From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE JEE(Advanced)-2013

ANSWERS, HINTS & SOLUTIONS
FULL TEST –IV
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	A	C
2.	B	B	A
3.	C	D	A
4.	D	B	D
5.	C	C	B
6.	B	A	C
7.	A	A	A
8.	A	C	C
9.	C	C	D
10.	D	D	B
11.	B, D	D	B, C, D
12.	A, B	A, B, C	A, B, D
13.	A, C	A, C, D	A, C, D
14.	A, B, C	B, C, D	A, B, C, D
15.	A, B, C, D	B, C, D	A, B, C
1.	2	6	4
2.	9	2	9
3.	6	3	3
4.	2	3	8
5.	3	8	9

Physics

PART – I

SECTION – A

1. On heating a metal sheet, distance between any two points increases.

2. Heat taken by ice to convert to water at 100°C fully :
$5 \times (40) \times (0.5) + 5 \times 80 + 5 \times (100) \times (1) = 1000$ cal.
Heat given by steam to condense fully :
$2 \times 500 = 1000$ cal. Hence everything will be water at 100°C.

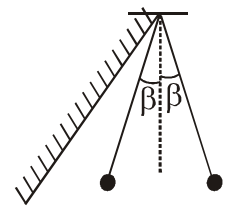
3. $W_{AB} + W_{BC} + W_{CD} + W_{DA} = \Delta Q$ $\{\because \Delta U = 0$ in cyclic process$\}$

$\Rightarrow W_{AB} + 0 + nRT_0 \ln\left(\frac{V_0}{3V_0}\right) + nR(2T_0 - T_0) = 4nRT_0$ $\{\because$ DA is isobaric process$\}$

get $W_{AB} = nRT_0 \ln 3 + 3nRT_0$

4. As $\alpha > \beta$, no collision will occur with the wall and the ball is doing SHM with amplitude β only.

$T = 2\pi\sqrt{\frac{\ell}{g}}$.

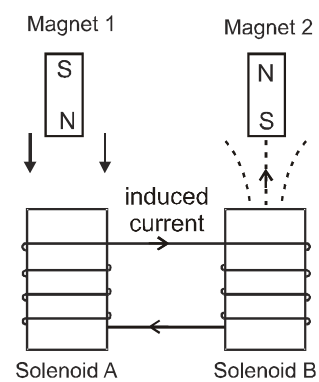


5. As the fluid is at rest; pressure at the same horizontal level in a connected fluid is same if it is at equilibrium.

6. The magnetic field will make electrons revolve around the direction of B. It may cause some electrons not to reach the collector plate. If it is very strong; it will not let electrons reach the collector. As the magnitude is not given, hence photo current may decrease.

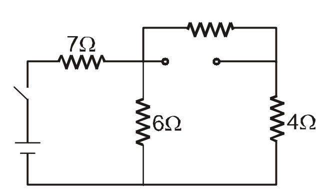
7. The work done by cell = $\int V\,dq = \int_0^V CV\,dV = \frac{1}{2}CV^2$.

8. As the magnet-1 falls into solenoid A, the magnetic flux associated with solenoid A increases. From Lenz's law, induced current in solenoid A will oppose this increase in magnetic flux. Hence direction of induced current in solenoids is as shown.
The nature of magnetic field produced by solenoid B is as shown. Therefore magnet 2 will be attracted by magnetic field due to solenoid B.



9. at t = 0

$\Rightarrow R_{eq.} = \frac{(4+2)\times 6}{6+6} + 7 = 3 + 7 = 10\ \Omega$

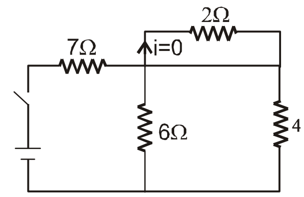


$\Rightarrow\ i_1 = \dfrac{10}{10} = 1$ A.

at $t = \infty$

$\Rightarrow\ 7 + \dfrac{4 \times 6}{6 + 4} = 9.4$

$\Rightarrow\ i_2 = \dfrac{10}{9.4}$ so $\dfrac{i_1}{i_2} = \dfrac{1}{(10/9.4)} = 0.94$

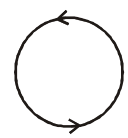


10. Power delivered by mg is converted to the heat dissipated in R_1 and R_2

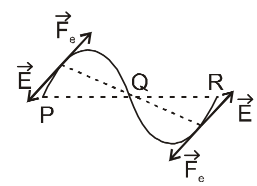
$\Rightarrow$ mgv = $P_{R_1} + P_{R_2}$

solving, we get P_{R_2} = 6W

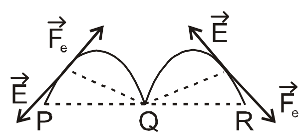
11. The changing magnetic field inside the plane produces electric lines of forces in anticlockwise direction.
There is no direct connection in the shown conductors, so electrons, experiencing electric force, try to accumulate as shown.



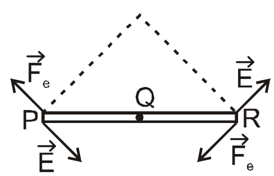
All electrons accumulate at Q symmetrically
$V_P = V_R$



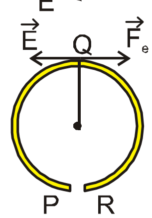
All electrons accumulate at R
$V_P > V_R$



electrons accumulate
at P $V_P < V_R$



electrons accumulate at R
$V_P > V_R$



12. Fission of a nucleus is feasible only if the binding energy of daughter nuclei is more than the parent nucleus.
A = 55 will have more BE than 110.
A = 70 will have same BE as 110 but A = 40 will have more B.E.
A = 100 will have same BE as 110 but A = 10 will have lesser B.E.
A = 90 will have same BE as 110 but A = 20 will have lesser B.E.

13. $\lambda \propto \dfrac{1}{T} \Rightarrow T_1 > T_2 > T_3$ as $\lambda_1 < \lambda_2 < \lambda_3$ (Wien's law)

Now as the area under the curve E_λ and λ gives the intensity; so

$\sigma A e_3 T_3^4 > \sigma A e_2 T_2^4$ {Areas of the bodies are same, given}

Now as $T_3 < T_2 \Rightarrow e_3 > e_2$.

14. $h\nu$ = K.E. (T) + work function (W)

$\Rightarrow h\nu = T + W$

$\Rightarrow$ 4.25 eV = $T_A + W_A$ (for Metal A)

$\Rightarrow$ 4.70 eV = $T_B + W_B$ (for Metal B)

Since $T_B = (T_A - 1.5)$ eV

Also $\lambda = h/p$

$\Rightarrow \lambda = \frac{h}{\sqrt{2mT}} \left\{\because \frac{p^2}{2m} = T = K.E.\right\}$

$\Rightarrow \frac{\lambda_A}{\lambda_B} = \sqrt{\frac{T_B}{T_A}}$

Since $\lambda_A = \frac{1}{2}\lambda_B$

$\Rightarrow T_A = 4T_B$

$\Rightarrow T_B = T_A - 1.50$ gives

$T_B = 4T_B - 1.5$

$\Rightarrow T_B = 0.5$ eV

$\Rightarrow T_A = 2$ eV

$\Rightarrow W_A = 2.25$ eV

$\Rightarrow W_B = 4.20$ Ev

15. $P = V^3$, for ideal gas

$PV = nRT$

(A) relation between V and T

$V \times (3V^3) = nRT$

$\Rightarrow V^4 = \left(\frac{nR}{3}\right)T \Rightarrow V^4 \propto T$

(B) Relation between P and T

$PV = nRT \Rightarrow P\left(\frac{P}{3}\right)^{1/3} = nRT$

$\Rightarrow P^{4/3} \propto T$

(C) For expansion

$V \to$ increases

work-done : positive

internal energy : increases

Hence, heat will have to supplied to the gas.

(D) As $T \propto V^4$

with increase in temperature, volume increases

Hence work done is positive.

SECTION –C

1. $v = \sqrt{\frac{T}{\mu}}$

T can be calculated by using Hooke's Law and on stretching μ also changes.

2. $f_1 = \left(\frac{340}{340 - 34}\right)f = \frac{10}{9}f$

and $f_2 = \left(\frac{340}{340-17}\right)f = \frac{20}{19}f$

and $\frac{f_1}{f_2} = \frac{\frac{10}{9}}{\frac{20}{19}} = \frac{19}{18}$

3. For 1st reading of oscillator

$f_A = (514 \pm 2)$Hz

$\Rightarrow$ f_A = 516 Hz or 512 Hz

For 2nd reading of oscillator

$f_A = (510 \pm 6)$ Hz

$\Rightarrow$ f_A = 516 Hz or 504 Hz

$\Rightarrow$ A has a frequency of 516 Hz

4. Velocity of approach of man towards the bicycle = (u – v)
Hence velocity of approach of image towards bicycle is 2(u – v).

5. For A :

Total number of waves = $\frac{(1.5)t}{\lambda}$ ....(1)

$\because \left(\begin{array}{c}\text{Total number} \\ \text{of waves}\end{array}\right) = \left(\frac{\text{optical path length}}{\text{wavelength}}\right)$

For B and C :

Total number of waves = $\frac{n_B\left(\frac{1}{3}\right)}{\lambda} + \frac{(1.6)\left(\frac{2t}{3}\right)}{\lambda}$ ....(2)

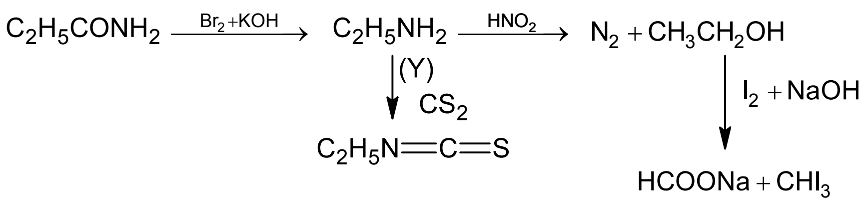
Equating (1) and (2)

$\Rightarrow n_B = 1.3$

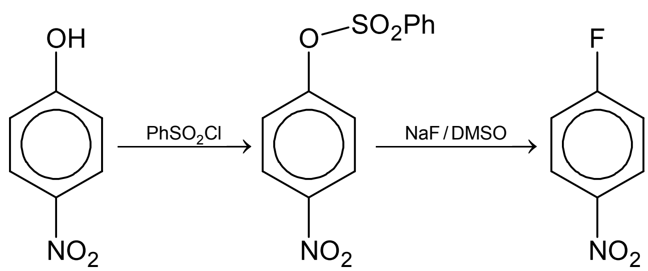
Chemistry PART – II

SECTION – A

1. Reaction of X with Br_2 + KOH suggests that X is an amide. Evolution of N_2 and formation of alcohol suggests that Y is a 1° aliphatic amine. Iodoform test of Z suggests that it is an alcohol containing $H_3C-\underset{OH}{\underset{|}{C}H}-$ group.



2.



(A) (B)

F^- is very reactive unsolvated which can displace $PhSO_3^-$ which being a good leaving group in presence of strong withdrawing group —NO_2.

3.

$$PCl_3 \quad + \quad \frac{1}{2}O_2 \longrightarrow \quad POCl_3$$

$$\frac{11}{137.3} = 0.0801 \qquad \frac{1.34}{32} = 0.0419 \qquad 0.0801$$

Limiting reagent

Moles of $POCl_3$ formed = 0.0801

Mass of $POCl_3$ = 0.0801 × 153.3

= 12.3 g

Percentage yield = $\frac{11.2}{12.3}\times 100 = 91\%$

4. d = 0.714 g/L at STP

$\Rightarrow$ m = 0.714 g T = 273 K

P = 1 atm V = 1 L

$$n = \frac{PV}{RT} = \frac{1\times 1}{0.0821\times 273} = 4.46\times 10^{-2}$$

mass of this one litre sample is known from density

molar mass of the gas, M = $\frac{0.714}{4.46\times 10^{-2}} = 16 g/mole$

5. $U_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.314 \times 300}{0.03995}} = 432.78 \approx 433$

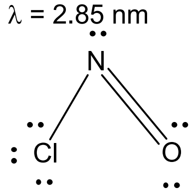
As molar mass of Ar = 39.95 g/mol
= 0.03995 kg/mol

6. $\frac{1}{\lambda} = Z^2 Rh\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$= 6^2 \times 1.097 \times 10^7 \left[\frac{1}{1^2} - \frac{1}{3^2}\right]$

$= 36 \times 1.097 \times 10^7 \left[\frac{8}{9}\right] m^{-1}$

λ = 2.85 nm

7. 

Central N-atom is bonded to two other atoms and has one l.p., the electron pair arrangement is trigonal planar. The $C\ell - N - O$ bond angle is about 120° (we expect it to be slightly less than 120 because of greater lp-bp-repulsions) and the molecule is V-shaped.

8. $NCl_3 + 4H_2O \longrightarrow NH_4OH + 3HOCl$

10.

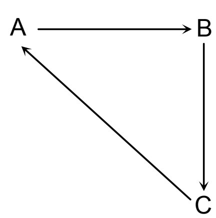
$Cu^{+2} + 2e^- \longrightarrow Cu, \qquad \Delta G_1 = -2F \times 0.34$

$Cu^+ \longrightarrow Cu^{+2} + e^- \qquad \Delta G_2 = F \times 0.16$

$Cu^+ + e^- \longrightarrow Cu$

$\Delta G_3 = \Delta G_1 + \Delta G_2 = -0.52\ F$

$\Rightarrow E_{cu^+/Cu} = 0.52\ V$

11. 

Thus it is a cyclic process.
Hence, $\Delta E = 0$, $\Delta H = 0$, $\Delta S = 0$
and $\Delta E = q + w$ (1st law)
$\therefore 0 = q + w$
or $q = -w$
Total work done = $W_{A \to B} + W_{B \to C} + W_{C \to A}$

$\therefore w = -P(V_B - V_A) + 0 + 2.303\ nRT \log \frac{V_C}{V_A}$

$= -(40 - 20) + 0 + 2.303 \times 1 \times 0.082 \times \log \frac{V_C}{V_A}$

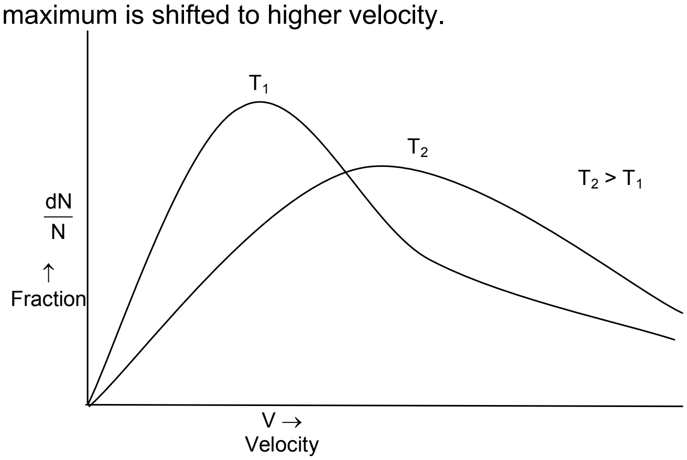
= – 6.13 litre-atmosphere
= – 620.77 J

12. Milli equivalent of $Ba(MnO_4)_2$ = Meq of Fe^{+2}
= Meq of $FeCrO_4$
= Meq of $K_2Cr_2O_7$

13. $$2[CaSO_4.2H_2O] \xrightarrow[-3H_2O]{120^0 C} \underset{\text{Plaster of Paris}}{2CaSO_4.H_2O} \xrightarrow[-H_2O]{\Delta} 2CaSO_4 \xrightarrow[\text{strongly}]{\text{heated}} 2CaO + 2SO_2 + O_2$$

14. In case of B, C and D, the salt are of weak base and strong acid which undergo hydrolysis to give acidic solutions CH_3COONa however, on hydrolysis gives basic solution.

15. On increasing temperature, the Maxwell curve of distribution of molecular velocity is flattened and maximum is shifted to higher velocity.



SECTION – C

1. $$C_{10}H_{20} \xrightarrow[\text{reductive}]{O_3} H_3C-CH_2-\underset{}{\overset{CH_3}{\overset{|}{C}H}}-CHO \ (C_5H_{10}O)$$

$\Rightarrow$ Structure of A $H_3C-CH_2-\overset{CH_3}{\overset{|}{C}H}-CH{=}CH-\overset{CH_3}{\overset{|}{C}H}-CH_2-CH_3$

No. of stereoisomers of A = 6

3. $x \times 1 + y \times 1 = 4 \times 1$ Eq. (1)
$x \times 1 + 2y = 5 + 1$ Eq. (2)
From Eq. (1) and Eq. (2) we get
$y = 1$
$x = 3$
$\Rightarrow x / y = 3$

4. $t_{1/2} \propto \frac{1}{a^{1-n}}$
$\Rightarrow t_{1/2} = K\, a^{1-n}$
K^{-1} rate constant
Log $t_{1/2}$ = log K + (1 – n) log a
Y = C + mx
Slope = (1– n) = –2
$\Rightarrow$ n = 3

5. $K_h = \frac{K_w}{K_b} = \frac{10^{-14}}{10^{-6}} = 10^{-8}$

Mathematics PART – III

SECTION – A

1. $3x^3 + bx^2 + bx + 3 = 0 \Rightarrow 3(x^3 + 1) + bx(x + 1) = 0$ has roots $-1, 2, \frac{1}{2}$.

So, $\lim_{x\to\frac{1}{2}} \frac{e^{f(x)}-1}{2x-1} = \lim_{x\to\frac{1}{2}} \frac{3x^2+bx^2+bx+3}{2x-1} = \lim_{x\to\frac{1}{2}} \frac{3(x+1)(x-2)\left(x-\frac{1}{2}\right)}{2\left(x-\frac{1}{2}\right)} = \frac{3}{2}\times\frac{3}{2}\times\frac{-3}{2} = \frac{-27}{8}$

7. $f''(x) = \frac{1+x}{1+f(x)}$. Also $f''(x) > 0 \Rightarrow f'(x)$ is increasing $\Rightarrow f'(x) > f'(0) = 0 \ \forall\ x > 0$

8. When $P < -3$, $F(x+p)$ will have 4 positive roots

9. We have $\frac{a}{15} = \frac{b}{8} = \frac{c}{17} \Rightarrow a = 15\lambda, b = 8\lambda, c = 17\lambda$ (λ being a positive constant)
Note that $a^2 + b^2 = c^2$
Triangle ABC is right angled
$R = \frac{1}{2}(17\lambda)$, Δ = area of $\Delta ABC = 60\lambda^2$
$s = 20\lambda$, $s - a = 5\lambda$, $s - b = 12\lambda$, $s - c = 3\lambda$
$r_1 + r_2 + r_3 - r = \frac{\Delta}{s-a}+\frac{\Delta}{s-b}+\frac{\Delta}{s-c}-\frac{\Delta}{s} = 12\lambda + 5\lambda + 20\lambda - 3\lambda = 34\lambda$
$\Rightarrow \frac{r_1+r_2+r_3-r}{R} = \frac{34\lambda}{17\lambda}\times 2 = 4$

10. Any line perpendicular to $x - y + 10 = 0$ is of the form $x + y = k$
If this line is a tangent to the hyperbola $x^2 - 2y^2 = 16$, $k^2 = 16(-1)^2 - 8 = 8$ (using $c^2 = a^2m^2 - b^2$)
$\therefore k = \pm 2\sqrt{2}$
$\therefore T_1$ and T_2 are $x + y + 2\sqrt{2} = 0$ and $x + y - 2\sqrt{2} = 0$
$\therefore$ Distance between them = $\frac{4\sqrt{2}}{\sqrt{2}} = 4$

11. $y = \frac{x+3}{x+1} > 0 \Rightarrow x < -3$ or $x > -1$
or $\begin{matrix} x\to -3 \\ y \to 0 \end{matrix} \qquad \begin{matrix} x \to \infty \\ y \to 1 \end{matrix}$
$(0,1)\cup(1,\infty)$

12. $P(x)$ is an even function.
$\therefore \quad P(x) = ax^4 + bx^2 + 1$ and $P'(x) = 4ax^3 + 2bx = 2x(2ax^2 + b)$
It has two minima. Hence, a > and b < 0.
So, at $x = \pm\sqrt{\frac{-b}{2a}}, P(x)$ has minima.

$2\sqrt{\frac{-b}{2a}} = 2 \quad \Rightarrow b = -2a$

$\therefore$ Maximum at (0, 1).

Also, $\frac{8\sqrt{2}}{15} = 2\int_0^{\sqrt{\frac{-b}{a}}} \left(1-\left(ax^4+bx^2+1\right)\right)dx \quad \Rightarrow b = -1 \; a = \frac{1}{2}$

Now, $\lim\limits_{x\to 0} \frac{P(x)-\left(g(x)+g(-x)\right)}{x^2}$ is finite.

$\Rightarrow C = \frac{1}{2}, B = -1$

Also, y = 1 is tangent to $Ax^2 - x + \frac{1}{2} = f(x)$

$\Rightarrow Ax^2 - x + \frac{1}{2} = 1$ has equal roots

$\Rightarrow A = -\frac{1}{2}$

13. z_1 and z_2 are end points of diameter.

14. S′ is radical circle of S_1, S_2 and S. S″ is circle of centre = radical centre and radius = 8 and $r_1 = 4$, r = 8

15. 2ae = 5, 2a = (2√2 + 1) √5, e ⇒ $\frac{\sqrt{5}}{2\sqrt{2}+1}$

Foci are $S_1(1, 1)$ and $S_2(4, 5)$ $\frac{S_1N}{S_2N} = \frac{PS_1}{PS_2} = \frac{\sqrt{40}}{\sqrt{5}} = 2\sqrt{2}$

SECTION – C

1. Perimeter of Δ DEF = a cos A + b cos B + c cos C
= R [sin 2A + sin 2B + sin 2C]
= R [4 sin A + sin B + sin C]
$= 4R\,\frac{abc}{8R^3} = \frac{abc}{2R^2} = \frac{2\Delta}{R} = 4\text{cm}.$

2. A = $A = \left\{1, \sqrt{2}, \sqrt{3}, 2\right\}$, $B = \left\{\frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}\right\}$ $m = 3^4 - \left({}^3c_1\, 2^4 - {}^3c_2\right) = 36 = 2^2\, 3^2$ hence number of divisors of m is 9

4. $\frac{(1+x)^{20}+(1-x)^{20}}{2} = {}^{20}c_0 + {}^{20}c_2\, x^2 + {}^{20}c_4\, x^4 + ------ {}^{20}c_{20}\, x^{20}$

$= {}^{20}c_0\, x^{20} + {}^{20}c_2\, x^{18} + {}^{20}c_4\, x^{16} + ------ {}^{20}c_{20}$

So, $\sum_{r=0}^{9} {}^{20}c_{2r}\; {}^{20}c_{2r+2}$ = coeff of x^{22} in $\frac{\left[(1+x)^{2n}+(1-x)^{2n}\right]}{4}$

⇒ a = 10 ⇒ xy = 40 has total order pair (x, y) solution = 4 × 2 = 8