

**CONCEPT RECAPITULATION TEST  
(Set – IV)**

**Paper 1**

**Time Allotted: 3 Hours**

**Maximum Marks: 252**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

**INSTRUCTIONS**

**A. General Instructions**

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two section: **Section-A & Section-C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

**B. Filling of OMR Sheet**

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

**C. Marking Scheme For All Three Parts.**

- (i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **- 1 mark** for wrong answer.

**Section-A (09 – 13)** contains 5 multiple choice questions which have more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

**Section-A (14 – 18)** contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **- 1 mark** for wrong answer.

- (ii) **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value and each question carries **+3 marks** for correct answer. There is no negative marking.

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**Useful Data**
**PHYSICS**

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34} \text{ J-s}$
Charge of electron	$e = 1.6 \times 10^{-19} \text{ C}$
Mass of electron	$m_e = 9.1 \times 10^{-31} \text{ kg}$
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{\text{water}} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

**CHEMISTRY**

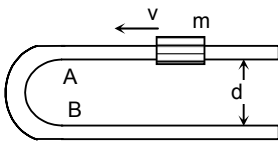
Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	$N_a$	=	$6.023 \times 10^{23}$
Planck's constant	h	=	$6.625 \times 10^{-34} \text{ J-s}$
		=	$6.625 \times 10^{-27} \text{ erg-s}$
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	$1.66 \times 10^{-27} \text{ kg}$
1 eV		=	$1.6 \times 10^{-19} \text{ J}$

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

**Physics****PART – I****SECTION – A**  
Single Correct Choice Type

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

- An air column in a pipe, which is closed at one end, will be in resonance with vibrating tuning fork of frequency 264 Hz, if the length of the column is  
 (A) 31.25 (B) 62.50  
 (C) 93.75 (D) 125
  - A fixed U-shaped smooth wire has a semi-circular bending between A and B as shown in the figure. A bead of mass 'm' moving with uniform speed v through the wire enters the semicircular bend at A and leaves at B. The magnitude of average force exerted by the bead on the part AB of the wire is  
 (A) 0 (B)  $\frac{4mv^2}{\pi d}$   
 (C)  $\frac{2mv^2}{\pi d}$  (D) none of these
- 
- A particle is moving along the path given by  $y = \frac{C}{6}t^6$  (where C is a positive constant). The relation between the acceleration (a) and the velocity (v) of the particle at t=5sec is  
 (A)  $5a = v$  (B)  $a = 5v$   
 (C)  $a = \sqrt{v}$  (D)  $a = v$
  - The kinetic energy acquired by a mass m in travelling a certain distance d, starting from rest, under the action of a force F such that the force F is  
 (A) directly proportional to  $t^2$  (B) independent of t  
 (C) directly proportional to  $t^4$  (D) directly proportional to t

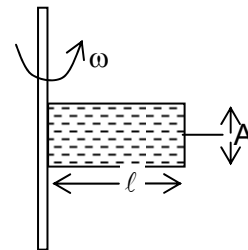
**Rough work**

5. Let  $I$  be the moment of inertia of a uniform square plate about an axis  $AB$  that passes through its centre and is parallel to two of its sides.  $CD$  is a line in the plane of the plate that passes through the centre of the plate and makes an angle  $\theta$  with  $AB$ . The moment of inertia of the plate about the axis  $CD$  is then equal to

(A)  $I$  (B)  $I \cos^2 \theta$   
 (C)  $I \sin^2 \theta$  (D)  $I \cos^2(\theta/2)$

6. A closed cylinder of length ' $\ell$ ', containing a liquid of variable density  $\rho(x) = \rho_0(1 + \alpha x)$  is rotating with constant angular velocity  $\omega$ . Find the net force exerted by the liquid on the axis of rotation. (Take the cylinder to be massless and  $A$  = cross sectional area of cylinder)

(A)  $\rho_0 A \omega^2 \ell^2 \left[ \frac{1}{2} + \frac{1}{3} \alpha \ell \right]$  (B)  $\rho_0 A \omega^2 \ell^2 \left[ \frac{1}{2} + \frac{2}{3} \alpha \ell \right]$   
 (C)  $\rho_0 A \omega^2 \ell^2 \left[ \frac{1}{2} + \alpha \ell \right]$  (D)  $\rho_0 A \omega^2 \ell^2 \left[ \frac{1}{2} + \frac{4}{3} \alpha \ell \right]$



7. Water rises to a height of 10cm in a capillary tube and mercury falls to a depth of 3.42 cm in the same capillary tube. If the density of mercury is 13.6g/cc and the angle of contact of mercury and water are  $135^\circ$  and  $0^\circ$ , respectively, the ratio of surface tension of water and mercury is

(A) 1 : 0.15 (B) 1 : 3  
 (C) 1 : 6.5 (D) 1.5 : 1

8. A pendulum has time period  $T$  in air. When it is made to oscillate in water, it acquired a time period  $T' = \sqrt{2}T$ . The specific gravity of the pendulum bob is equal to

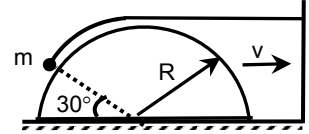
(A)  $\sqrt{2}$  (B) 2  
 (C)  $2\sqrt{2}$  (D) None of these

**Rough work**

## Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

9. A point object of mass  $m$  is slipping down on a smooth hemispherical body of mass  $M$  and radius  $R$ . The point object is tied to a wall with an ideal string as shown. At a certain instant, speed of the hemisphere is  $v$  and its acceleration is  $a$ . Then speed  $v_p$  and acceleration  $a_p$  of a particle has value (Assume all the surfaces in contact are frictionless)



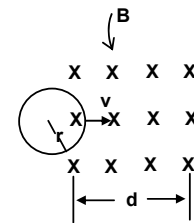
(A)  $v_p = v \sin 60^\circ$

(B)  $v_p = v$

(C)  $a_p = a$

(D)  $a_p = \sqrt{\left[\left(\frac{v^2}{R}\right) + \left(a \frac{\sqrt{3}}{2}\right)\right]^2 + \left(\frac{a}{2}\right)^2}$

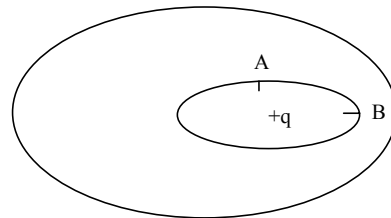
10. A conducting loop is pulled with a constant velocity towards a region of uniform magnetic field of induction  $B$  as shown in the figure. Then the current involved in the loop is ( $d > r$ )



- (A) clockwise while entering  
 (B) anti-clockwise while entering  
 (C) zero when completely inside  
 (D) clockwise while leaving

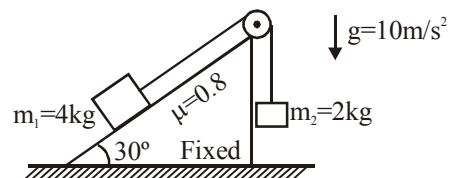
**Rough work**

11. An ellipsoidal cavity is carved within a perfect conductor. A positive charge  $q$  is placed at the centre of the cavity. The points A and B are on the cavity surface. Then



- (A) electrical field near A in the cavity must be equal to the electric field near B in the cavity.  
 (B) charge density at A must be equal to the charge density at B.  
 (C) potential at A must be equal to the potential at B.  
 (D) total electric field flux through the surface of the cavity is  $q/\epsilon_0$ .
12. A motor boat is to reach at a point  $30^\circ$  upstream on other side of a river flowing with velocity 5 m/s. Velocity of motor boat with respect to water is  $5\sqrt{3}$  m/sec. The driver should steer the boat at an angle of  
 (A)  $30^\circ$  up w.r.t. the line of destination from the starting point  
 (B)  $60^\circ$  up w.r.t.. normal to the bank  
 (C)  $120^\circ$  w.r.t. stream direction  
 (D) None of these

13. Two blocks of masses  $m_1$  and  $m_2$  are connected through a massless inextensible string. Block of mass  $m_1$  is placed at the fixed rigid inclined surface while the block of mass  $m_2$  hanging at the other end of the string, which is passing through a fixed massless frictionless pulley shown in figure. The coefficient of static friction between the block and the inclined plane is 0.8. The system of masses  $m_1$  and  $m_2$  is released from rest.



- (A) the tension in the string is 20 N after releasing the system  
 (B) the contact force by the inclined surface on the block is along normal to the inclined surface  
 (C) the magnitude of contact force by the inclined surface on the block  $m_1$  is  $20\sqrt{3}$ N  
 (D) none of these

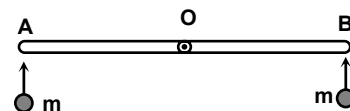
**Rough work**

## Comprehension Type

This section contains **2 paragraphs**. Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **which ONLY ONE is correct**.

## Paragraph for Question Nos. 14 to 15

Two identical uniform rods OA and OB each of length  $\ell$  and mass  $m$  are connected to each other by a massless pin connection (both the rods can rotate about O which is free to move), that allows free rotation. The assembly is kept on a frictionless horizontal plane. Now two point masses each of mass  $m$  moving with speed  $u$  perpendicular to the AB and hit the assembly inelastically at points A and B as shown in the figure.



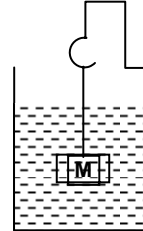
14. The speed of the centre of mass of the whole assembly just after the collision will be  
 (A)  $u/4$  (B)  $u/2$   
 (C)  $u$  (D) none of these
15. Find the angular speed of rods just after the collision  
 (A)  $\frac{3u}{4\ell}$  (B)  $\frac{6u}{5\ell}$   
 (C)  $\frac{3u}{2\ell}$  (D) zero.

*Rough work*

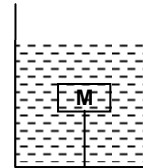
**Paragraph for Question Nos. 16 to 18**

Buoyant force on an object completely immersed in a fluid does not depend on the density of the object. It would only depend on the weight of liquid displaced. If the vessel in which an object is immersed is accelerated then the pseudo force acting on the object in the frame of the vessel depends on the mass of the object. The direction of motion of an object relative to a vessel can be found by finding the resultant of buoyant force, the pseudo force, the gravitational force and any other force acting on the body.

16. Consider a block immersed in a beaker containing water as shown:  
 If the beaker now starts accelerating upwards then the tension in the string will:
- (A) decrease
  - (B) increase
  - (C) remain unchanged
  - (D) data insufficient



17. Consider a wooden block immersed in a beaker containing water. If the beaker now starts accelerating upwards then:
- (A) Tension in the string will increase
  - (B) Tension the string will decrease
  - (C) Tension in the string will remain unchanged
  - (D) data insufficient



18. If in the previous problem the beaker was given a rightward acceleration then relative to the beaker the block will have a tendency to move:
- (A) Leftwards
  - (B) Rightwards
  - (C) Upwards
  - (D) Downwards

**Rough work**



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**SECTION –C**  
**Integer Answer Type**

This section contains **10 questions**. The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

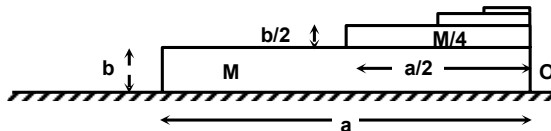
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1. Drops of water are thrown tangentially of the horizontal rim of a rotating wet umbrella. The rim is 3 ft in diameter and is held 4 ft above the ground and makes 14 revolutions in 33 seconds. Drops of water will meet the ground on a circle of diameter (in ft).
2. An AC source of angular frequency  $\omega$  is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of source is changed to  $\omega/3$  (but maintaining the same voltage), the current in the circuit is found to be halved. The ratio of reactance to resistance at the original frequency  $\omega$  is  $\sqrt{\frac{K}{5}}$ . Find the value of K.
3. Two vibrating strings of the same material but lengths L and 2L have radii 2r and r respectively. They are stretched under the same tension. Both the strings vibrate in their fundamental modes, the one of length L with frequency  $\nu_1$  and the other with frequency  $\nu_2$ . Then find the ratio of  $\nu_1/\nu_2$ .
4. The angle of a prism is  $30^\circ$ . The rays incident at  $60^\circ$  on one refracting face suffer a deviation of  $30^\circ$ . Then the angle of emergence is  $3K^\circ$ . Find the value of K.
5. A monochromatic beam of light ( $\lambda = 4900 \text{ \AA}$ ) incident normally upon a surface produces a pressure of  $5 \times 10^{-7} \text{ N/m}^2$  on it. Assuming that 25% of the light incident is reflected and the rest absorbed, the number of photons falling per second on a unit area of thin surface is  $3 \times 10^{5k} \text{ m}^{-2} \text{ s}^{-1}$ . Find the value of k.

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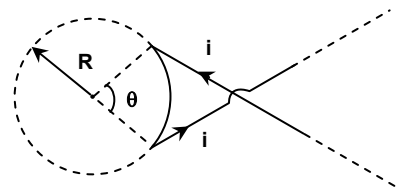
**Rough work**

6. Infinite number of bricks are placed one over the other as shown in the figure. Each succeeding brick having half the length and breadth of its preceding brick and the mass of each succeeding bricks being  $(1/4)^{\text{th}}$  of the preceding one. Taking 'O' as the origin, the x coordinate of centre of mass of the system of bricks is at  $\frac{-3a}{k}$ . Find the value of k.



7. A particle strikes a smooth horizontal surface at an angle of  $45^\circ$  with a velocity of 100 m/s and rebounds. If the coefficient of restitution between the floor and the particle is 0.57 then the angle which the velocity of the particle after it rebounds will make with the floor is  $(15K)^\circ$ . Find the value of K.
8. A thin wire is wound very tightly in one layer on the surface of a sphere of paramagnetic material ( $\mu_r \approx 1$ ). The planes of all the turns can be assumed to be perpendicular to the same diameter of the sphere. The turns cover the entire surface of the sphere. The radius of the sphere is R, the total number of turns is N, and the current in the winding is I. Find the magnetic induction at the centre of the sphere. (Given  $\mu_0 NI = 20 R$ )
9. The displacement y of a particle executing periodic motion is given by  $y = 4 \cos^2(1/2 t) \sin(1000 t)$ . This expression may be considered as a result of the superposition of n waves. Find the value of n.

10. A current carrying wire has the configuration shown in the figure. Two semi-infinite straight sections, each tangent to the same circle, are connected by a circular arc, of angle  $\theta$  along the circumference of the circle, with all sections lying in the same plane. Find the value of  $\theta$  (in rad) in order for B(magnetic field) to be zero at the centre of the circle.



**Rough work**

# Chemistry

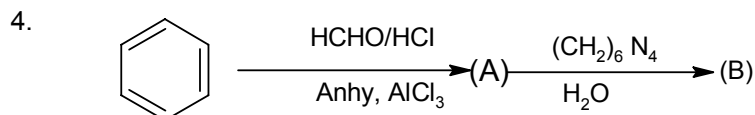
## PART – II

### SECTION – A

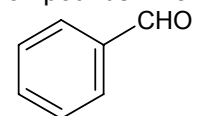
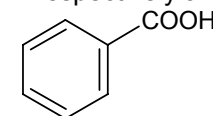
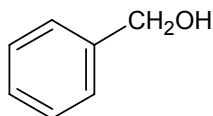
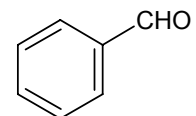
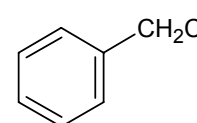
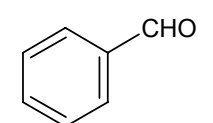
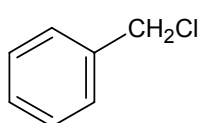
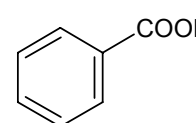
#### Straight Objective Type

This section contains **8 multiple choice** questions numbered **1 to 8**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

- Which of the following statement is true?
  - activation energy of the free radical step (for eg.  $\text{Cl}^\bullet + \text{Cl}^\bullet \longrightarrow \text{Cl}_2$ ) can be zero.
  - decrease in activation energy increases the rate of reaction
  - $t_{1/2}$  of the first order reaction is independent of initial concentration.
  - all of these
- A nitrogen fluoride on analysis found to contains 42.3% nitrogen and has a vapour density of 33. The hybridization of 'N' in the molecule is,
  - $\text{sp}^3$
  - $\text{sp}^3\text{d}$
  - $\text{sp}^2$
  - both  $\text{sp}^2$  and  $\text{sp}$
- Which of the following is not the correct statement regarding  $\text{C}_2$  molecule
  - It has total 12 electrons, out of which  $8e^-$  occupy bonding orbital while  $4e^-$  are antibonding orbitals
  - $\text{C}_2$  Molecule has been found to exist in vapour phase
  - $\text{C}_2$  Molecule containing double bonds and both are  $\pi$  - bonds
  - $\text{C}_2$  Molecule is paramagnetic

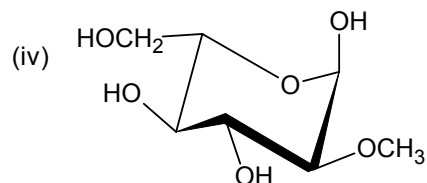
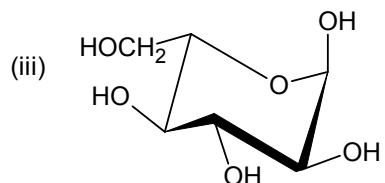
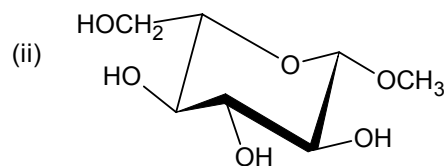
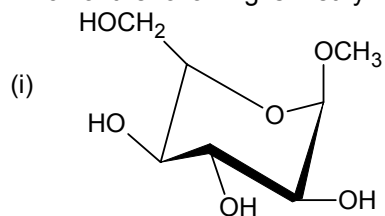


The Compounds 'A' and 'B' respectively are

- |     |   |   |   |     |  |   |   |
|-----|---|---|---|-----|--|---|---|
| (A) |  | , |  | (B) |  | , |  |
| (C) |  | , |  | (D) |  | , |  |

Rough Work

5. Which of the following is methyl- $\alpha$ -D-glucoside?



(A) (i)  
(C) (iii)

(B) (ii)  
(D) (iv)

6. The equilibrium  $\text{NH}_4\text{HS(s)} \rightleftharpoons \text{NH}_3(\text{g}) + \text{H}_2\text{S(g)}$  is followed to set up at  $127^\circ\text{C}$  in a closed vessel. The total pressure at equilibrium was 20 atm. The  $K_c$  for the reaction:

(A)  $0.092 \text{ M}^2$   
(C)  $3.045 \text{ M}^2$

(B)  $0.085 \text{ M}^2$   
(D) None of these

7. Bessemerisation is carried out for  
I : Fe, II : Cu, III : Al, IV : Ag

(A) II and III  
(C) III and IV

(B) I and II  
(D) I and III

8. Critical temperature of  $\text{H}_2$ , He,  $\text{N}_2$  and  $\text{O}_2$  in decreasing order is

(A)  $\text{N}_2 > \text{O}_2 > \text{H}_2 > \text{He}$   
(C)  $\text{N}_2 > \text{O}_2 > \text{He} > \text{H}_2$

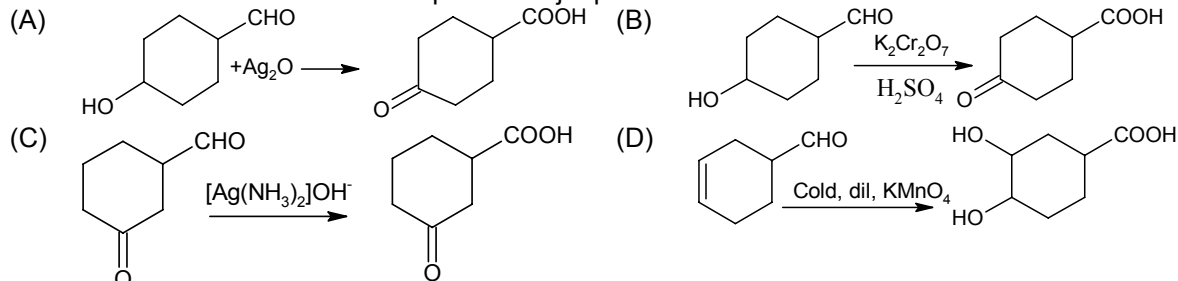
(B)  $\text{O}_2 > \text{N}_2 > \text{He} > \text{H}_2$   
(D)  $\text{O}_2 > \text{N}_2 > \text{H}_2 > \text{He}$

*Rough Work*

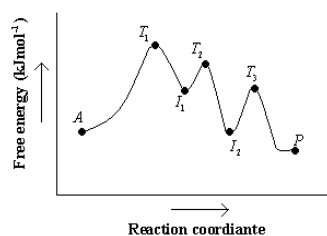
## Multiple Correct Choice Type

This section contains **5 multiple choice** questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. Select the correct reactions with respect to major product in the reaction



10.



For a reaction  $A \rightarrow P$ , the reaction profile diagram is as shown in the graph. On the basis of the graph choose the correct statement (s)

- (A) The reaction follows in three steps. (B)  $I_1$  is less stable than  $I_2$   
 (C) Rate determining step is  $A \rightarrow I_1$  (D)  $I_2$  is less stable than  $I_1$
11. Activation energy of forward and backward process of a reaction are  $60 \text{ kJ mol}^{-1}$  and  $40 \text{ kJ mol}^{-1}$  respectively. Which of the following are true for the reaction?
- (A) It is endothermic reaction (B) It is exothermic reaction  
 (C) Heat of reaction is  $+20 \text{ kJ mol}^{-1}$  (D) Threshold energy of reaction is  $100 \text{ kJ mol}^{-1}$

**Rough Work**

12. A metal (M) crystallizes into bcc lattice and if the radius of metal atom is 'r' cm, then the fraction of metal atoms that cannot lie on the surface of a cubic crystal that is 'l' cm in length, is/are.....

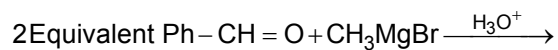
(A)  $\frac{48\sqrt{3}r}{l}$

(B)  $\frac{8\sqrt{3}r}{l}$

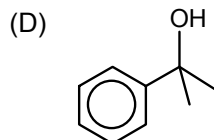
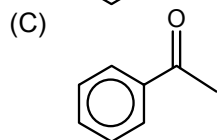
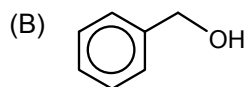
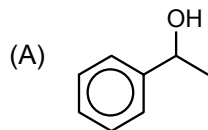
(C)  $\frac{4r}{\sqrt{3}l}$

(D)  $\frac{4\sqrt{3}r}{l}$

13. Consider the reaction:



Which of the following will be the product



*Rough Work*

**Paragraph Type**

This section contains **2 paragraphs**. Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT**.

**Paragraph for Question Nos. 14 to 15**

When metal carbonates are strongly heated, in general, metal oxide and  $\text{CO}_2$  are obtained. However, carbonates such as  $\text{Na}_2\text{CO}_3$  are thermally stable and do not undergo thermal decomposition. Bicarbonates such as  $\text{NaHCO}_3$  upon heating results their respective carbonates along with  $\text{CO}_2$ .  $\text{Ag}_2\text{CO}_3$  on the other hand when heated leaves behind a residue of Ag along with release of  $\text{CO}_2$  and  $\text{O}_2$ .

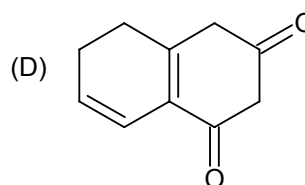
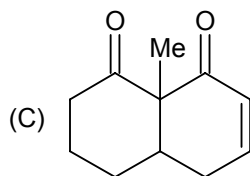
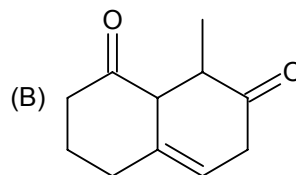
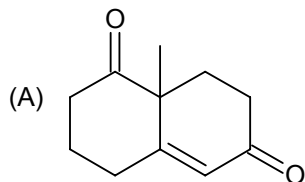
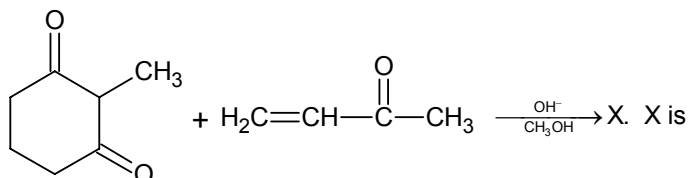
14. 0.2 moles of  $\text{Na}_2\text{CO}_3$  and 0.4 moles of  $\text{NaHCO}_3$  are strongly heated volume of  $\text{CO}_2$  at STP released will be:
- (A) 1.12 lit. (B) 4.48 lit.  
(C) 11.2 lit. (D) 22.4 lit.
15. 0.4 moles each of  $\text{MgCO}_3$  and  $\text{CaCO}_3$  and strongly heated.  $\text{CO}_2$  released is allowed to dissolve in  $\text{H}_2\text{O}$ . Number of  $\text{H}^+$  obtained from formed  $\text{H}_2\text{CO}_3$  upon complete dissociation will be (where  $N_A$  is Avagadro's number)
- (A)  $0.8 N_A$  (B)  $1.6 N_A$   
(C)  $2 N_A$  (D)  $0.4 N_A$

**Rough Work**

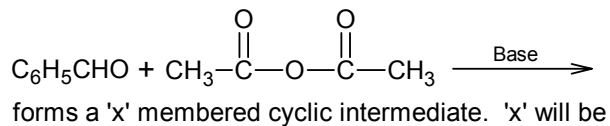
Paragraph for Question Nos. 16 to 18

Carbonyl compounds having or without  $\alpha$  - H do undergo many named organic reaction which find lots of use in synthesis of many organic compounds; an application of those have been asked below:

16.



17.



- (A) 4  
(C) 5

- (B) 6  
(D) 8

18. In the reaction,  $\text{HCHO} + \text{HCHO} \xrightarrow{\text{conc. OH}^-}$  Cannizaro product, what will happen to the order of the reaction if the concentration of  $\text{OH}^-$  is highly increased?

- (A) Increase (B) Decrease  
(C) None (D) Can't be predicted

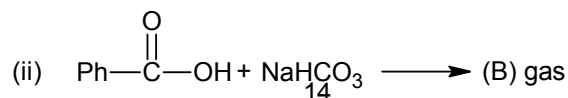
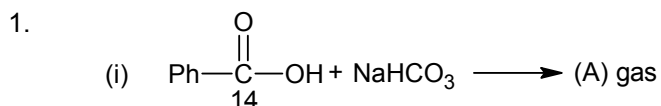
**Rough Work**



## SECTION – C

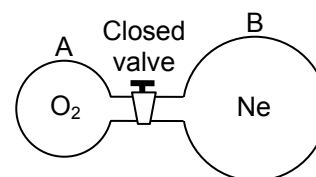
## Integer Answer Type

This section contains **10 questions**. The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

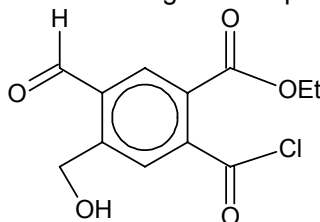


Sum of molecular mass of  $\frac{A+B}{10} = ?$

2. Initially bulb "A" contained oxygen gas at 27°C and 950 mm of Hg and bulb "B" contained neon gas at 27°C and 900 mm of Hg. These bulbs are connected by a narrow tube of negligible volume equipped with a stopcock and gases were allowed to mix-up freely. Then pressure in the combined system was found to be 910 mm of Hg. If volume of bulb B was measured to be 10 L. Then find the mass of oxygen gas present initially in bulb "A".

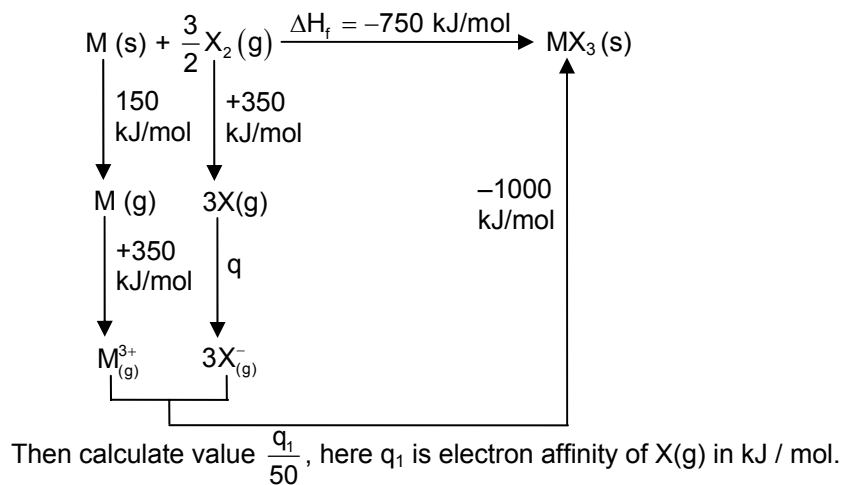


3. A, B and C are isodiaphers while C, D and E are isobars. Calculate the difference of protons between A and E.  ${}_{82}^{206}\text{A} \longrightarrow \text{B} \longrightarrow \text{C} \longrightarrow \text{D} \longrightarrow \text{E}$   
Given : Isodiaphers and isobars are formed in successive  $\alpha$  and  $\beta$ -emission respectively.
4. How many moles of RMgX consumed in the given compound?

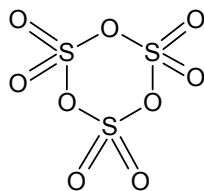


**Rough Work**

5. Consider the following Born-Haber's cycle for formation of  $\text{MX}_3(\text{s})$ .

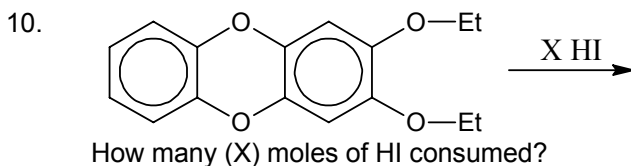


6. Consider the following molecule



Calculate value of  $\frac{p}{q}$ , here  $p$  and  $q$  are total number of  $d\pi - p\pi$  bonds and total number of  $sp^3$  hybridized atoms respectively in given molecule.

7. In compound  $\text{PCl}_x\text{F}_{5-x}$ , possible values of  $x$  are 0 to 5, then calculate value of  $x_1 + x_2 + x_3$  (where  $x_1, x_2$  and  $x_3$  ..... are possible values of  $x$ , with zero dipole moment for given compound).
8. When one litre of a saturated solution of  $\text{PbCl}_2$  (mol. wt. = 278) is evaporated, the residue is found to weigh 2.78g. If  $K_{sp}$  of  $\text{PbCl}_2$  is represented as  $y \times 10^{-6}$  then find the value of  $y$ .
9.  $x$  g sample of  $\text{NH}_4\text{NO}_3$  is decomposed in a Bomb calorimeter. The temperature of calorimeter increase by  $4^\circ\text{C}$ . The heat capacity of the system is  $1.25 \text{ kJ/gm}^\circ\text{C}$ . Calculate the value of  $x$ . Given molar heat of decomposition of  $\text{NH}_4\text{NO}_3$  is  $400 \text{ kJ mol}^{-1}$ .



**Rough Work**

**Mathematics****PART – III****SECTION – A****Straight Objective Type**

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Let  $f(x) = \begin{cases} \lim_{n \rightarrow \infty} \frac{x^n - \sin(x^n)}{x^n + \sin(x^n)}, & \text{if } x > 0, x \neq 1 \\ 1, & \text{if } x = 1 \end{cases}$ . Then, at  $x = 1$ ,

- (A)  $f$  is continuous  
 (B)  $f$  has removable discontinuity (i.e.,  $\lim_{x \rightarrow 1} f(x)$  exists, but this limit is different from  $f(1)$ )  
 (C)  $f$  has finite (jump) discontinuity (i.e.,  $f(1+)$  and  $f(1-)$  both exist finitely, but they are different)  
 (D)  $f$  has infinite or oscillatory discontinuity (for eg. like  $\sin \frac{1}{x}$  at  $x = 0$  and  $\tan x$  at  $x = \frac{\pi}{2}$ )

2. The locus of the vertices of the parabolas represented by the equation  $y = \frac{a^3 x^2}{3} + \frac{a^2 x}{2} - 2a$  ( $a$  is a non-zero parameter) is

- (A) a circle (B) a parabola  
 (C) an ellipse (D) a rectangular hyperbola

3. Three straight lines mutually perpendicular to each other meet in a point  $P$  and one of them intersects the  $x$ -axis and another intersects the  $y$ -axis, while the third line passes through a fixed point  $(0, 0, c)$  on the  $z$ -axis. Then the locus of  $P$  is

- (A)  $x^2 + y^2 + z^2 - 2cx = 0$  (B)  $x^2 + y^2 + z^2 - 2cy = 0$   
 (C)  $x^2 + y^2 + z^2 - 2cz = 0$  (D)  $x^2 + y^2 + z^2 - 2c(x + y + z) = 0$

**Rough work**

4. Number of ways of selecting two distinct integers 'a' and 'b' from the set  $\{1, 2, 3, \dots, 5n\}$ ,  $n \in \mathbb{N}$  so that  $a^4 - b^4$  is divisible by 5
- (A)  $\frac{17n^2 + 5n}{2}$  (B)  $\frac{15n^2 - 17n}{2}$   
 (C)  $\frac{17n^2 - 5n}{2}$  (D)  $\frac{15n^2 + 17n}{2}$
5. The value of the expression  ${}^{10}C_0 10^9 - {}^{10}C_1 9^8 + {}^{10}C_2 8^7 - \dots - {}^{10}C_9$  is
- (A) 9 (B) 10  
 (C) 9|10 (D) 0
6. The value of  $\int_{\frac{3\pi}{4}}^{\pi} \left[ \sin x + \left[ \frac{4x}{\pi} \right] \right] dx$ , where  $[.]$  denotes greatest integer function
- (A) 0 (B)  $\frac{5\pi}{4}$  sq. units  
 (C)  $\frac{7\pi}{4}$  sq. units (D)  $\frac{3\pi}{4}$  sq. units
7. Equation of the circle of minimum radius which touches both the parabolas  $y = x^2 + 2x + 4$  and  $x = y^2 + 2y + 4$  is
- (A)  $2x^2 + 2y^2 - 11x - 11y - 13 = 0$  (B)  $4x^2 + 4y^2 - 11x - 11y - 13 = 0$   
 (C)  $3x^2 + 3y^2 - 11x - 11y - 13 = 0$  (D)  $x^2 + y^2 - 11x - 11y - 13 = 0$
8. If  $\frac{x^2}{f(4a)} + \frac{y^2}{f(a^2 - 5)} = 1$  represents an ellipse with major axis as y-axis and f is a decreasing function positive for all 'a' then a belongs to
- (A) (0, 6) (B) (-1, 1)  
 (C) (-1, 5) (D) (5,  $\infty$ )

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**Rough work**

## Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

9. The area of the smaller portion enclosed by the curves  $x^2 + y^2 = 9$  and  $y^2 = 8x$  is  
 (A)  $\frac{\sqrt{2}}{3} + \frac{9\pi}{4} - \frac{9}{2}\sin^{-1}\left(\frac{1}{3}\right)$  (B)  $2\left(\frac{\sqrt{2}}{3} + \frac{9\pi}{4} - \frac{9}{2}\sin^{-1}\left(\frac{1}{3}\right)\right)$   
 (C)  $2\left(\frac{\sqrt{2}}{3} + \frac{9\pi}{4} + \frac{9}{2}\sin^{-1}\left(\frac{1}{3}\right)\right)$  (D)  $\frac{\sqrt{2}}{3} + \frac{9\pi}{4} + \frac{9}{2}\sin^{-1}\left(\frac{1}{3}\right)$
10. If  $f : \mathbb{R} \rightarrow \mathbb{R}$ ,  $f(x)$  is a differentiable function such that  $\{f(x)\}^2 = e^2 + \int_0^x [\{f(t)\}^2 + \{f'(t)\}^2] dt$ ,  
 $\forall x \in \mathbb{R}$ . The value of  $f(1)$  can take is/are  
 (A)  $e^2$  (B)  $-e^2$   
 (C) 1 (D)  $-1$
11. If  $0 < c < b < a$  and the roots  $\alpha, \beta$  of the equation  $cx^2 + bx + a = 0$  are imaginary, then  
 (A)  $\frac{|\alpha| + |\beta|}{2} = |\alpha| |\beta|$  (B)  $\frac{1}{|\alpha|} = \frac{1}{|\beta|}$   
 (C)  $\frac{1}{|\alpha|} + \frac{1}{|\beta|} < 2$  (D)  $\frac{1}{|\alpha|} + \frac{1}{|\beta|} > 2$
12. Suppose  $a, b > 0$  and  $x_1, x_2, x_3$  ( $x_1 > x_2 > x_3$ ) are roots of  $\frac{x-b}{a} + \frac{x-a}{b} = \frac{b}{x-a} + \frac{a}{x-b}$  and  $x_1 - x_2 - x_3 = c$ , then  
 (A)  $a, c, b$  are in H.P. and  $x_1 = a + b$  (B)  $a, c, b$  are in A.P. and  $x_2 = a + b$   
 (C)  $a, c, b$  are in A.P. and  $x_3 = 0$  (D)  $a, c, b$  are in H.P. and  $x_3 = 0$

---

**Rough work**

13. If inside a big circle exactly 24 small circles each of radius 2 can be drawn in such a way that each small circle touches the big circle and also touch both its adjacent small circles. Then the radius of the big circle is

(A)  $2\left(1 + \operatorname{cosec} \frac{\pi}{24}\right)$

(B)  $\left(\frac{1 + \tan \frac{\pi}{24}}{\cos \frac{\pi}{24}}\right)$

(C)  $2\left(1 + \operatorname{cosec} \frac{\pi}{12}\right)$

(D)  $\frac{2\left(\sin \frac{\pi}{48} + \cos \frac{\pi}{48}\right)^2}{\sin \frac{\pi}{24}}$

**Comprehension Type**

This section contains **2 paragraphs**. Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of **which ONLY ONE** is correct.

**Paragraph for Question Nos. 14 to 15**

**Read the following write up carefully and answer the following questions:**

A box contains  $n$  coins of which at least one is biased. Let  $E_k$  denote the event that exactly  $k$  out of the  $n$  coins are biased. Also let  $P(E_k)$  be directly proportional to  $k(k+1)$  for  $1 \leq k \leq n$ . Then

14. If  $p(n)$  denotes the probability that a coin selected out of the  $n$  coins at random is biased, then  $\lim_{n \rightarrow \infty} p(n)$  is equal to

(A)  $\frac{1}{4}$

(B)  $\frac{3}{4}$

(C)  $\frac{1}{2}$

(D)  $\frac{7}{8}$

15. If a coin selected at random is found to be biased, then the probability that it is the only biased coin in the box is

(A)  $\frac{1}{(n+1)(n+2)(n+3)(n+4)}$

(B)  $\frac{12}{n(n+1)(n+2)(3n+1)}$

(C)  $\frac{24}{n(n+1)(n+2)(n+3)}$

(D)  $\frac{24}{n(n+1)(n+2)(3n+1)}$

**Rough work**

## Paragraph for Question Nos. 16 to 18

Read the following write up carefully and answer the following questions:

A series of the form  $f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos nx + \sum_{n=1}^{\infty} b_n \sin nx$  is called Fourier series where  $a_0, a_1, a_2, \dots, a_n, b_1, b_2, \dots, b_n$  are constants and these coefficients are evaluated for  $x \in [\alpha, \alpha + 2\pi]$  using the formula  $a_0 = \frac{1}{\pi} \int_{\alpha}^{\alpha+2\pi} f(x) dx, a_n = \frac{1}{\pi} \int_{\alpha}^{\alpha+2\pi} f(x) \cos nx dx$  and  $b_n = \frac{1}{\pi} \int_{\alpha}^{\alpha+2\pi} f(x) \sin nx dx$ . Let us consider  $f(x) = x + x^2$  for  $-\pi \leq x \leq \pi$ , then

16. The value of  $a_0$  is

(A)  $\frac{2\pi^2}{3}$

(B)  $\frac{4\pi^3}{5}$

(C)  $\pi$

(D)  $\frac{3\pi^2}{2}$

17. The value of  $a_n$  is

(A)  $\frac{4(-1)^n}{n^2}$

(B)  $\frac{4}{n^2}$

(C)  $\frac{2(-1)^n}{n^2}$

(D)  $\frac{2}{n^2}$

18. The approximate value of  $\frac{\pi^2}{6}$  is given by

(A)  $1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \dots \infty$

(B)  $2 - \frac{1}{2^2} + \frac{2}{3} - \frac{2}{4^3} + \dots \infty$

(C)  $2 + \frac{1}{2} + \frac{2}{3} + \frac{2}{4^2} + \dots \infty$

(D)  $2 - \frac{2}{3^2} + \frac{2}{5^2} - \frac{2}{7^2} + \dots \infty$

## SECTION – C

## Integer Answer Type

This section contains **10 questions**. The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

1. If two natural numbers  $x, y$  are selected at randomly and probability that  $x^2 + y^2$  is multiple of 5 is  $p$ , then  $25p$  is \_\_\_\_\_.

*Rough work*

2. For  $y > 0$  and  $x \in \mathbb{R}$ ,  $ydx + y^2dy = xdy$  where  $y = f(x)$ . If  $f(1) = 1$ , then find  $f(-3)$  \_\_\_\_\_.
3. If the area bounded by  $[x] + [y] = n$  and  $y = k$ ;  $n, k \in \mathbb{N}$  and  $k \leq (n+1)$  and  $[.]$  is greatest integer function, in the first quadrant, is  $n + r$ , then find  $r$ .
4. If  $\lim_{n \rightarrow \infty} \frac{\sum_{r=1}^n \sqrt{r} \sum_{r=1}^n \frac{1}{\sqrt{r}}}{\sum_{r=1}^n r} = \frac{k}{3}$  then find  $k$  \_\_\_\_\_.
5. A curve passing through the point  $(1, 1)$  has the property that the perpendicular distance of the origin from normal at any point 'P' of the curve is equal to the distance of P from the x-axis is a circle with radius \_\_\_\_\_.
6. The real value of  $m$  for which the substitution  $y = u^m$  will transform the differential equation  $2x^4y \frac{dy}{dx} + y^4 = 4x^6$  into a homogeneous equation is  $\frac{\lambda}{2}$ . Then the value of  $\lambda$  is \_\_\_\_\_.
7. Let  $y = f(x)$  be a curve passing through  $(e, e^e)$  which satisfy the differential equation  $(2ny + xy \log_e x)dx - x \log_e x dy = 0$   $x > 0, y > 0$ . If  $g(x) = \lim_{n \rightarrow \infty} (0.020)^n f(x)$ . Then  $\int_{\frac{1}{e}}^e g(x) dx$  equal to \_\_\_\_\_.
8. If  $\int \frac{x^4 + 1}{x(x^2 + 1)^2} dx = A \ln |x| + \frac{B}{1 + x^2} + c$ , where  $c$  is the constant of integration then  $A + B$  is \_\_\_\_\_.
9. The number of solutions of the inequality  $2^{\frac{1}{\sin^2 \alpha_2}} \cdot 3^{\frac{1}{\sin^2 \alpha_3}} \cdots n^{\frac{1}{\sin^2 \alpha_n}} \leq n!$  where  $\alpha_i \in (-\pi, 2\pi)$  for  $i = 1, 2, 3, \dots, n$  is  $K^{n-1}$  then  $K$  is equal to \_\_\_\_\_.
10. The number of solutions of the equation  $|\cos x| = 2[x]$ , where  $[.]$  denotes greatest integer function, is equal to \_\_\_\_\_.

**Rough work**