\Rightarrow \lim_{x\to 0}\frac{\sin\left(\pi(1-\sin^2 x)\right)}{x^2}=\lim_{x\to 0}\frac{\sin(\pi\sin^2 x)}{x^2}$$

$$\Rightarrow \lim_{x\to 0}\frac{\sin(\pi\sin^2 x)}{(\pi\sin^2 x)}.\ \pi\frac{\sin^2 x}{x^2}$$

$$\Rightarrow 1.\ \pi.\ 1=\pi$$

Solution

Q.32: (2)

$$\frac{dp}{dt}=\frac{p}{2}-200\Rightarrow \int\frac{dp}{\frac{p}{2}-200}=\int dt+c$$

$$\Rightarrow \ell n\left|\frac{p}{2}-200\right|=t+C$$

$$\frac{p}{2}-200=\alpha.e^{t/2}$$

$$p=2\alpha e^{t/2}+400$$

at $t=0,\ p=100$

$$\Rightarrow\ 2\alpha=-300$$

$$\Rightarrow\ p=400-300.e^{t/2}$$

Solution

Q. 33: (2)

P	q	$p\Leftrightarrow q$	$\sim q$	$p\leftrightarrow\sim q$	$\sim(p\leftrightarrow\sim q)$
T	T	T	F	F	T
T	F	F	T	T	F
F	T	F	F	T	F
F	F	T	T	F	T

Hence $\sim(p\leftrightarrow\sim q)=p\Leftrightarrow q$

Solution

Q. 34: (1)

Given condition $\alpha+\beta=4\alpha\beta$

$\Rightarrow -\frac{q}{p}=4.\frac{r}{p}\Rightarrow q=-4r$

p, q, r : in A.P $\Rightarrow$ p + r = 2q

$\Rightarrow$ p + r = -8r $\Rightarrow$ p = -9r

$\Rightarrow \frac{p}{9}=\frac{q}{4}=\frac{r}{-1}$

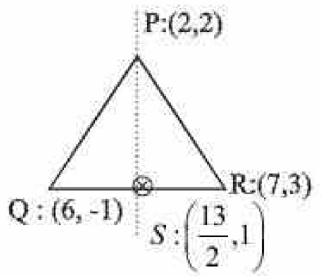
$\Rightarrow$ equation is $9x^2+4x-1=0$

$|\alpha-\beta|=\sqrt{(\alpha+\beta)^2-4\alpha\beta}=\sqrt{\frac{16}{81}+\frac{4}{9}}$

$=\frac{2\sqrt{13}}{9}$

Solution

Q. 35: (3)



Equation of PS : $y-2=\frac{-1}{9/2}(x-2)$

$y-2=\frac{-2}{9}(x-2)$

$9y-18=-2x+4$

2x = 9y - 22 = 0

line || to PS $\Rightarrow 2x+9y+\lambda=0$

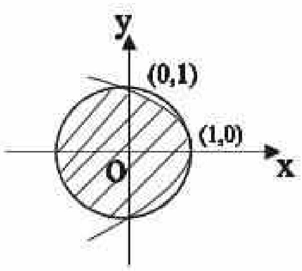
passing through $(1,-1)\Rightarrow\lambda=7$

$\Rightarrow 2x+9y+7=0$

Solution

Q. 36 : (2)

Area $=\frac{1}{2}\pi.1^2+2.\int_0^1(1-y^2)dy$



$$= \frac{\pi}{2} + 2.\left[y - \frac{y^3}{3}\right]^1$$

$$= \frac{\pi}{2} + \frac{4}{3}$$

Solution

Q. 37: (3)

Given $A.A^1 = A^1.A$

$$B.B^1 = (A^{-1}.A^1).(A^{-1}.A^1)^1$$

$$= (A^{-1}A^1).(A.A^{1^{-1}})$$

$$= A^{-1}(A^1 A)A^{1^{-1}} = A^{-1}\, A A^{-1}\, A^{1^{-1}}$$

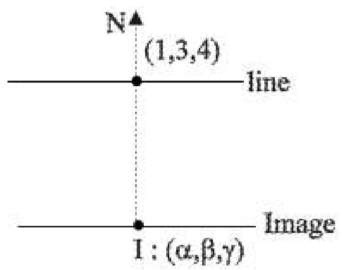
$$= (A^{-1}A)\,(A^1.A^{1^{-1}}) = I.I$$

$$= I^2 = I$$

Solution

Q. 38: (2)

line is || to the plane (not in the plane)



line $\perp$ to plane passing through $(1, 3, 4)$

$$\Rightarrow \frac{x-1}{2} = \frac{y-3}{-1} = \frac{2-4}{1} = r$$

P lies on the plane => $r = -1 \Rightarrow P:(-1, 4, 3)$

$$\frac{\alpha+1}{2} = -1,\ \frac{\beta+3}{2} = 4,\ \frac{r+4}{2} = 3 \Rightarrow (\alpha, \beta, \gamma):(-3, 5, 2)$$

$$\Rightarrow \text{ Image: } \frac{x+3}{3} = \frac{y-5}{1} = \frac{z-2}{-5}$$

Solution

Q. 39: (4)

$$f^1(x) = \frac{\alpha}{x} + 2\beta x + 1$$

when $x = -1,\ f^1(x) = 0 \Rightarrow -\alpha - 2\beta + 1 = 0$ ------ (1)

$x = 2\ \ f^1(x) = 0 \Rightarrow \quad \frac{\alpha}{2} + 4\beta + 1 = 0$ ------ (2)

$$\alpha + 8\beta + 2 = 0 \quad \text{-----} \; (3)$$

$$(1) + (2) \Rightarrow 6\beta + 3 = 0 \Rightarrow \beta = -1/2, \quad \alpha = 2$$

Solution

Q. 40 : (2)

$$x - [x] = \{x\} = \frac{-2 \pm \sqrt{4 + 12a^2}}{-6}$$

$$\Rightarrow \{x\} = \frac{2 \mp 2\sqrt{1 + 3a^2}}{6}, \quad x \neq I$$

$$0 < \{x\} < 1$$

$$0 < \frac{1 \mp \sqrt{1 + 3a^2}}{3} < 1$$

$$\Rightarrow a \in (-1, 0) \cup (0, 1)$$

Solution

Q. 41: (1)

$$y + 1 = \sqrt{1^2 + (y-1)^2}$$

$$(y+1)^2 - (y-1)^2 = 1$$

$$4y = 1$$

$$y = \frac{1}{4}$$

$$\text{radius} = \frac{1}{4}$$

Solution

Q. 42: (1)

$$\text{Coefficient of } x^3 = {}^{18}C_3(-2)^3 + a\,{}^{18}C_2(-2)^2 + b\,{}^{18}C_1(-2)^1 = 0$$

$$51a - 3b = 544 \quad \text{-----------} \; (1)$$

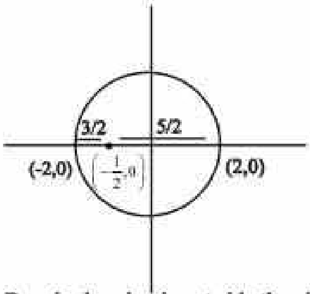
$$\text{Coefficient of } x^4 = {}^{18}C_4(-2)^4 + a\,{}^{18}C_3(-2)^3 + b\,{}^{18}C_2(-2)^2 = 0$$

$$544a - 51b = 4080 \quad \text{-------}(2)$$

Solving (1) and (2)

$$a = 16 \quad b = \frac{272}{3}$$

Solution
Q. 43: (3)



Required region is out side the circle

from figure it is clear that $\left|z+\frac{1}{2}\right| \geq \frac{3}{2}$

Hence, minimum value lies in $(1,2)$

Solution
Q. 44 : (3)

$$\int\left(1+x-\frac{1}{x}\right)e^{x+\frac{1}{x}}\,dx$$

$$\int e^{x+\frac{1}{x}}\left[x\left(x-\frac{1}{x^2}\right)+1\right]dx$$

$$x\,e^{x+\frac{1}{x}}+c$$

Solution
Q. 45: (2)

Equation of tangent of $y^2=4x$ is

$$y=mx+\frac{1}{m}$$

If it is tangent of $x^2=-32y$ then

$$\frac{1}{m}=8m^2$$

$$m^3=\frac{1}{8} \Rightarrow m=\frac{1}{2}$$

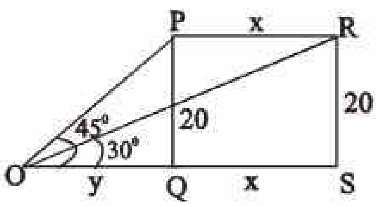
Solution
Q. 46 : (1)

$$f_4(x)-f_6(x)=\frac{1}{4}\left(\sin^4 x+\cos^4 x\right)-\frac{1}{6}\left(\sin^6 x+\cos^6 x\right)$$

$$=\frac{1}{4}\left(1-\frac{1}{2}\sin^2 2x\right)-\frac{1}{6}\left[1-\frac{3}{4}\sin^2 2x\right]$$

$$=\frac{1}{4}-\frac{1}{6}=\frac{1}{12}$$

Solution
Q. 47 : (1)



$$\frac{20}{y} = \tan 45 \Rightarrow 20 = y$$

$$\frac{20}{x+y} = \tan 30$$

$$20\sqrt{3} = 20 + x$$

$$x = 20(\sqrt{3}-1)$$

$$\text{speed} = \frac{x}{t} = \frac{20(\sqrt{3}-1)}{1} = 20(\sqrt{3}-1)$$

Solution
Q. 48 : (1)

$$\left[\vec{a}\times\vec{b}\ \ \vec{b}\times\vec{c}\ \ \vec{c}\times\vec{a}\right]$$

$$= (\vec{a}\times\vec{b}).\left[(\vec{b}\times\vec{c})\times(\vec{c}\times\vec{a})\right]$$

$$= (\vec{a}\times\vec{b}).\left[(\vec{b}\times\vec{c}\cdot\vec{a})\vec{c} - (\vec{b}\times\vec{c}\cdot\vec{c})\vec{a}\right]$$

$$= \left[\vec{a}\ \vec{b}\ \vec{c}\right]^2$$

$$\lambda = 1$$

Solution
Q.49 : (4)

$$P(A') = \frac{1}{4} \Rightarrow P(A) = 1 - \frac{1}{4} = \frac{3}{4}$$

$$P(B\cap A') = 1 - \frac{1}{2} - \frac{1}{4} - \frac{1}{6}$$

$$= \frac{1}{12}$$

$$P(B) = \frac{1}{4} + \frac{1}{12} = \frac{1}{3}$$

$$P(A\cap B) = \frac{1}{4} = P(A).P(B)$$

A and B are independent but not equally likely

Solution
Q. 50 : (4)

Sol : $\frac{x^2}{6} + \frac{y^2}{2} = 1$

Let equation tanget : $\frac{x}{\sqrt{6}}\cos\theta + \frac{y}{\sqrt{2}}\sin\theta = 1$ -------- (1)

equation of perpendicular line passing through origin

$$\frac{x\sin\theta}{\sqrt{2}} - \frac{y}{\sqrt{6}}\cos\theta = 0 \quad \text{-----} \quad (2)$$

from (1) and (2)

$$\cos\theta = \frac{x\sqrt{6}}{x^2+y^2} \quad , \quad \sin\theta = \frac{\sqrt{2}y}{x^2+y^2}$$

$$\cos^2\theta + \sin^2\theta = 1$$

$$6x^2 + 2y^2 = (x^2+y^2)^2$$

Solution
Q.51 : (1)

Using Mean Value Theorem

$$f^1(c) = \frac{f(1)-f(0)}{1-0} = \frac{6-2}{1} = 4$$

$$\text{and } g^1(c) = \frac{g(1)-g(0)}{f-0} = \frac{2-0}{1} = 2$$

$$\Rightarrow f^1(c) = 2g^1(c)$$

Solution
Q.52 : (1)

Let a, ar, ar^2 are in G.P with r > 1
Now a, 2ar, ar^2 are in A.P

$$\Rightarrow r^2 + 1 = 4r$$

$$\Rightarrow (r-2)^2 = 3$$

$$\Rightarrow r - 2 = \pm\sqrt{3} \Rightarrow r = \sqrt{3} + 2$$

Solution
Q.53 : (1)

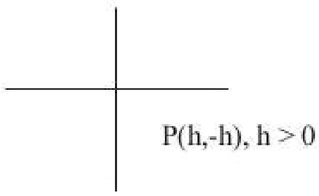
$$g(x) = f^{-1}(x)$$

$$\Rightarrow f[g(x)] = x$$

$$\Rightarrow f'[g(x)] \times g'(x) = 1$$

$$\Rightarrow g^1(x) = \frac{1}{f^1[g(x)]} = \frac{1}{\frac{1}{1+[g(x)]^5}} = 1 + [g(x)]^5$$

Solution
Q.54 : (4)



Intersection point between 4ax + 2ay + c = 0 and 5bx + 2by + d = 0 is $\left(\frac{bc-ad}{ab}, \frac{4ad-5bc}{2ab}\right)$

Now $\frac{bc-ad}{ab}=\frac{5bc-4ad}{2ab}$

$\Rightarrow 3bc-2ad=0$

Solution
Q.55 : (4)

$$\begin{vmatrix} 1+1+1 & 1+\alpha+\beta & 1+\alpha^2+\beta^2 \\ 1+\alpha+\beta & 1+\alpha^2+\beta^2 & 1+\alpha^2+\beta^3 \\ 1+\alpha^2+\beta^2 & 1+\alpha^3+\beta^3 & 1+\alpha^4+\beta^4 \end{vmatrix}$$

$$=\begin{vmatrix} 1 & 1 & 1 \\ 1 & \alpha & \beta \\ 1 & \alpha^2 & \beta^2 \end{vmatrix}\begin{vmatrix} 1 & 1 & 1 \\ 1 & \alpha & \beta \\ 1 & \alpha^2 & \beta^2 \end{vmatrix}=(1-\alpha)^2\ (\alpha-\beta)^2\ (\beta-1)^2$$

Hence k = 1

Solution
Q.56 : (1)

$$\int_0^{\pi}\left|1-2\sin\frac{x}{2}\right|dx$$

$$=2\int_0^{\pi/2}\left|1-2\sin t\right|dt \text{ where } \frac{x}{2}=t;\ \text{dx}=2\text{dt}$$

$$=2\left[\int_0^{\pi/6}(1-2\sin t)\,dt+\int_{\pi/6}^{\pi/2}(2\sin t-1)\,dt\right]$$

$$=2\left[\left[t+2\cos t\right]_0^{\pi/6}+\left[-2\cos t-t\right]_{\pi/6}^{\pi/2}\right]$$

$$=2\left[\left(\frac{\pi}{6}+\sqrt{3}-2\right)-\left(\frac{\pi}{2}-\sqrt{3}-\frac{\pi}{6}\right)\right]$$

$$=2\left[2\sqrt{3}-2-\frac{\pi}{6}\right]$$

$$=4\sqrt{3}-4-\frac{\pi}{3}$$

Solution
Q.57 : (4)

$$10^9+2(11)^1\times10^8+3(11)^2(10)^1+----+10\times(11)^9=10^9k$$

$$\Rightarrow 10^9\left[1+2\times\frac{11}{10}+3\times\left(\frac{11}{10}\right)^2+---+10\times\left(\frac{11}{10}\right)^9\right]=10^9k$$

$$\Rightarrow k=1+2\times\frac{11}{10}+3\times\left(\frac{11}{10}\right)^2+----10\times\left(\frac{11}{10}\right)^9 \quad ---------------- (1)$$

Now $\frac{11}{10}k = \frac{11}{10}+2\times\left(\frac{11}{10}\right)^2+-----+9\left(\frac{11}{10}\right)^9+10\times\left(\frac{11}{10}\right)^{10}$ ------(2)

equation (1) - equation (2)

$$\Rightarrow \frac{-1}{10}k = 1+\frac{11}{10}+\left(\frac{11}{10}\right)^2+-----+\left(\frac{11}{10}\right)^9-10\times\left(\frac{11}{10}\right)^{10}$$

$$= \frac{\left(\frac{11}{10}\right)^{10}-1}{\frac{11}{10}-1}-10\times\left(\frac{11}{10}\right)^{10}$$

$$\Rightarrow k = -10^2\times\left(\frac{11}{10}\right)^{10}+10^2+10^2\times\left(\frac{11}{10}\right)^{10} = 100$$

Solution
Q.58 : (2)

$(m+n)^2 = m^2+n^2 \Rightarrow 2mn = 0 \Rightarrow m = 0 \; or \; n = 0$

1) If $m = 0 \Rightarrow l = -n \Rightarrow$ D.R $\langle 1,0,-1\rangle$

2) If $n = 0 \Rightarrow l = -m \Rightarrow$ D.R $\langle 1,-1,0\rangle$

Now $\ell_1\ell_2+m_1m_2+n_1n_2 = \frac{1}{\sqrt{2}}.\frac{1}{\sqrt{2}}+0+0 = \frac{1}{2}$

$\Rightarrow \cos\theta = \frac{1}{2} \Rightarrow \theta = \frac{\pi}{3}$

Solution
Q.59 : (3)

As we know variance of first n natural numbers is $\frac{n^2-1}{12}$

Hence variance of first 50 even natural numbers will be $\frac{50^2-1}{12} = 833$

Solution
Q.60 : (1)

As $X \subset Y \Rightarrow X \cup Y = Y$

PHYSICS

Solution :

Q.61. (1)

$$\text{Pressure} = \frac{f}{A} = \text{thermal sterss}$$

$$= Y\alpha\Delta T$$

$$= 2\times10^{11}\times1.1\times10^{-5}\times100 = 2.2\times10^{9}\,Pa$$

Solution :

Q.62. (2)

Decay current $i = i_0 e^{-\frac{t}{\tau}}$

Voltage across the resistance is

$$V_R = iR = V_0 e^{-\frac{t}{\tau}}$$

Voltage across the inductor is

$$V_L = L\frac{di}{dt} = L\left(-\frac{i_0}{\tau}\cdot e^{-\frac{t}{\tau}}\right) = -V_0 e^{-\frac{t}{\tau}}$$

The Ratio $V_R / V_L = -1$

Solution :

Q.63. (1)

The energy of the photon released in the transition corresponding to $3 \to 2$ is

$$h\nu = E_3 - E_2 = 13.6\left(\frac{1}{4}-\frac{1}{9}\right) \approx 2eV$$

if K.E of electron ejected from the metal plate is K

$$R = \frac{\sqrt{2mK}}{qB}$$

$$K = \frac{R^2q^2B^2}{2m} = \frac{\left(10\times10^{-3}\right)^2\left(1.6\times10^{-19}\right)^2\left(3\times10^{-4}\right)^2}{2\times9.1\times10^{-31}}J \;= 0.79eV.$$

$$h\nu = w + K.E.$$

$$2eV = W + 0.79eV$$

$$W \approx 1.1eV$$

Solution :

Q.64. (2)

$$OB = R\cos\alpha \quad CD = R\sin\alpha$$

$$OA = R\sin\alpha \quad DE = R\cos\alpha$$

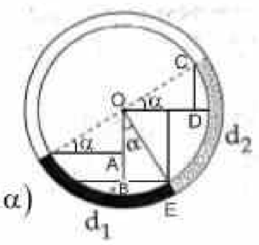
$$P_1 = P_0 + d_1 g\left(AB\right)$$

$$P_1 = P_0 + d_1 g(OB - OA)$$

$$P_1 = P_0 + d_1 gR(\cos\alpha - \sin\alpha)$$

$$P_2 = P_0 + d_2 g(CE) = P_0 + d_2 g(CD + De)$$

$$P_2 = P_2 + d_2 g(R\sin\alpha + R\cos\alpha) = P_0 + d_2 gR(\sin\alpha + \cos\alpha)$$



As system is in equlibrium $P_1 = P_2$

$$P_0 + d_1 gR(\cos\alpha - \sin\alpha) = P_0 + d_2 gR(\sin\alpha + \cos\alpha)$$

$$d_1(\cos\alpha - \sin\alpha) = d_2(\sin\alpha + \cos\alpha)$$

$$\frac{d_1}{d_2} = \frac{\sin\alpha + \cos\alpha}{\cos\alpha - \sin\alpha} = \frac{1 + \tan\alpha}{1 - \tan\alpha}$$

Solution :
Q.65. (4)

Net torque acting on bodies zero, so angular momentum is conserved

Solution :
Q.66. (1)

$$\frac{1}{f_1} = \left(\frac{3/2}{4/3} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{9}{8} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{8}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f_2} = \left(\left(\frac{3/2}{5/3}\right) - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{9}{10} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)_2 = -\frac{1}{10}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{2}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

So $f_1 > f$ and f_2 is Negative

Solution :
Q.67. (2)

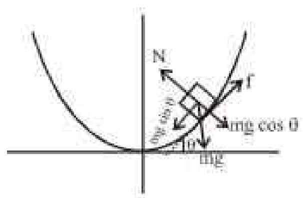
$$\left\{f \propto \frac{1}{\lambda}\right\} \text{ and } \mu = A + \frac{B}{\lambda^2} \quad \sin\theta_c = \frac{1}{\mu}$$

$$f \uparrow, \lambda \downarrow, \mu \uparrow, \theta_c \downarrow$$

Solution :
Q.68. (4)

$$y = \frac{x^3}{6}$$

$$\tan\theta = \frac{dy}{dx} = \frac{3x^2}{6} = \frac{x^2}{2}$$



$$f = mg\sin\theta$$

$$\tan\theta = \mu$$

$$\frac{x^2}{2} = 0.5 \Rightarrow x^2 = 1$$

$$x = 1$$

height of the block would be $= \frac{x^3}{6} = \frac{1}{6}m$

Solution :

Q.69. (2)

$$B = \mu_0 ni$$

$$\frac{B}{\mu_0} = H = ni$$

$$3\times10^3 = \frac{100}{10^{-1}} i$$

$$i = 3amp$$

Solution :

Q.70. (1)

Force acting on the rod at any instant is

$$f = i(\ell B) = 10\times3\times3\times10^{-4}e^{-0.2x}$$

$$\vec{f} = -9\times10^{-3}e^{-0.2x}{}_N\,\hat{a}_x$$

Total work done in moving from $x = 0$ to $x = 2m$ is

$$w\int_0^2 f dx = \int_0^2 9\times10^{-3}e^{-0.2x}dx$$

$$= 9\times10^{-3}\left(\frac{e^{-0.2x}}{-0.2}\right)_0^2$$

$$= 9\times10^{-3}\left(\frac{e^{-0.4}}{-0.2} + \frac{1}{0.2}\right)$$

$$w = \frac{9\times10^{-3}}{0.2}\left(1 - e^{-0.4}\right)$$

Power required is $P = \frac{w}{f} = \frac{9\times10^{-3}}{0.2\times5\times10^{-3}}\left(1 - e^{-0.4}\right)$

$$P = 9\left(1 - e^{-0.4}\right) = 9(1 - 0.67)$$

$$= 9(0.33) = 2.97w$$

Solution :

Q.71. (3)

$$I_A\cos^2\theta_1 = I_B\cos^2\theta_2$$

$$I_A\cos^2 30° = I_B\cos^2 60°$$

$$I_A\left(\frac{3}{4}\right) = I_B\left(\frac{1}{4}\right)$$

$$\frac{I_A}{I_B}=\frac{1}{3}$$

Solution :

Q.72. (4)

In forward bias connetion, P - n junction diode should connect such that P should be at higher potention than N. so desired connection is option : 4

Solution :

Q.73. (2)

$$dV=-\vec{E}\cdot\vec{dr}$$

$$\int dV=-\int_{x=0}^{x=2m}E\,dx\cos 0$$

$$\int_{V_0}^{V_A}dV=-\int_0^2 30x^2dx=-30.\left(\frac{x^3}{3}\right)_0^2$$

$$V_A-V_0=-30\left(\frac{8}{3}-0\right)=-80V$$

Q.74. (3)

Solution :

Q.75. (4)

$$I=e^{\frac{1000V}{T}-1}\simeq e^{\frac{1000V}{T}}$$

$$\Delta I\simeq\frac{dI}{dV}\times\Delta V=\frac{1000}{T}\times e^{\frac{1000V}{T}}\times\Delta V$$

$$=\frac{1000}{300}\times(5mA)\times(0.01)$$

$$\frac{1}{6}mA\simeq 0.2mA$$

Solution :

Q.76. (3)

$$\Delta U_{C\to A}<0$$

$$\Delta U_{A\to B}>0$$

$$\Delta U_{B\to C}=\frac{fnR\,\Delta T}{2}$$

$$=\frac{5}{2}\times 1\times R(-200)$$

$$=-500R$$

Solution :
Q.77. (2)

$$(2n+1)\frac{V}{4\ell} \le 1250$$

$$(2n+1) \le 1250 \times \frac{4 \times 0.8}{340}$$

or $(2n+1) \le 12.5$

$\therefore$ Possible no of harmonics $= 6$

Solution :
Q.78. (2)

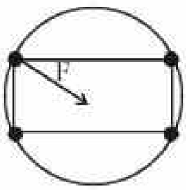
Total power $= 15 \times 40 + 5 \times 100 + 5 \times 80 + 1 \times 1000$
$= 2500\,W$

Applied voltage $= 220\,V$

Current $= \frac{2500}{220} \simeq 11.36\,A$

Hence minimum capacity of fuse wire is 12 A

Solution :
Q. 79. (3)



Resultant gravitational force on one particle due to other three particles $= F = \frac{GM^2}{4R^2}\left(2\sqrt{2}+1\right)$

F provides necessary centripetal force

$$\therefore \frac{Mv^2}{R} = \frac{GM^2}{4R^2}\left(2\sqrt{2}+1\right)$$

Or $V = \frac{1}{2}\sqrt{\frac{GM}{R}\left(2\sqrt{2}+1\right)}$

Solution :
Q. 80. (2)

Time taken by the particle to reach maximum height $= \frac{u}{g}$

Time taken by the particle to reach ground $= \frac{u}{g} + \sqrt{\frac{2}{g}\left(H + \frac{u^2}{2g}\right)}$

According to the given problem $\frac{nu}{g} = \frac{u}{g} + \sqrt{\frac{2}{g}\left(H + \frac{u^2}{2g}\right)}$

or $\frac{(n-1)^2 u^2}{g^2} = \frac{2}{g}\left(H + \frac{u^2}{2g}\right)$

or $u^2 n(n-2) = 2gH$

Solution :
Q.81. (1)

Solution :
Q.82. (4)

$$E = \frac{\sigma}{K \in_0}$$

$$3\times10^4 = \frac{\sigma}{2.2\times8.85\times10^{-12}}$$

or $\sigma = 3\times10^4 \times 2.2\times8.85\times10^{-12}$

$\simeq 5.8\times10^{-7} c/m^2$

Solution :
Q.83. (4)

$76\times8 = P\times x$

Where P is new pressure exerted by air and x is length of air column

or $P = \frac{76\times8}{x}$

(Pressure exerted by air column) + (Pressure exerted by mercury column) = Atmospheric pressure

$$\frac{76\times8}{x} + (54 - x) = 76$$

Solving the obtain $x = 16cm$

Solution :
Q.84. (3)

Consider equation of given SHM as

$X = A\cos\omega t$

According to given problem

$A - a = A\cos\omega t$ ...(1)

and $A - 3a = A\cos2\omega t$ ...(2)

$\therefore$ $\cos\omega t = \frac{A-a}{A}$ and $\cos2\omega t = \frac{A-3a}{A}$

$\cos2wt = 2\cos^2 wt - 1$

or $\left(\frac{A-3a}{A}\right)^2 = 2\left(\frac{A-a}{A}\right)^2 - 1$

or $A = 2a$

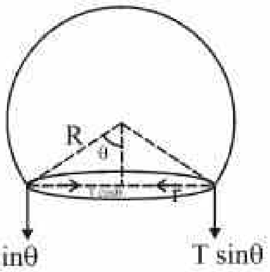
substituting $A = 2a$ in equation (1)
we obtain $a = 2a\cos wt$

or $\cos wt = \frac{1}{2}$

or $\frac{2\pi}{T}\tau = \frac{\pi}{3}$

or $T = 6\tau$

Solution
Q.85 (4)



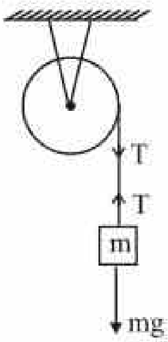
Bubble starts to move up if
unbalance force due to excess pressure and force exerted by base due to surface tension = Buoyancy force

$$T\sin\theta \times 2\pi r + \frac{2T}{R} \times \pi r^2 = \frac{4}{3}\pi R^3 \rho g$$

or $\frac{4T \times \pi r^3}{R} = \frac{4\pi R^3 \rho g}{3}$

or $r = R\sqrt{\frac{\rho g}{3T}}$

Solution
Q. 86 (1)



For block,
$mg - T = ma$ ....(1)

For cylinder, $TR = mR^2 \times \frac{a}{R}$ ....(2)

Solving above two equations, we obtain

$$a = \frac{g}{2}$$

Solution
Q. 87 (3)

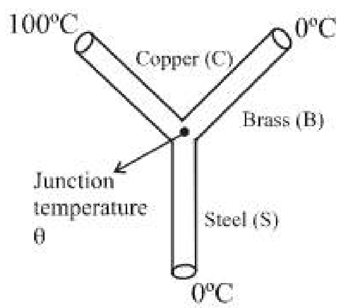
$$u_E = \frac{1}{2} \epsilon_0 E^2$$

and $u_B = \frac{1}{2}\frac{B^2}{\mu}$

But $E = cB$

$\therefore u_E = u_B$

Solution
Q. 88 (4)



Using law of junction, we obtain

$$\frac{K_C A(100-\theta)}{46} = \frac{K_B A(\theta-0)}{13} + \frac{K_S A(\theta-0)}{12}$$

Solving above equation we obtain.

$\theta \simeq 41.03°C$

Rate of flow of heat through the copper rod

$$= \frac{K_C A(100-\theta)}{l_C}$$

$$= \frac{0.96 \times 4(100-41.03)}{46}$$

$\simeq 1.2$ cal / s

Solution

Q. 89 (2)

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$$

or $\lambda Z^2 =$ constant

or $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$

Solution

Q. 90 (2)

$$W = \int_0^L F dx$$

$$= \int_0^L \left(ax + bx^2\right)dx$$

$$= \left[\frac{ax^2}{2} + \frac{bx^3 3}{}\right]_0^L$$

$$= \frac{aL^2}{2} + \frac{bL^3}{3}$$