JEE MAIN

COURSE
NUCLEUS

TEST CODE				
1	1	2	9	1

MOCK TEST-8

Class: **XII** ***Time:*** **3 Hours.** ***Max. Marks:*** **360**

IMPORTANT INSTRUCTIONS

1. The question paper consists of **'90'** objective type questions. There are **'30'** questions each in **Physics** , **Chemistry** and **Mathematics** respectively. **Please fill the OMR answer Sheet accordingly and carefully.**

2. Each question has four choices (1), (2), (3) and (4) out of which **ONLY ONE** is correct.

3. You will be **awarded 4 marks** for each question, if you have darkened only the bubble corresponding to the correct answer and zero mark if no bubble are darkened. In all other cases, **minus one (–1) mark** will be awarded.

4. There is only one correct response for each question. Filling up more than one response in each question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 3 above.

5. Use **Black or Blue Ball Point Pen** only for filling particulars.

6. Use of **Calculator, Log Table, Slide Rule and Mobile** is not allowed.

7. Rough work is to be done on the space provided at the bottom and in end of the booklet for this purpose in the Test Booklet only.

8. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator. However, the candidates are allowed to take away this Test Booklet with them.

9. Do not fold or make any stray marks on the Answer Sheet.

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USEFUL DATA

Atomic weights: Al = 27, Mg = 24, Cu = 63.5, Mn = 55, Cl = 35.5, O = 16, H = 1, P = 31, Ag = 108, N = 14, Li = 7, I = 127, Cr = 52, K=39, S = 32, Na = 23, C = 12, Br = 80, Fe = 56, Ca = 40, Zn = 65.5, Ti = 48, Ba = 137, U = 238, Co= 59, B =11, F = 19, He = 4, Ne = 20, Ar = 40 , Mo = 96

[Take : $ln\ 2 = 0.693$, $ln\ 1.1 = 0.095$, $ln\ 3 = 1.09$, $e = 1.6 \times 10^{-19}$, $m_e = 9.1 \times 10^{-31}$ kg]

Take: $\epsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$, $g = 10\ m/s^2$, $S_{water} = 1$ cal/gm °C, $L_{ice} = 80$ cal/gm. , $g = 10\ m/s^2$ unless otherwise stated

PHYSICS

Q.1 The wavelength corresponding to maximum spectral radiancy of a black body A is $\lambda_A = 5000Å$. Consider another black body B, whose surface area is twice that of A and total radiant energy by B is 16 times that emitted by A. The wavelength corresponding to maximum spectrum radiancy for B will be

(1) $5000\ (2)^{3/4}$ Å (2) 2500 Å (3) 10,000 Å (4) $5000\ (2)^{-3/4}$ Å

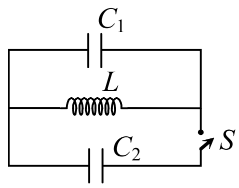
Q.2 The wavelength of characteristic K_α-line emitted by a hydrogen like element is 0.32 Å. The wavelength of the K_β -line emited by the same element will be

(1) 0.25 Å (2) 0.27 Å (3) 0.30 Å (4) 0.35 Å

Q.3 An open pipe of length 33 cm resonates to a frequency of 1000 Hz. The mode of vibration is: (velocity of sound = 330 m/s)

(1) Fundamental (2) The 2nd harmonic (3) The 3rd harmonic (4) The 4th harmonic

Q.4 At a moment (t = 0), when the charge on capacitor C_1 is zero, the switch is closed. If I_0 be the current through inductor at t = 0 , for t > 0



(1) maximum current through inductor equals $I_0/2$.

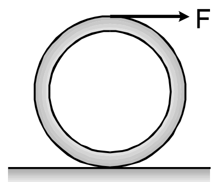
(2) maximum current through inductor equals $\frac{C_1 I_0}{C_1 + C_2}$.

(3) maximum charge on $C_1 = \frac{C_1 I_0 \sqrt{LC_2}}{C_1 + C_2}$.

(4) maximum charge on $C_1 = C_1 I_0 \sqrt{\frac{L}{C_1 + C_2}}$.

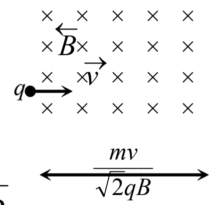
SPACE FOR ROUGH WORK

Q.5 A ring of mass m and radius R rolls on a horizontal rough surface without slipping due to an applied force 'F'. The friction force acting on ring is : –



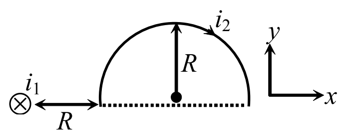
(1) $\frac{F}{3}$ (2) $\frac{2F}{3}$ (3) $\frac{F}{4}$ (4) Zero

Q.6 A positive charge q is projected in magnetic field of width $\frac{mv}{\sqrt{2}\,qB}$ with velocity v as shown in figure. Then time taken by charged particle to emerge from the magnetic field is



(1) $\frac{m}{\sqrt{2}\,qB}$ (2) $\frac{\pi m}{4qB}$ (3) $\frac{\pi m}{2qB}$ (4) $\frac{\pi m}{\sqrt{2}\,qB}$

Q.7 A very long current carrying wire is placed along z-axis having current of magnitude i_1 towards negative z-axis. A semicircular wire of radius R and having current i_2 is placed in x-y plane, such that line joining two end points of the semicircular wire passes through long wire as shown in figure. Nearest distance of semicircular wire from long wire is R. Net magnetic force on semicircular wire will be



(1) $\frac{\mu_0 i_1 i_2}{2\pi}\ln 3$ (2) $\frac{\mu_0 i_1 i_2}{2\pi}\ln\frac{3}{2}$ (3) zero (4) $\frac{\mu_0 i_1 i_2}{2\pi}$

Q.8 A heater boils a certain quantity of water in time t_1. Another heater boils the same quantity of water in time t_2. If both heaters are connected in series, the combination will boil the same quantity of water in time

(1) $\frac{1}{2}(t_1+t_2)$ (2) (t_1+t_2) (3) $\frac{t_1 t_2}{(t_1+t_2)}$ (4) $\sqrt{t_1 t_2}$

Q.9 A 500 W heating unit is designed to operate from a 115 volt line. If the line voltage drops to 110 volt, the percentage drop in heat output will be
(1) 10.20% (2) 8.1% (3) 8.6% (4) 7.6%

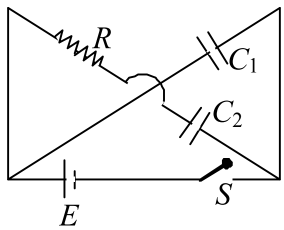
Q.10 A black body emits radiation at the rate P when its absolute temperature is T. At this temperature the wavelength at which the radiation has maximum spectral emissive power is λ_0. If at another temperature T′ the power radiated is P′ and wavelength at maximum spectral emissive power is $\frac{\lambda_0}{2}$ then
(1) P′ T′ = 32PT (2) P′ T′ = 16PT (3) P′ T′ = 8PT (4) P′ T′ = 4PT

SPACE FOR ROUGH WORK

Q.11 n identical charge particle are placed on the vertices of a regular polygon of n sides of side length *a*. One of the charge particle is released from polygon. When this particle reaches a far of distance, another particle adjacent to the first particle is released. The difference of kinetic energies of both the particles at infinity is k. Magnitude of charge is

(1) $\sqrt{4\pi\varepsilon_0 ak}$ (2) $\frac{k}{4\pi\varepsilon_0 a}$ (3) $\frac{k}{a}$ (4) $\sqrt{ka}$

Q.12 In the circuit shown, the capacitors C_1 and C_2 have capacitance C each. The switch S is closed at time t = 0. Taking $Q_0 = CE$ and $\tau = RC$, the charge on C_2 after time t will be



(1) $Q_0(1-e^{-t/2\tau})$ (2) $Q_0(1-e^{-t/\tau})$

(3) $\frac{Q_0}{2}(1-e^{-t/2\tau})$ (4) $Q_0(1-e^{-2t/\tau})$

Q.13 A copper sphere is suspended in a evacuated chamber maintained at 300 K. The sphere is maintained at constant temperature of 900 K by heating electrically. A total of 300 W electric power is needed to do this. When half of the surface of the copper sphere is completely blackened, 600 W is needed to maintain the same temperature of sphere. The emissivity of copper is

(1) $\frac{1}{4}$ (2) $\frac{1}{3}$ (3) $\frac{1}{2}$ (4) 1

Q.14 The frequency of a sonometer wire is 100 Hz. When the weights producing the tensions are completely immersed in water the frequency becomes 80 Hz and on immersing the weights in a certain liquid the frequency becomes 60 Hz. The specific gravity of the liquid is

(1) 1.42 (2) 1.77 (3) 1.82 (4) 1.21

Q.15 A stationary source of sound is emitting waves of frequency 30Hz towards a stationary wall. There is an observer standing between the source and the wall. If the wind blows from the source to the wall with a speed 30 m/s then the number of beats heard by the observer is (velocity of sound with respect to wind is 330 m/s)

(1) 10 (2) 3 (3) 6 (4) zero

Q.16 A 3.6 m long vertical pipe is filled completely with a liquid. A small hole is drilled at the base of the pipe due to which liquids starts leaking out. This pipe resonates with a tuning fork. The first two resonances occur when height of water column is 3.22 m and 2.34 m respectively. The area of cross-section of pipe is

(1) 25 π cm^2 (2) 100 π cm^2 (3) 200 π cm^2 (4) 400 π cm^2

SPACE FOR ROUGH WORK

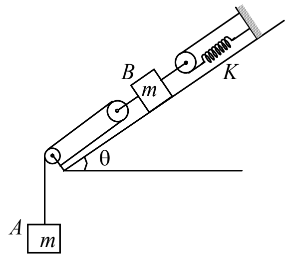
Q.17 A closed organ pipe of length L is vibrating in its first overtone. There is a point Q inside the pipe at a distance 7L/9 from the open end. The ratio of pressure amplitude at Q to the maximum pressure amplitude in the pipe is

(1) 1 : 2 (2) 2 : 1 (3) 1 : 1 (4) 2 : 3

Q.18 A simple pendulum is suspended from the ceiling of an empty box falling in air near earth surface. The total mass of system is M. The box experiences air resistance $\vec{R} = -k\vec{v}$ where v is the velocity of box and k is a positive constant. After some time it is found that period of oscillation of pendulum becomes double the value when it would have suspended from a point on earth. The velocity of box at that moment (take g in air same as on earth's surface)

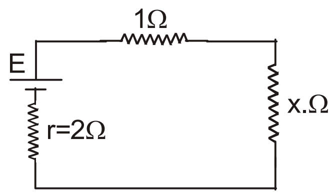
(1) $\frac{Mg}{4k}$ (2) $\frac{Mg}{k}$ (3) $\frac{Mg}{2k}$ (4) $\frac{2Mg}{k}$

Q.19 Two blocks A and B, each of mass m are connected by means of a pulley-spring system on a smooth inclined plane of inclination θ as shown in the figure. All the pulleys and spring are ideal. Now, B is slightly displaced from its equilibrium position. It starts to oscillate. Time period of oscillation of B will be (Take m = 4 kg, K = 5 N/m, π = 3.14)



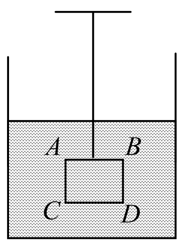
(1) 3.14 s (2) 6.28 s (3) 4.28 s (4) 5.14 s

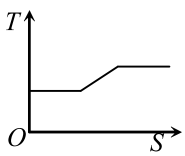
Q.20 In the given circuit the power generated in 1Ω resistance will be maximum for 'x' equal to:

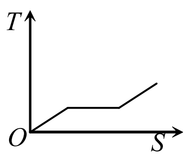


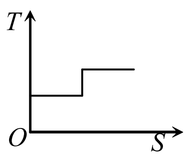
(1) 1 Ω (2) 3 Ω
(3) 2/3 Ω (4) 0 Ω

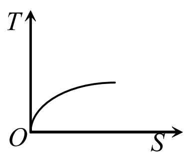
Q.21 A metallic square plate ABCD is suspended vertically with a pair of sides horizontal by an ideal string as shown in the figure. A beaker of water is brought below the plate and raised till the plate is completely immersed and the level of water is well above the plate. If the point of support is slowly raised vertically at constant velocity, the graph of tension T in the string against the displacement S of the point of support is best represented by



(1) 

(2) 

(3) 

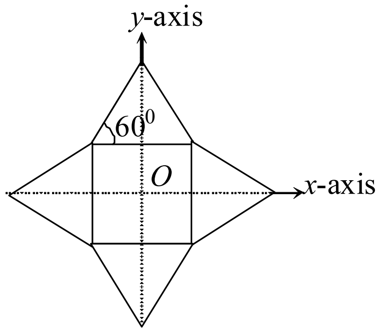
(4) 

SPACE FOR ROUGH WORK

Q.22 A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius (1.01)R. The period of the second satellite is larger than the first one by approximately

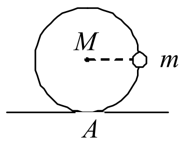
(1) 0.7 % (2) 1 % (3) 1.5 % (4) 3 %

Q.23 Moment of inertia of a uniform symmetric plate as shown in figure about x-axis is I. Moment of inertia of this plate about an axis passing through centre of plate O and perpendicular to the plane of plate is



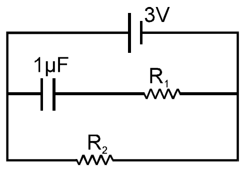
(1) 2I (2) I
(3) I/2 (4) I/4

Q.24 A uniform body of mass M of radius R has a small mass m attached at edge as shown in the figure. The system is placed on a perfectly rough horizontal surface such that mass m is at the same horizontal level as the centre of body. It is assumed that there is no slipping at point A. If I_A is the moment of the inertia of combined system about point of contact A then the normal reaction at point A just after the system is released from rest is ($M = 6$ kg, $m = 2$ kg, $I_A = 4 \text{kg m}^2$, $R = 1$m, $g = 10\text{m/s}^2$)



(1) 60N (2) 80 N (3) 75 N (4) 70 N

Q.25 A 1 μF capacitor is connected in the circuit shown below. The e.m.f. of the cell is 3 volts and internal resistance is 0.5 ohms. The resistors R_1 and R_2 have values 4 ohms and 1 ohm respectively. The charge on the capacitor in steady state must be :



(1) 2 μ C (2) 1 μ C (3) 1.33 μ C (4) zero

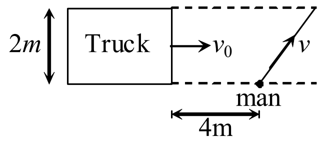
Q.26 Energy due to position of a particle is given by, $U = \frac{\alpha\sqrt{y}}{y+\beta}$, where α and β are constants, y is distance.

The dimensions of $(\alpha \times \beta)$ are

(1) $[M^0LT^0]$ (2) $[M^{1/2}L^{3/2}T^{-2}]$ (3) $[M^0L^{-7/2}T^0]$ (4) $[ML^{7/2}T^{-2}]$

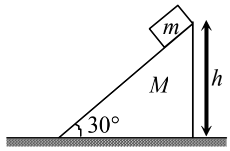
SPACE FOR ROUGH WORK

Q.27 A 2m wide truck is moving with a uniform speed $v_0 = 8$ m/s along a straight horizontal road. A pedestrian starts to cross the road with a uniform speed v when the truck is 4 m away from him. The minimum value of v so that he can cross the road safely is



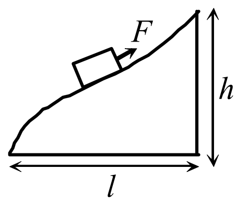
(1) 2.62 m/s (2) 4.6 m/s (3) 3.57 m/s (4) 1.414 m/s

Q.28 A block of mass m released on an inclined plane of inclination 30° and mass M height of the block varies with time as $h = 1.5 - 1.5t^2$. (t = time in second). What is the acceleration of M?



(1) 1 m/s^2 (2) $\frac{2}{\sqrt{3}}$ m/s^2 (3) 3 m/s^2 (4) 2 m/s^2

Q.29 A body of mass m was slowly taken up the hill by a force F which at each point was directed along the tangent to the trajectory as shown in the figure. Find the work performed by this force. (The height of the hill is h, the length of its base is l and the coefficient of friction is μ)



(1) $mgh + \mu mg\left(\sqrt{l^2 + h^2}\right)$ (2) $mgh + \mu mgl$

(3) $mgh - \mu mg\left(\sqrt{l^2 + h^2}\right)$ (4) $mgh - \mu mgl$

Q.30 The position vector of a particle is given as $\vec{r} = (t^2 - 4t + 6)\hat{i} + (t^2)\hat{j}$. The time after which the velocity vector and acceleration vector becomes perpendicular to each other is equal to

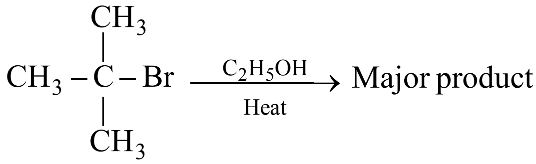
(1) 1sec (2) 2 sec (3) 1.5 sec (4) not possible

SPACE FOR ROUGH WORK

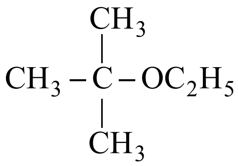
CHEMISTRY

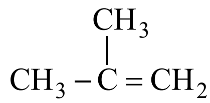
Q.31 The first and second ionisation potential of helium atoms are 24.6 eV and 54.4 eV respectively. The energy required to convert 1 mole of He atoms into He^{2+} ions in kJ is :

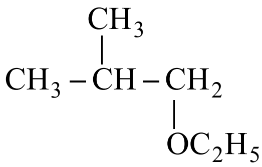
(1) 758.4 (2) 7584 (3) 7.584 (4) 75.84

Q.32 

Major product is :

(1) 

(2) 

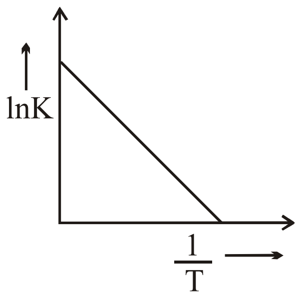
(3) 

(4) $CH_2 - CH = CH - CH_3$

Q.33 For the reaction,

$$AB_2(g) + A(s) \rightleftharpoons B_2(g) + A_2(g)\ ,$$

following graph is obtained



where $K \rightarrow$ Equilibrium Constant

$T \rightarrow$ Temperature in Kelvin

Which of the following will increase the concentration of AB_2 at equilibrium.

(1) Adding more of A (s) (2) Decreasing temperature

(3) Adding inert gas at constant volume (4) Decreasing the volume of container

SPACE FOR ROUGH WORK

Q.34 What will be the dihedral angle present in hydrogen peroxide (H_2O_2) in solid phase.
(1) 111.5° (2) 180° (3) 90.2° (4) 0°

Q.35 Amongst butane, butan-1-ol and butanal the decreasing order of boiling point is -
(1) butane > butan-1-ol > butanal (2) butanal > butan-1-ol > butane
(3) butan-1-ol > butanal > butane (4) butane > butanal > butan-1-ol

Q.36 The degree of hydrolysis of 0.1 M NaCN solution is 4%. What will be the solubility of $Al(OH)_3$ in this solution.[$K_{sp\ Al(OH)_3} = 6.4 \times 10^{-20}$]
(1) 0.04 mol L^{-1} (2) 10^{-15} mol L^{-1} (3) 10^{-12} mol L^{-1} (4) 1.6×10^{-7} mol L^{-1}

Q.37 Borohydrides are prepared by reaction of metal hydrides with B_2H_6 in diethyl ether. Select **incorrect** statement:
(1) Hybridisation of Boron changes
(2) Metal M can be Li or Na
(3) Geometry around Boron is Tetrahedral in both reactant and product
(4) Boron hydrides are used as reducing agent

Q.38 $PhNH_2$ and PhNHMe can be differentiated by :
(1) $CHCl_3$, KOH (2) $NaNO_2$, HCl (3) both (4) none of these

Q.39 Surfactant molecules can cluster together as micelles, which are colloid sized cluster of molecules. Micelles form only above critical micelle concentration (CMC) and above certain temperature called Kraft temperature. ΔH of micelle formation can be positive or negative. Which of the following is **NOT TRUE** about micelle formation?
(1) ΔS of micelle formation is positive
(2) the hydrophobic part lie towards interior of micelle
(3) the hydrophilic part lie towards surface of micelle
(4) ΔS of micelle formation is negative

Q.40 Consider the following complex :
$[M(NH_3)_4(H_2O)(Cl)]$
Select the **correct** statement:
(1) All stereoisomers are optically inactive (2) Number of geometrical isomers = 4
(3) Total 3 stereoisomers possible (4) All stereoisomers are optically active

SPACE FOR ROUGH WORK

Q.41 Which of the following is not a condensation polymer?
(1) Glyptal (2) Nylon-66 (3) Dacron (4) Teflon

Q.42 Consider the following cell

$$Pt \mid H_2(P_1 atm) \mid H^+ (M_1) \mid\mid H^+ (M_2) \mid H_2 (P_2 atm) \mid Pt$$

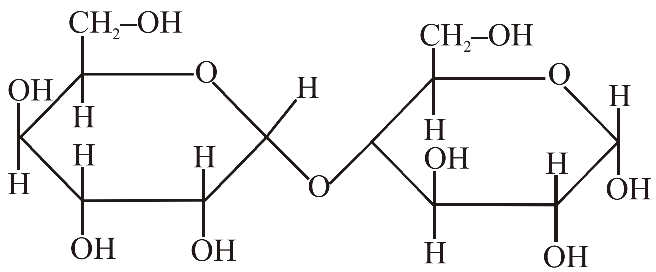
Where P_1 and P_2 are pressures. M_1 and M_2 are molarities.
What will be the emf of cell at 25°C if $P_1 = P_2$ and M_1 is 50% higher than M_2?

[Take : $\frac{2.303\,RT}{F} = 0.06$ **and log 3 = 0.48 , log 2 = 0.3]**

(1) –0.0052 V (2) –0.0108 V (3) –0.040 V (4) 0.0108 V

Q.43 Which of the following properties does not belong to the complex formed in Mond's process.
(1) It is diamagnetic (2) It follows 18 electron rule
(3) It is square planar (4) Volatile at 100°C

Q.44 Incorrect statement about given carbohydrate is -



(1) Above compound is a reducing sugar.
(2) Hemi acetal group.
(3) Above compound is a non-reducing sugar.
(4) Above compound has a glycosidic linkage.

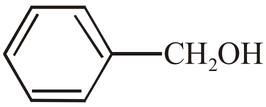
Q.45 Identify the **correct** statement.
(1) Half life of first order reaction is independent of temperature
(2) For zero order reaction half life depends on initial concentration of reactant.
(3) A reactant molecule having sufficient energy must get converted into product.
(4) First order reaction must be complex

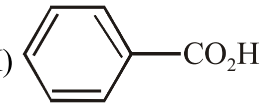
SPACE FOR ROUGH WORK

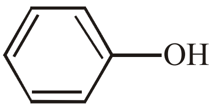
Q.46 For carbonates of alkali metals as we move down the group what will be the correct order of covalent characters, solubility and thermal stability -

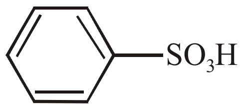
(1) Increase, Decrease, Increase
(2) Decrease, Increase, Increase
(3) Increase, Increase, Decrease
(4) Decrease, Decrease, Increase

Q.47 The order of acidity of compounds I-IV, is -

(I) 

(II) 

(III) 

(IV) 

(1) I < III < II < IV
(2) IV < I < II < III
(3) III < I < II < IV
(4) II < IV < III < I

Q.48 An unknown compound A dissociates at 500ºC to give products as follows -

$$A(g) \rightleftharpoons B(g) + C(g) + D(g)$$

Vapour density of the equilibrium mixture is 60 when it dissociates to the extent to 20%. What will be the molecular weight of Compound A –

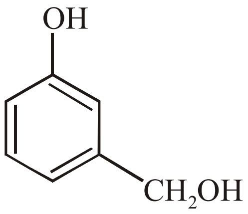
(1) 120 (2) 108 (3) 134 (4) 168

Q.49 In which octahedral complex t_{2g} and e_g orbitals both have symmetrical electronic distribution?
[where Δ_0 = Splitting energy, PE = Pairing energy per pair]

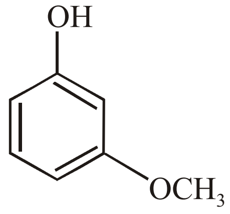
(1) $d^5(\Delta_0 < PE)$ (2) $d^4(\Delta_0 > PE)$ (3) $d^7(\Delta_0 < PE)$ (4) $d^9(\Delta_0 > PE)$

SPACE FOR ROUGH WORK

Q.50 Two isomeric compounds (I) and (II) are heated with HBr-

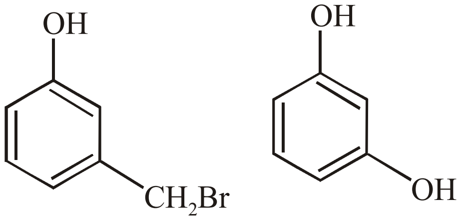


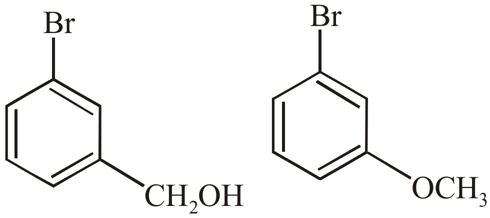
(I)

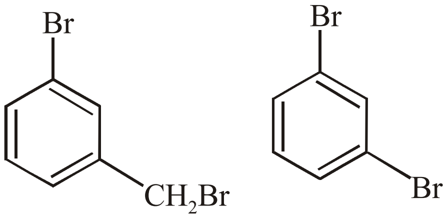


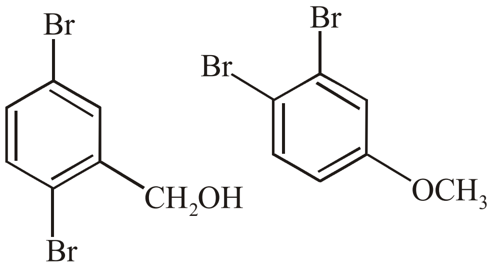
(II)

The products obtained are -

(1) 

(2) 

(3) 

(4) 

SPACE FOR ROUGH WORK

Q.51 If ε_0 be the permittivity of vacuum and r be the radius of orbit of H-atom in which electron is revolving then velocity of electron is given by :

(1) $v = \frac{e}{\sqrt{4\pi\varepsilon_0 rm}}$ (2) $v = e \times \sqrt{4\pi\varepsilon_0 rm}$ (3) $v = \frac{4\pi\varepsilon_0 rm}{e}$ (4) $v = \frac{4\pi\varepsilon_0 rm}{e^2}$

Q.52 $Na_2CrO_4 + H_2SO_4 \rightarrow$

For the above said reaction select correct statement -

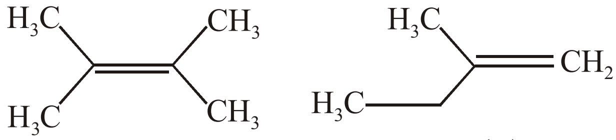
(1) It is a redox reaction in which green solution of $[Cr(H_2O)_6]^{3+}$ is produced.

(2) One of the product in reaction has trigonal planer structure.

(3) Dimeric bridged tetrahedral complex is produced.

(4) Dark blue colour is obtained in reaction.

Q.53 The number of possible enantiomeric pair(s) produced from the bromination (Br_2/CCl_4) of (I) and (II), respectively, are -



(I) (II)

(1) 0, 1 (2) 1, 0 (3) 0, 2 (4) 1, 1

Q.54 When heated above 916ºC, iron changes its bcc crystalline form to fcc without the change in the radius of atom. The ratio of density of the crystal before heating and after heating is :

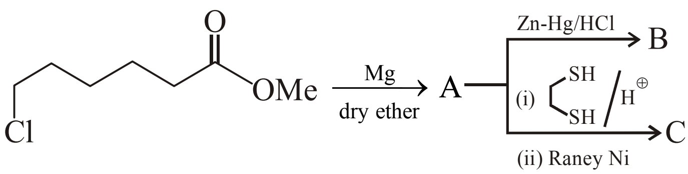
(1) 1.069 (2) 0.918 (3) 0.725 (4) 1.231

Q.55 Select correct order of stability of following oxides.

(1) $Cl_2O > Br_2O > I_2O$ (2) $Cl_2O > I_2O > Br_2O$

(3) $I_2O > Cl_2O > Br_2O$ (4) $I_2O > Br_2O > Cl_2O$

Q.56

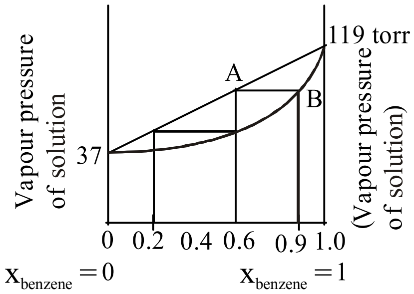


Relationship between B and C is

(1) Chain isomers (2) Homologus (3) Identical (4) No relation between them

SPACE FOR ROUGH WORK

Q.57 For a solution of Benzene and Toluene choose the correct option from the following diagram :



$x \rightarrow$ represents mole fraction in liquid state

$y \rightarrow$ represents mole fraction in vapour state

(1) At point A : $y_{benzene} = 0.6$
(2) At point B : $x_{toluene} = 0.1$
(3) At point A : $x_{toluene} = 0.4$
(4) At point B : $y_{benzene} = 0.1$

Q.58 Which of the following metal nitrate can show given change.

Aqueous solution of metal nitrate $\xrightarrow[NH_4OH]{Excess}$ (No change in colour and no precipitate in test tube)

(1) $Pb(NO_3)_2$ (2) $Fe(NO_3)_2$ (3) $AgNO_3$ (4) $Hg(NO_3)_2$

Q.59 What is the major product of the following reaction sequence?

$HO–CH_2 – \overset{\overset{O}{\|}}{C} – OH \xrightarrow[2.\ CH_3ONa(1eq.)]{1.\ SOCl_2(excess)}$

(1) $Cl–CH_2 – \overset{\overset{O}{\|}}{C} – CH_3$
(2) $ClCH_2 – \overset{\overset{O}{\|}}{C} – O – CH_3$
(3) $CH_3 – O – CH_2– \overset{\overset{O}{\|}}{C} – CH_3$
(4) $CH_3 – O – CH_2– \overset{\overset{O}{\|}}{C} – Cl$

Q.60 At 27ºC the reaction,

$$C_6H_6(l) + \frac{15}{2}O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(l)$$

proceeds spontaneously because the magnitude of-

(1) $\Delta H = T\Delta S$ (2) $\Delta H > T\Delta S$ (3) $\Delta H < T\Delta S$ (4) $\Delta H > 0, T\Delta S < 0$

SPACE FOR ROUGH WORK

MATHEMATICS

Q.61 Let $f : R \to R$ be $f(x) = x^3 + 3$ and $g : R \to R$ be $g(x) = 2x + 1$, then $f^{-1} \text{ o } g^{-1}$ (23) is equal to

(1) 2 (2) 3 (3) $(14)^{\frac{1}{3}}$ (4) $(15)^{\frac{1}{3}}$

Q.62 A teacher conducts quiz among the five students of his batch and distributes the answer sheets among them randomly for evaluation then the probability that there are at least two students who are not evaluating their own answer sheet, is equal to

(1) $\frac{1}{120}$ (2) $\frac{7}{120}$ (3) $\frac{119}{120}$ (4) $\frac{113}{120}$

Q.63 Let A and B be two sets containing two and three elements respectively. The number of subsets of $A \times B$ having at least 2 but not more than 4 elements, is equal to

(1) 15 (2) 20 (3) 35 (4) 50

Q.64 The eccentricity of the ellipse $3x^2 + 4y^2 = 12$ is changed at the rate 0.1/second. The time at which it will coincide with the auxiliary circle is

(1) 2 seconds (2) 3 seconds (3) 5 seconds (4) 6 seconds

Q.65 The area of the region bounded by curves $y = e^x$, $y = e^{-x}$, $x = 0$ and $x = 1$ is

(1) $e + \frac{1}{e}$ (2) $ln\left(\frac{4}{e}\right)$ (3) $4\, ln\left(\frac{4}{e}\right)$ (4) $e + \frac{1}{e} - 2$

Q.66 The value of $\binom{50}{5} - \binom{5}{1}\binom{40}{5} + \binom{5}{2}\binom{30}{5} - \binom{5}{3}\binom{20}{5} + \binom{5}{4}\binom{10}{5}$, is equal to

[**Note** : where $\binom{n}{r}$ denotes ${}^nC_r$]

(1) 0 (2) 10^5 (3) -10^5 (4) 5^5

Q.67 The radius of director circle of auxiliary circle of the ellipse $(3x + 4y - 1)^2 + 5(4x - 3y + 2)^2 = 250$ is

(1) $\sqrt{5}$ (2) $\sqrt{10}$ (3) $\sqrt{500}$ (4) $\sqrt{20}$

SPACE FOR ROUGH WORK

Q.68 Five different digits from the set of numbers {1, 2, 3, 4, 5, 6, 7} are written in a random order. The probability that 5 digit number thus formed is divisible by 9 is

(1) $\frac{1}{21}$ (2) $\frac{2}{21}$ (3) $\frac{5}{21}$ (4) $\frac{7}{21}$

Q.69 If system of equations $2x + ky = 0$, $kz - 2y = 0$ and $kx + 2z = 0$, has non trivial solution then the value of k is

(1) – 1 (2) 1 (3) 2 (4) no real value

Q.70 The shortest distance between z axis and the line $\frac{x-2}{3} = \frac{y-5}{2} = \frac{z+1}{-5}$ is equal to

(1) $\frac{11}{\sqrt{13}}$ (2) $\frac{17}{\sqrt{13}}$ (3) $\frac{11}{13}$ (4) $\frac{\sqrt{11}}{13}$

Q.71 $\sim p \wedge q$ logically equivalent to

(1) $p \to q$ (2) $q \to p$ (3) $\sim (p \to q)$ (4) $\sim (q \to p)$

Q.72 $\lim\limits_{x \to \infty} \frac{\sum\limits_{r=1}^{10} (x+r)^{2010}}{(x^{1006}+1)(2x^{1004}+1)}$ is equal to

(1) $\frac{1}{2}$ (2) 1 (3) 5 (4) 1005

Q.73 If for a derivable function f, $f(0) = f(1) = 0$, $f'(1) = 2$ and $y(x) = f(e^x)\, e^{f(x)}$, then $y'(0)$ is equal to

(1) 0 (2) 1 (3) 2 (4) None of these

Q.74 If $f(x) = (x^2 + 3x + 2)(x^2 - 7x + a)$ and $g(x) = (x^2 - x - 12)(x^2 + 5x + b)$, then the values of 'a' and 'b', if $(x + 1)(x - 4)$ is H.C.F. of f (x) and g (x), are

(1) a = 10, b = 6 (2) a = 4, b = 12 (3) a = 12, b = 4 (4) a = 6, b = 10

Q.75 Coefficient of variation of two distributions are 50% and 60% and their arithmetic means are 30 and 25, respectively. Difference of standard deviation is

(1) 1 (2) 1.5 (3) 2.5 (4) 0

SPACE FOR ROUGH WORK

Q.76 The value of $\sum_{n=0}^{100} i^{n!}$ is equal to

[**Note :** where $i = \sqrt{-1}$]

(1) – 1 (2) i (3) 2i + 95 (4) 97 + i

Q.77 Let matrix $A = \begin{bmatrix} x & y & -z \\ 1 & 2 & 3 \\ 1 & 1 & 2 \end{bmatrix}$, where x, y, z ∈ N. If $\left|(\text{adj}\left(\text{adj}(\text{adj}(\text{adj}A))\right))\right| = 4^8 \cdot 5^{16}$, then the number of such matrices A is equal to

(1) 28 (2) 36 (3) 55 (4) 66

Q.78 If $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$, $\vec{b} = \hat{i} + \hat{j}$, $\vec{c}$ are vectors such that $\vec{a} \cdot \vec{c} = |\vec{c}|$, $|\vec{c} - \vec{a}| = 2\sqrt{2}$ and the angle between $\vec{a} \times \vec{b}$ and $\vec{c}$ is 30°, then the value of $10\left|(\vec{a} \times \vec{b}) \times \vec{c}\right|$ is

(1) 17 (2) 11 (3) 13 (4) 15

Q.79 If $f(x) = \int_0^x \frac{1}{(f(t))^2}\, dt$ and $\int_0^2 \frac{1}{(f(t))^2}\, dt = \sqrt[3]{6}$, then f (9) is equal to

(1) 0 (2) 1 (3) 2 (4) 3

Q.80 Let f (x) be derivable for all x. If f (1) = – 2 and f '(x) ≥ 2, ∀ x ∈ [1, 6], then

(1) f (6) < 8 (2) f (6) ≥ 8 (3) f (6) ≥ 5 (4) f (6) ≤ 5

Q.81 There are 10 stations on a circular path. A train has to stop at 3 stations such that no two stations are adjacent. The number of such selections is equal to

(1) 50 (2) 60 (3) 70 (4) 80

Q.82 A line L varies such that length of perpendicular on it from origin O is always 4 units. If L cuts x-axis and y-axis at A and B respectively, then minimum value of $OA^2 + OB^2$ is

(1) 16 (2) 32 (3) 64 (4) 128

Q.83 If $\int_0^a f(2a - x)\, dx = 4$ and $\int_0^a f(x)\, dx = 2$, then $\int_0^{2a} f(x)\, dx$ is equal to

(1) 2 (2) 4 (3) 6 (4) 8

SPACE FOR ROUGH WORK

Q.84 ABCD is a square plot. The angle of elevation of the top of a pole standing at D from A or C is 30° and that from B is θ, then $\tan\theta$ is equal to

(1) $\frac{1}{3}$ (2) $\frac{1}{\sqrt{6}}$ (3) $\frac{1}{2\sqrt{6}}$ (4) $\frac{1}{2\sqrt{3}}$

Q.85 If $f(x)=\begin{cases} -x^2+2, & x\le 0 \\ x^2+\frac{15}{8}, & x>0 \end{cases}$, then

(1) $f(x)$ increases at $x=0$ (2) $x=0$ is a point of local maximum of $f(x)$
(3) $x=0$ is a point of local minimum of $f(x)$ (4) $x=0$ is not an extremum of $f(x)$

Q.86 The distance of the point $(1,-5,9)$ from the plane $x-y+z=5$ measured along the line $x=y=z$ is

(1) $\frac{20}{3}$ (2) $3\sqrt{10}$ (3) $10\sqrt{3}$ (4) $\frac{10}{\sqrt{3}}$

Q.87 If $x^2+4y^2-4=0$, then maximum value of x^2-xy is equal to

(1) $\sqrt{5}$ (2) $2+\sqrt{5}$ (3) $2\sqrt{5}+4$ (4) $2\sqrt{5}-1$

Q.88 The eccentricity of the hyperbola whose latus rectum is half of its transverse axis is

(1) $\frac{3}{\sqrt{2}}$ (2) $\frac{3}{2}$ (3) $\sqrt{\frac{3}{2}}$ (4) $\sqrt{2}$

Q.89 If $|z-1-i|=1$, then the locus of a point represented by the complex number $5(z-i)-6$ is
(1) a circle with centre (1, 0) and radius 3
(2) a circle with centre (– 1, 0) and radius 5
(3) line passing through origin
(4) line passing through (– 1, 0)

Q.90 A parabolic mirror is kept along $y^2=4x$ and two different light rays parallel to its axis are reflected along the same straight line. If one of the incident ray is at 4 units distance from the axis, then the distance of other incident ray from axis is
(1) 1 (2) 2 (3) 3 (4) 6

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Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	4	2	2	4	4	2	1	2	3	1	1	2	2	2	4
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans	2	1	1	2	4	1	3	1	4	1	4	3	2	2	1
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Q.No.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
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Q.No.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
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Q.No.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans	1	3	4	3	4	2	4	2	3	1	4	3	3	3	4
Q.No.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans	3	2	4	4	2	1	3	3	2	2	3	2	3	2	1

HINTS & SOLUTIONS

PHYSICS

Q.1 $P = \sigma A T^4$

$\Rightarrow \frac{P_A}{P_B} = \frac{A_A}{A_B}\left(\frac{T_A}{T_B}\right)^4 \Rightarrow T_B = T_A 2^{3/4}$

as $\lambda_m T$ = constant $\Rightarrow \frac{\lambda_A}{\lambda_B} = \frac{T_B}{T_A}$

$\Rightarrow \lambda_B = 5000(2)^{-3/4}$ Å.

Q.2 $\frac{1}{\lambda_{k\alpha}} = RZ^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$ & $\frac{1}{\lambda_{k_B}} = RZ^2\left(\frac{1}{1^2} - \frac{1}{3^2}\right)$;

dividing we get,

$\lambda_{k_B} = 0.27$ Å

Q.3 As ; $\frac{V}{2\ell} = \frac{330 \times 100}{2 \times 33}$

= 500 Hz

In second harmonic frequency $= \frac{V}{\ell}$

= 1000 Hz.

Q.4 $\frac{1}{2}LI_0{}^2 = \frac{1}{2}(C_1 + C_2)V^2$,

$V = \left[\frac{LI_0^2}{(C_1 + C_2)}\right]^{1/2}$,

$Q_1 = C_1 V = C_1 I_0 \sqrt{\frac{L}{C_1 + C_2}}$

Q.5 $F + f = ma$ .... (1)

Also ; $FR - fR = I\frac{a}{R}$

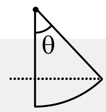
$F - f = ma$ .... (2)

$[I = mR^2]$

From (1) & (2)

$f = 0.$

Q.6 $\sin\theta = \dfrac{\dfrac{mv}{\sqrt{2}\,qB}}{\dfrac{mv}{qB}} = \dfrac{1}{\sqrt{2}}$

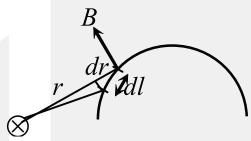


$\Rightarrow \theta = 45°$

$t = \dfrac{T}{8} = \dfrac{\pi m}{4qB}$

Q.7 Magnetic field at a distance r from the wire will be

$B = \dfrac{\mu_0}{2\pi}\dfrac{i_1}{r}$



force on the small element of length dl on semicircular wire is

$dF = i_2\, d\vec{l} \times \vec{B} = i_2(dl_\perp)B = i_2 B\, dr$

$(\because dl_\perp = dr)$

$F = \int_R^{3R} i_2\, B\,dr = \dfrac{\mu_0}{2\pi} i_1 i_2 \ln 3$

Q.8 Q = quantity of energy required

$P_1 t_1 = Q,\ \ P_2 t_2 = Q$

$P_{series} = \dfrac{P_1P_2}{P_1+P_2}$

$P_{series}\, t_0 = Q,\ \ \left(\dfrac{P_1P_2}{P_1+P_2}\right)t_0 = Q$

Solving $t_0 = t_1 + t_2$

Q.9 $P_{consumed} = \left(\dfrac{V_A}{V_R}\right)^2 \times P_R$

$= \left(\dfrac{110}{115}\right)^2 \times 500 = 457.46$ W

So, percentage drop in power output

$= \dfrac{(500 - 457.46)}{500} \times 100 = 8.6\%$

Q.10 For a black body, wavelength for maximum intensity :

$\lambda \alpha \dfrac{1}{T}$ & $P \alpha T^4$

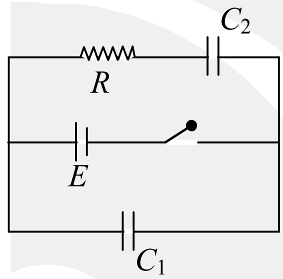
$\Rightarrow$ $P \alpha \dfrac{1}{\lambda^4}$ $\Rightarrow$ $P' = 16$ P.

$\therefore$ $P'T' = 32PT$

Q.11 $\dfrac{q^2}{4\pi\varepsilon_0 a} = k$

Q.12 Rearranging the circuit, we observed that C_1 is joined directly to the cell and acquires its full charge when S is closed. It plays no part in the charging of C_2 through R.

So, $q_2 = Q_0(1 - e^{-t/\tau})$



Q.13 $300 = e\sigma A(900^4 - 300^4)$ ...(i)

$600 = \dfrac{\sigma A}{2}(900^4 - 300^4) + \dfrac{e\sigma A}{2}(900^4 - 300^4)$ ...(ii)

$e = \dfrac{1}{3}$

Q.14 $f \propto \sqrt{g}$

In water $f_w = 0.8 f_{air}$

$\therefore$ $\dfrac{g'}{g} = (0.8)^2 = 0.64$

or $\dfrac{\rho_w}{\rho_m} = 0.36$ ...(i)

In liquid, $\dfrac{g'}{g} = (0.6)^2 = 0.36$

or $\dfrac{\rho_L}{\rho_m} = 0.64$

From equations (i) and (ii) $\frac{\rho_L}{\rho_w} = \frac{0.64}{0.36}$

$S_L = \rho_L/\rho_w = 1.77$

Q.15 Doppler's effect depends upon velocity of approach and separation of source and observer. hence no change in frequency received by the observer.
$\therefore$ no beat is heard.

Q.16 $f = \frac{(2n+1)v}{4(l+e)}$; $(l_1 + e) = \frac{v}{4f}$; $(l_2 + e) = \frac{3v}{4f}$

$\Rightarrow \frac{l_2 + e}{l_1 + e} = 3$

$l_2 = (3.6 - 2.34)$ m and $l_1 = (3.6 - 3.22)$

$\Rightarrow e = 0.06$ m $= 0.6\, r \Rightarrow r = 0.1$ m

$A = 100\, \pi\, cm^2$

Q.17 $\Delta Pm = 2\, P_0 \cos kx$
(assuming closed end as origin)

At point Q, $x = L - \frac{7L}{9} = \frac{2L}{9}$

$\Delta Pm = 2\Delta P_0 \cos\left(\frac{2\pi}{\lambda} \times \frac{2L}{9}\right) = \Delta P_0$

$\therefore$ Required ratio = 1 : 2

Q.18 $T = 2\pi\sqrt{\frac{l}{g-a}}$, a is the downward acceleration of box

$T_0 = 2\pi\sqrt{\frac{l}{g}} \Rightarrow a = \frac{3g}{4}$

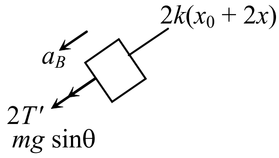
$Mg - R = Ma \Rightarrow R = \frac{Mg}{4}$, $v = \frac{Mg}{4k}$

Q.19 Let elongation of spring be x_0 in equilibrium. Then,

$$2T + mg\sin\theta = 2kx_0 \qquad ....(i)$$

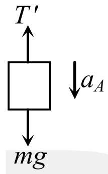
and $\quad T = mg \qquad ....(ii)$

Let Block B is displaced by x down the inclination
F.B.D. of B



$$-ma_B = 2k(x_0 + 2x) - 2T' - mg\sin\theta \; ...(iii)$$

F.B.D. of A



$mg - T = ma_A$

Also, $a_A = 2a_B$

$T' = mg - 2ma_B$

$$-ma_B = 2kx_0 + 4kx - 2mg + 4ma_B - mg\sin\theta$$

$$-ma_B = 4kx + 4ma_B$$

$$a_B = -\frac{4k}{5m}x$$

$\therefore \quad T = 2\pi\sqrt{\frac{5m}{4k}}$

$T = 6.28$ s.

Q.20 Current in the circuit is given by

$$i = \frac{\varepsilon}{3+x}$$

Power generated in 1Ω

$$= \left(\frac{\varepsilon}{3+x}\right)^2 \times 1 = \frac{\varepsilon^2}{3+x}$$

Power will be max when $3 + x$ is minimum
i.e., for $x = 0$

Q.21 As the block moves out of the liquid, tension increases.

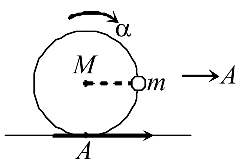
Q.22 $T = \frac{2\pi R}{\sqrt{\frac{GM}{R}}}$, $T \propto R^{3/2}$

Radius of 2nd satellite is 1% greater

Hence time period is $1 \times \frac{3}{2} = 1.5$ % larger

Q.23 From perpendicular axis theorem
$I_z = I_x + I_y = 2I$

Q.24 $(A_{CM})_x = \dfrac{mA + MA}{m+M} = A$



$(A_{CM})_y = \dfrac{M \times 0 + mR\alpha}{m+M} = \dfrac{mR\alpha}{m+M}$

$f = (M+m)A$ ...(i)

$(M+m)g - N = (M+m)(A_{CM})_y$ ...(ii)

$mgR = I_A \alpha$ ...(iii)

$A = R\alpha$ ...(iv)

$\therefore$ N = 70 N

Q.25 In steady state no current flows through capacitor. The potential difference across capacitor and resistor of resistance R_2 is same.
$\therefore$ charge on capacitor

$= CV = C \times \dfrac{R_2}{r+R_2} \times 3 = 1\mu F \times \dfrac{1}{5+1} \times 3$

$= 2\mu C$.

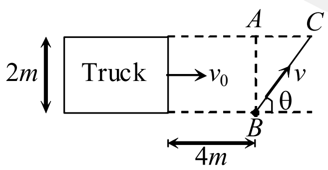
Q.26 $[\beta] = L$

$ML^2T^{-2} = \dfrac{\alpha[L]^{1/2}}{[L]}$

$\alpha = [M][L^{5/2}][T^{-2}]$

Q.27 For safe crossing, the condition is that the man must cross the road by the time the truck covers the distance 4 + AC or 4 + 2cot

$\therefore \quad \dfrac{4 + 2\cot\theta}{8} = \dfrac{2/\sin\theta}{v}$



or $\quad v = \dfrac{8}{2\sin\theta + \cos\theta}$ ...(i)

For minimum v, $\dfrac{dv}{d\theta} = 0 \Rightarrow \tan\theta = 2$

From equation (i), $v_{min} = \dfrac{8}{\sqrt{5}} = 3.57$ m/s

Q.28 Acceleration of block m with respect to inclined plane = 6

Acceleration of inclined plane = $\dfrac{2}{\sqrt{3}}$

Q.29 Work done by friction = $-\mu mgl$
Work done by gravity = $-mgh$
So work done by force = $mgh + \mu mgl$

Q.30 $\vec{r} = (t^2 - 4t + 6)\hat{i} + t^2\hat{j}$; $\vec{v} = \dfrac{d\vec{r}}{dt} = (2t-4)\hat{i}$

$+ 2t\hat{j}$, $\vec{a} = \dfrac{d\vec{v}}{dt} = 2\hat{i} + 2\hat{j}$

if $\vec{a}$ and $\vec{v}$ are perpendicular

$\vec{a} \cdot \vec{v} = 0$

$(2\hat{i} + 2\hat{j}) \cdot ((2t-4)\hat{i} + 2t\hat{j}) = 0$

$8t - 8 = 0$

t = 1 sec.

Ans. t = 1 sec.

CHEMISTRY

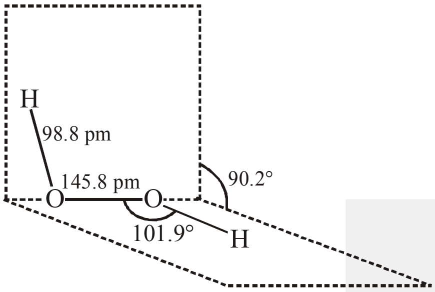
Q.31 $IE_1 \longrightarrow 24.6$ eV
$IE_2 \longrightarrow 54.4$ eV

$He \xrightarrow[(IE_1 + IE_2)]{} He^{2+}$

= 24.6 + 54.4 eV
= 79.0 eV
In kJ → $79.0 \times 1.6 \times 10^{-22} \times 6 \times 10^{23}$
= 7584 kJ

Q.33 Reaction is endothermic ⇒ ΔH = positive
So on increasing temperature reaction will shift forward. On decreasing volume concentration of every species will increases.

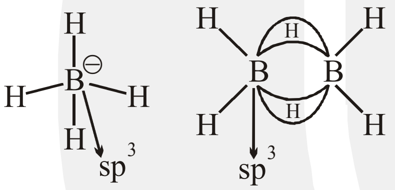
Q.34



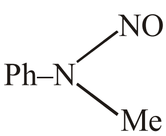
Q.35 due to H-bonding butan-1-ol has highest boiling point out of the three compounds. Butanal has higher boiling point than butane due to its higher polarity.

Q.36 $CN^{-} + H_2O \rightleftharpoons HCN + OH^{-}$
0.1–0.1 h 0.1 h
$[OH^{-}] = 0.1 \times 0.04 = 4 \times 10^{-3}$ M
$K_{sp} = [Al^{3+}]\,[OH^{-}]^3$
$6.4 \times 10^{-20} = S \times [4 \times 10^{-3}]^3$
$S = 10^{-12}$ mol L^{-1}

Q.37 $2MH + B_2H_6 \longrightarrow 2M^{+}[BH_4]^{-}$ {M = Li or Na}



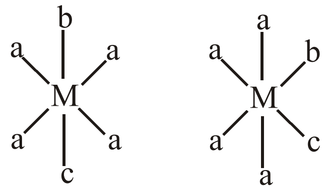
Q.38 (1) $PhNH_2 + CHCl_3 + KOH \rightarrow PhNC + 3KCl + 3H_2O$
unpleasant smell (isocyanide test)
$PhNHMe + CHCl_3 + KOH$ –ve isocyanide test as it not 1° amine.
(2) $PhNH_2 + NaNO_2 + HCl \rightarrow PhN_2^{+}\,Cl^{-}$
(Diazonium reaction)
$PhNHMe + NaNO_2 + HCl \rightarrow$



(yellow oil)

Q.39 The formation of micelle only above certain temperature called Kraft temperature suggests positive ΔS of micelle formation which even overcome effect of positive ΔH of micelle formation. Besides kinetic effect also become important at high temperature.

Q.40 Ma_4bc



G.I. = 2, O.I. =0, S.I. = 2
All S.I.are optically inactive

Q.41 Teflon is a addition polymer

Q.42 $Pt\,|\,H_2(P_1 atm)\,|\,H^{+}(M_1)\,||\,H^{+}(M_2)\,|\,H_2(P_2\ atm)\,|\,Pt$

at anode $\underset{P_1}{H_2} \longrightarrow \underset{(M_1)}{2H^{+}} + 2e^{-}$

at cathode $\underset{(M_2)}{2H^{+}} \longrightarrow \underset{P_2}{H_2}$

net cell reaction $\underset{(M_2)}{2H^{+}} + H_2(P_1) \longrightarrow \underset{(M_1)}{2H^{+}} + H_2(P_2)$

$$E_{Cell} = E^{\circ}_{Cell} - \frac{0.06}{2}\log\frac{[H^{+}]^2(P_2)}{(H^{+})^2(P_1)}$$

$\because$ $P_1 = P_2$

$E^{\circ}_{Cell} = 0$

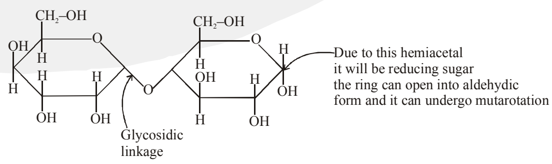
$$E_{Cell} = -\frac{0.06}{2}\log\frac{[H^{+}]^2_{M_1}}{[H^{+}]^2_{M_2}}$$

$$= -\frac{0.06}{2}\log(1.5)^2$$

$= -\,0.0108$ V **Ans.**

Q.43 $Ni\,(s) + 4CO\,(g) \longrightarrow Ni(CO)_4(g)$
d^{10}, sp^3, tetrahedral complex

Q.44

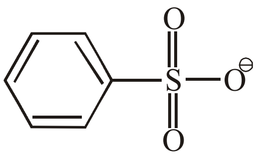


Q.46 Carbonates of alkali metals

(a) Covalent character $\rightarrow Li_2CO_3 > Na_2CO_3 > K_2CO_3 > Rb_2CO_3 > Cs_2CO_3$

(b) Solubility $\rightarrow Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$

(c) Thermal stability $\rightarrow Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$

Q.47 

is most stable conjugate base.

Q.48 $A(g) \rightleftharpoons B(g) + C(g) + D(g)$

$\alpha = 0.2 \quad VD = 60$

$\Rightarrow M_{obs} = 120 \qquad n = 3 - 1 = 2$

$$\alpha = \frac{M_{Th} - M_{Obs}}{M_{Obs}(n-1)}$$

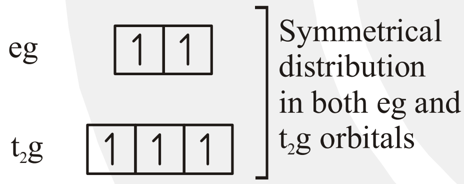
$$0.2 = \frac{M_{Th} - 120}{120(3-1)}$$

$M_{Th} = (0.2 \times 240) + 120$

$= 48 + 120$

$= 168$ Ans.

Q.49 $d^5 \rightarrow WFL\ (\Delta_0 < PE)$



Q.51 $$\frac{mv^2}{r} = \frac{KZe^2}{r^2}$$

For H : Z = 1

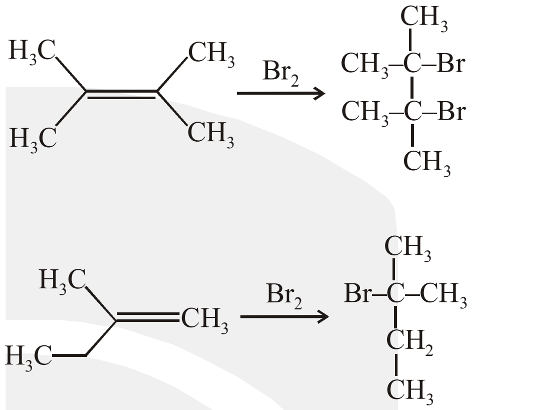
$$\frac{mv^2}{r} = \frac{Ke^2}{r^2} \quad \left(K = \frac{1}{4\pi\varepsilon_0}\right)$$

$$\frac{mv^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$$

$$v^2 = \frac{e^2}{4\pi\varepsilon_0 rm}$$

$$v = \frac{e}{\sqrt{4\pi\varepsilon_0 rm}}$$

Q.52 $\underset{\text{(Yellow)}}{2CrO_4^{2-}} \underset{OH^-}{\overset{H^+}{\rightleftharpoons}} \underset{\text{(d}^3\text{s, tetrahedral)}}{Cr_2O_7^{2-}} + H_2O$

Q.53 

Chiral center present

Q.54 $$\frac{d_{bcc}}{d_{fcc}} = \frac{\left(2M \times 3\sqrt{3}/(N_A \times 64r^3)\right)}{\left(4M \times 2\sqrt{2}/(N_A \times 64r^3)\right)} = 0.918$$

Q.55 Stability of halogen oxide :

$I_2O > Cl_2O > Br_2O$

Q.57 Theory based

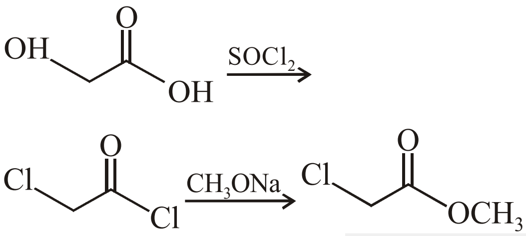
Q.58 (1) $Pb(NO_3)_2$ (White) $\xrightarrow[NH_4OH]{Excess} Pb(OH)_2 \downarrow$ (White)

(2) $Fe(NO_3)_2$ (White) $\xrightarrow[NH_4OH]{Excess} Fe(OH)_2 \downarrow$ (Green)

(3) $AgNO_3$ (White) $\xrightarrow[NH_4OH]{Excess} [Ag(NH_3)_2]^+$ (soluble complex)

(4) $Hg(NO_3)_2$ (White) $\xrightarrow[NH_4OH]{Excess} HgO.HgNH_2NO_3 \downarrow$

Q.59



Q.60 Reaction is exothermic $\therefore \Delta H = -ve$
$\Delta G = \Delta H - T\Delta S$
Since process is spontaneous
$\Delta G = -$ ve
This is possible only if magnitude of
$\Delta H > T\Delta S$

MATHEMATICS

Q.61 $\because$ gof(x) = g $(x^3 + 3) = 2x^3 + 7$
gof(2) = $2 \cdot 8 + 7 = 23$
$\therefore$ gof(2) $= 23 \Rightarrow f^{-1}o\, g^{-1}(23) = 2$

Q.62 Required probability = 1 – all students are evaluating their own answer sheet

$$= 1 - \frac{1}{120} = \frac{119}{120}$$

Q.63 number of elements in A × B = 6
$\therefore$ number of required subsets =
$^6C_2 + {}^6C_3 + {}^4C_4$
= 15 +20 + 15 = 50

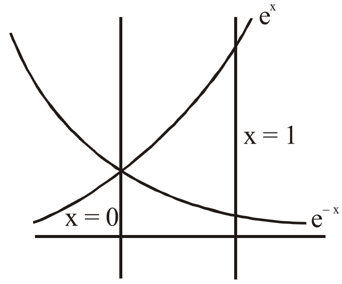
Q.64 $\because$ ellipse is $\frac{x^2}{4} + \frac{y^2}{3} = 1$

Its eccentricity $e = \sqrt{1 - \frac{3}{4}} = \frac{1}{2} = 0.5$

$\because$ eccentricity of auxiliary circle = 0
$\therefore$ ellipse will coincide with auxiliary circle in 5 seconds.

Q.65 Area = $\int_0^1 \left(e^x - e^{-x}\right)dx$

$= \left(e^x + e^{-x}\right)_0^1$



$= e + \frac{1}{e} - 2$

Q.66 given sum
$= {}^5C_0 \cdot {}^{50}C_5 - {}^5C_1 \cdot {}^{40}C_5$ ....
= coefficient of x^5 in
$({}^5C_0 \cdot (1 + x)^{50} - {}^5C_1 \cdot (1 + x)^{40}$ ....)
= coefficient of x^5 in $((1 + x)^{10} - 1)^5$
= coefficient of x^5 in
$({}^{10}C_1 \cdot x + {}^{10}C_2 \cdot x^2 + ... + {}^{10}C_{10} \cdot x^{10})^5$
$= ({}^{10}C_1)^5 = 10^5$

Q.67 ellipse is

$$\frac{\left(\frac{3x+4y-1}{5}\right)^2}{10} + \frac{\left(\frac{4x-3y+2}{5}\right)^2}{2} = 1$$

$\therefore$ radius of auxiliary circle = $\sqrt{10}$
$\therefore$ radius of its director circle =
$\sqrt{2} \cdot \sqrt{10} = \sqrt{20}$

Q.68 The number will be divisible by 9 if sum of the digits is divisible by 9.
$\therefore$ digits should be 1, 2, 3, 5, 7 or 1, 2, 4, 5, 6

$\therefore$ Probability = $\frac{2 \times 5!}{{}^7C_5 \times 5!} = \frac{2}{21}$

Q.69 $\because$ for non trivial solution

$$D = 0 \Rightarrow \begin{vmatrix} 2 & k & 0 \\ 0 & -2 & k \\ k & 0 & 2 \end{vmatrix} = 0$$

$\Rightarrow 2(-4 - 0) - k(0 - k^2) = 0$
$\Rightarrow k^3 = 8 \Rightarrow k = 2$

Q.70 z-axis is $\vec{r} = \vec{0} + \lambda(\hat{k})$

line is $\vec{r} = (2\hat{i} + 5\hat{j} - \hat{k}) + \mu\ (3\hat{i} + 2\hat{j} - 5\hat{k})$

$\therefore$ shortest distance

$$= \left|\frac{(2\hat{i} + 5\hat{j} - \hat{k})\cdot\left((3\hat{i} + 2\hat{j} - 5\hat{k})\times\hat{k}\right)}{\left|(3\hat{i} + 2\hat{j} - 5\hat{k})\times\hat{k}\right|}\right| = \frac{11}{\sqrt{13}}$$

Q.71

p	q	~ p	~ p ∧ q	q → p	~ (q → p)
T	T	F	F	T	F
T	F	F	F	T	F
F	T	T	T	F	T
F	F	T	F	T	F

$\therefore \sim p \wedge q = \sim(q \to p)$

Q.72 Given limit =

$$\lim_{x\to\infty}\frac{(x+1)^{2010} + (x+2)^{2010} + \ldots\ldots + (x+10)^{2010}}{(x^{1006}+1)(2x^{1004}+1)} = \frac{10}{2} = 5$$

Q.73 $\because$ $y'(x) = f'(e^x)\, e^{f(x)} + f(e^x)\cdot e^{f(x)}\cdot f'(x)$

$\therefore$ $y'(0) = f'(1)\, e^{f(0)} + f(1)\cdot e^{f(0)}\cdot f'(0)$

$= 2\cdot 1 + 0 = 2$

Q.74 Clearly $x^2 - 7x + a$ should have $x - 4$ as a factor

$\therefore$ $16 - 28 + a = 0 \Rightarrow a = 12$ and $x^2 + 5x + b$ should have $x + 1$ as a factor

$\therefore$ $+1 - 5 + b = 0 \Rightarrow b = 4$

Q.75 $\because$ $C{\cdot}V{\cdot} = \frac{\sigma}{\bar{x}} \times 100 \Rightarrow \sigma = \frac{C{\cdot}V{\cdot}\times\bar{x}}{100}$

$\therefore$ $\sigma_1 = \frac{50\times 30}{100} = 15$

and $\sigma_2 = \frac{60\times 25}{100} = 15$

Q.76

given sum $= i + i + i^2 + i^6 + i^{4!} + \ldots\ldots\ldots\ldots\ldots + i^{100!}$

$i + i - 1 - 1 + \underbrace{1 + 1 + \ldots\ldots\ldots 1}_{97\text{ times}} = 95 + 2i$

Q.77 $|A|^{2^4} = (2.5)^{16} \Rightarrow |A| = \pm 10$

$\because$ $|A| = x + y + z$, where $x, y, z \in N$

$\therefore$ $x + y + z = 10$

$\therefore$ number of solutions $= {}^{10-1}C_{3-1}$

$= {}^9C_2 = \frac{9\times 8}{2} = 36$

Q.78 $\because$ $|\vec{c} - \vec{a}| = 2\sqrt{2} \Rightarrow |\vec{c} - \vec{a}|^2 = 8$

$\Rightarrow |\vec{c}|^2 + 9 - 2\ \vec{c}\cdot\vec{a} = 8 \Rightarrow |\vec{c}|^2 - 2|\vec{c}| + 1$

$= 0 \Rightarrow |\vec{c}| = 1$

$$\Rightarrow \vec{a}\times\vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & -2 \\ 1 & 1 & 0 \end{vmatrix} = 2\hat{i} - 2\hat{j} + \hat{k}$$

$\therefore$ $10\left|(\vec{a}\times\vec{b})\times\vec{c}\right| = 10\left|\vec{a}\times\vec{b}\right|\ |\vec{c}|\ \sin 30°$

$= 10 \times 3 \times 1 \times \frac{1}{2} = 15$

Q.79 Differentiating, $f'(x) = \frac{1}{(f(x))^2}$

$\Rightarrow \int (f(x))^2 f'(x)\,dx = \int 1\,dx$

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

putting $x = 2$,

$\frac{6}{3} = 2 + C \Rightarrow C = 0$

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

$\therefore$ $f(9) = 3$

Q.80 $\because$ Using LMVT for $f(x)$ in $[1, 6]$

$f'(c) = \frac{f(6) - f(1)}{6 - 1} \geq 2$

$\Rightarrow f(6) + 2 \geq 10 \Rightarrow f(6) \geq 8$

Q.81 number of ways =

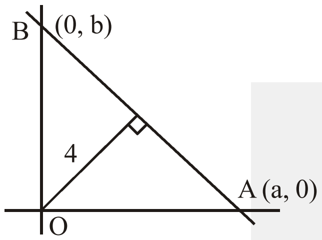
Total selections – (number of ways when exactly two consecutive) – (number of ways when all three consecutive

$= {}^{10}C_3 - 10\cdot{}^6C_1 - 10$

$= 120 - 60 - 10 = 50$

Q.82 Let equation of line be $\frac{x}{a}+\frac{y}{b}=1$

$\because$ Perpendicular distance from (0, 0) = 4



$$\Rightarrow \frac{1}{\sqrt{\frac{1}{a^2}+\frac{1}{b^2}}}=4 \Rightarrow \frac{1}{a^2}+\frac{1}{b^2}=\frac{1}{16}$$

$$\because \text{AM} \ge \text{HM} \Rightarrow \frac{a^2+b^2}{2} \ge \frac{2}{\frac{1}{a^2}+\frac{1}{b^2}}$$

$\Rightarrow a^2 + b^2 \ge 64$

$\therefore$ minimum value of $OA^2 + OB^2$ is equal to 64.

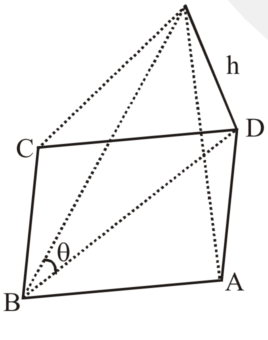
Q.83 $$\int_0^{2a} f(x)\,dx = \int_0^{a} f(x)dx + \underbrace{\int_a^{2a} f(x)dx}_{\substack{\text{Let } x = 2a-t \\ dx = -dt}}$$

$$= \int_0^{a} f(x)dx - \int_a^{0} f(2a-t)dt$$

$$= \int_0^{a} f(x)dx + \int_0^{a} f(2a-x)\,dx = 2 + 4 = 6$$

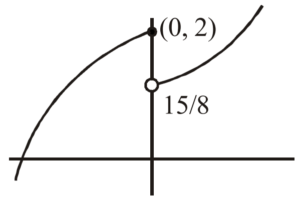
Q.84 Clearly, AD = CD = hcot 30° = $h\sqrt{3}$

$\therefore$ BD = AD$\sqrt{2}$ = $h\sqrt{6}$



$\therefore \tan\theta = \frac{1}{\sqrt{6}}$

Q.85 Clearly, x = 0 is point of local max.



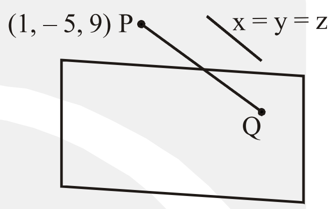
Q.86 equation of line parallel to given line through P is

$$\frac{x-1}{1}=\frac{y+5}{1}=\frac{z-9}{1}=\lambda$$

Its point of intersection with plane is

Q ($\lambda + 1, \lambda - 5, \lambda + 9$)

$\therefore (\lambda + 1) - (\lambda - 5) + (\lambda + 9) = 5$



$\Rightarrow \lambda = -10$

$\therefore$ Q = (– 9, – 15, – 1)

$\therefore PQ = 10\sqrt{3}$

Q.87 $\because x^2 + 4y^2 = 4 \Rightarrow \frac{x^2}{4}+\frac{y^2}{1}=1$

$\therefore x = 2\cos\theta$ and $y = \sin\theta$

$\therefore x^2 - xy = 4\cos^2\theta - 2\cos\theta \cdot \sin\theta$

$= 2(1 + \cos 2\theta) - \sin 2\theta$

$= 2 + 2\cos 2\theta - \sin 2\theta$

$\therefore$ maximum value $= 2 + \sqrt{5}$

Q.88 $\because \frac{2b^2}{a} = a \Rightarrow 2a^2(e^2 - 1) = a^2$

$\Rightarrow 2e^2 = 3 \Rightarrow e = \sqrt{\frac{3}{2}}$

Q.89 Let $w = 5(z - i) - 6$

$\Rightarrow w + 1 = 5(z - i - 1)$

$\Rightarrow |w + 1| = 5|z - i - 1| = 5$

$\therefore$ locus of w is a circle with centre $(-1, 0)$ of radius 5.

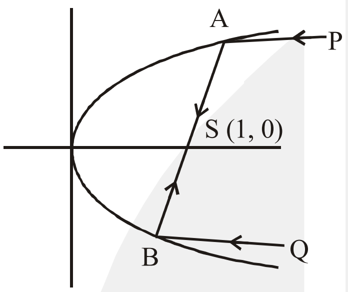
Q.90 After reflection both passes through locus

$\therefore$ AB is a focal chord

Let A be $(t^2, 2t)$

$\therefore 2t = 4 \Rightarrow t = 2$

$\therefore B = \left(\frac{1}{t^2}, \frac{-2}{t}\right)$



$\therefore$ Distance of QB from axis $= \left|\frac{-2}{t}\right| = 1$