

PHYSICS, CHEMISTRY & MATHEMATICS**CPT2****CODE: 120723****PAPER - 2****Time Allotted: 3 Hours****Maximum Marks: 312**

- 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

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Sections.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each section is further divided into two part: **Part A & B**
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 **Blue/Black Ball Point Pen** for each character of your Enrolment No. and write in ink 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) **PART-A (01 – 08)** contains 8 Multiple Choice Questions which have Only One Correct answer. Each question carries **+4 marks** for correct answer and **-2 marks** for wrong answer.

PART-A (09 – 16) contains 4 Paragraphs. Based upon each paragraph, 2 Multiple Choice Questions have to be answered. Each question has Only One Correct answer and carries **+3 marks** for the correct answer and **-1 mark** for a wrong answer.

- (ii) **PART-B (01 – 04)** contains 4 Matrix Match Type Question which have statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. There may be One or More Than One Correct choices. Each question carries **+12 marks** for all correct answer however for each correct row **+3 marks** will be awarded and **-1 mark** for each row matched incorrectly.

Name of the Candidate : _____

Batch : _____ **Date of Examination :** _____

Enrolment Number : _____

BATCH – All 1719

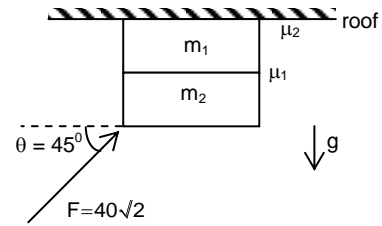
SECTION-I: PHYSICS

Part-A: Only One Option Correct Type

This section contains **8 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **Only One Option is correct**.

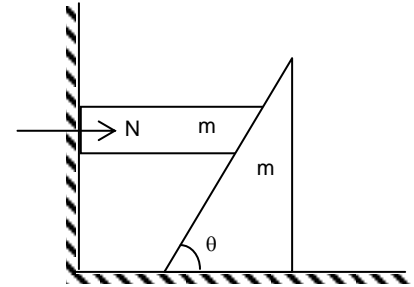
1. Two blocks of masses m_1 & m_2 are placed one onto other as shown in figure in touch with roof $m_1 = 1 \text{ kg}$, $m_2 = 2 \text{ kg}$
 $\mu_1 = 0.8$, $\mu_2 = 0$ then

- (A) friction force between blocks will be $\frac{40}{3} \text{ N}$ '
 (B) friction force between blocks will be 16 N
 (C) friction force between blocks will be 8 N
 (D) friction force between blocks will be 0 N



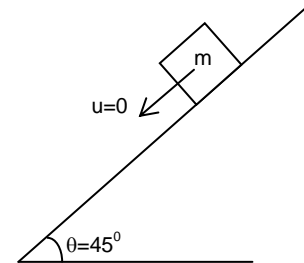
2. All surface are smooth, then normal force applied by vertical wall on rod will be (rod never loses contact with wedge)

- (A) $mg \sin \theta \cos \theta$ (B) $mg \sin 2\theta$
 (C) $mg \tan \theta$ (D) zero



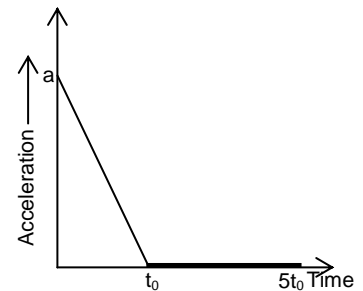
3. Coefficient of friction is varying with velocity of block as $\mu = \alpha V$ then maximum velocity of block will be

- (A) $\frac{1}{\alpha}$ (B) α
 (C) α^2 (D) $\frac{1}{\alpha^2}$



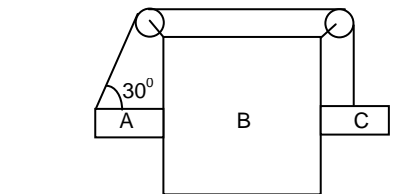
4. The acceleration time curve of a particle moving in a straight line is shown. The particle moves in time $5t_0$ by covering a displacement at_0^2 . Find the velocity of the particle in the last stretch of its journey : (just before crossing the distance at_0^2)

- (A) $\frac{at_0}{4}$ (B) $\frac{at_0}{6}$
 (C) $\frac{at_0}{\sqrt{2}}$ (D) $\frac{7}{30} at_0$



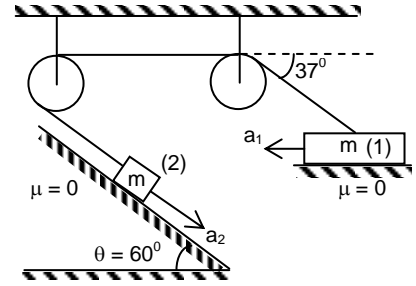
5. If mass of A is twice the mass of C and block A moves with acceleration a in the figure shown, find the coefficient of friction, if it is same for all surfaces. The blocks B does not move :

- (A) $\frac{3g - 5a}{\sqrt{3}g + a}$ (B) $\frac{5g - 3a}{\sqrt{3}g + a}$
 (C) $\frac{\sqrt{3}(2g - 3a)}{(2g + a)}$ (D) $\frac{7g - 5a}{\sqrt{3}g + a}$



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6. Two blocks are joined as shown in figure then acceleration of block (1) will be
- (A) $a_1 = \frac{10\sqrt{3}}{41}g$ (B) $a_1 = \frac{g}{2}$
- (C) $a_1 = \frac{g\sqrt{3}}{2}$ (D) none of these



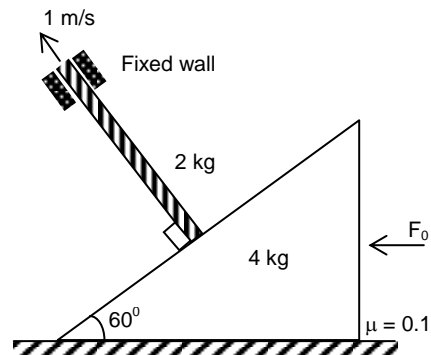
7. The velocity of water in a river is 18 km/hr near the surface. If the river is 5m deep, find the shearing stress between the horizontal layers of water. The coefficient of viscosity of water = 10^{-2} poise. (Assume velocity varies linearly with depth)
- (A) 10^{-1}N/m^2 (B) 10^{-2}N/m^2 (C) 10^{-3}N/m^2 (D) 10^{-4}N/m^2
8. A diatomic gas is compressed from a volume of 2m^3 to a volume of 1m^3 at a constant pressure of 100N/m^2 . Then it is heated at constant volume by supplying 150 J of energy. As a result, the internal energy of the gas
- (A) increases by 250 J (B) decreases by 100 J (C) increases by 50 J (D) none of these

Paragraph Type Questions

This section contains **4 paragraphs**. Based upon each paragraph, 2 Multiple Choice Questions have to be answered. Each question has **Only One Correct** answer.

Paragraph for Question Nos. 9 to 10

A rod of mass 2kg is constrained to move perpendicular to inclined plane of wedge which in turn is placed on rough horizontal surface having friction coefficient $\mu = 0.1$. A constant horizontal force F_0 is applied on wedge of mass 4kg in such a way that rod moves with constant velocity 1 m/s in upwards direction as shown in figure, then find out (there is no friction between incline and rod)



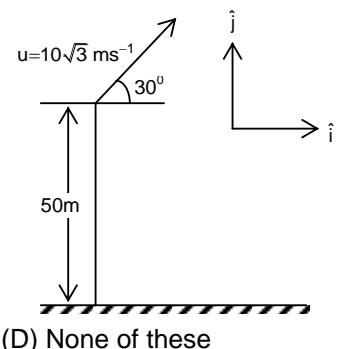
9. Power delivered by force F_0
- (A) $3\sqrt{3}$ (B) $\sqrt{3}$ (C) $2\sqrt{3}$ (D) none of these
10. Power delivered by contact force between wedge & rod on rod
- (A) 10 watt (B) 20 watt (C) 40 watt (D) Data is insufficient

Paragraph for Question Nos. 11 to 12

A projectile of mass 'm' is thrown from top of building of height 50 m as shown use, $g=10 \text{m/s}^2$

Answer the following question: -

11. At a time $t = t_0$, it was observed that instantaneous velocity of particle was perpendicular to velocity of projection. Find average velocity over time interval $0 \leq t \leq t_0$.
- (A) $5\sqrt{3} \text{ms}^{-1}$ (B) $10\sqrt{3} \text{ms}^{-1}$ (C) $20\sqrt{3} \text{ms}^{-1}$ (D) None of these

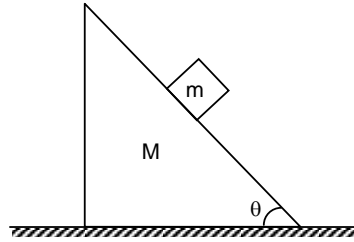


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12. Find average power consumed by gravity over the time interval $0 \leq t \leq t_0$
 (A) $5\sqrt{3}mg$ (B) $-5\sqrt{3}mg$ (C) $10\sqrt{3}mg$ (D) $-10\sqrt{3}mg$

Paragraph for question 13 to 14

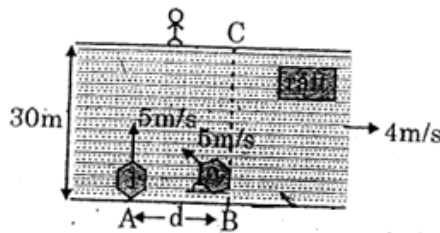
A small block m is kept on a wedge of M . Which is kept on ground. There is no friction anywhere. Answer the following questions.



13. Acceleration of M w.r.t. ground will be '
 (A) $a_0 = \frac{mg \sin \theta \cos \theta}{M + m \sin^2 \theta}$ (B) $a_0 = \frac{mg \sin \theta \cos \theta}{M - m \sin^2 \theta}$ (C) $a_0 = \frac{mg \sin \theta \cos \theta}{2M + m \sin^2 \theta}$ (D) $a_0 = \frac{mg \sin \theta \cos \theta}{M + 2m \sin^2 \theta}$
14. Choose the CORRECT statement:
 (A) $|\vec{a}_{M/\text{ground}}|$ must be greater than $|\vec{a}_{m/\text{ground}}|$
 (B) $|\vec{a}_{M/\text{ground}}|$ must be less than $|\vec{a}_{m/\text{ground}}|$
 (C) for some acute value of θ , m may free fall
 (D) for some acute value of θ , M has acceleration greater than g . (acceleration due to gravity)

Paragraph for question 15 to 16

Two boats A and B starts from A and B respectively and both boats reaches at point C (exactly in front of B) at different time. Answer the following questions.



15. The separation between point A and B is equal to:
 (A) 30m (B) 18m (C) 20m (D) 24m
16. Choose the CORRECT statement
 (A) $|\vec{v}_{A/\text{Raft}}| = |\vec{v}_{B/\text{Raft}}|$ and $|\vec{v}_{A/\text{ground}}| < |\vec{v}_{B/\text{ground}}|$ (B) $|\vec{v}_{A/\text{Raft}}| = |\vec{v}_{B/\text{Raft}}|$ and $|\vec{v}_{A/\text{ground}}| > |\vec{v}_{B/\text{ground}}|$
 (C) $|\vec{v}_{A/\text{Raft}}| > |\vec{v}_{B/\text{Raft}}|$ and $|\vec{v}_{A/\text{ground}}| = |\vec{v}_{B/\text{ground}}|$ (D) $|\vec{v}_{A/\text{Raft}}| = |\vec{v}_{B/\text{Raft}}|$ and $|\vec{v}_{A/\text{ground}}| = |\vec{v}_{B/\text{ground}}|$

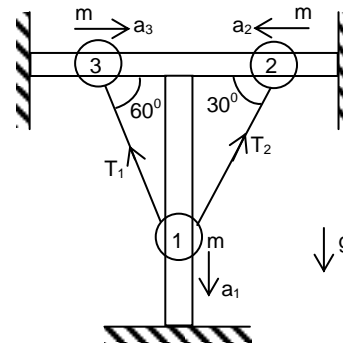
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Part-B : Matrix-Match Type Questions

This Section contains 4 Matrix Match Type Questions. Each question has four statements (A, B, C and D) given in Column I and five statements (p, q, r, s and t) in Column II. Any given statement in Column I can have correct matching with ONE or MORE statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.

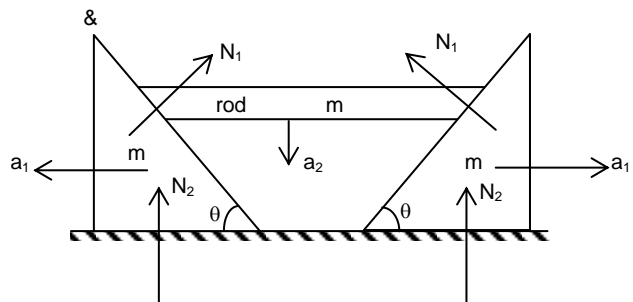
| | p | q | r | s | t |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| B | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| D | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

- 1 Three identical rings of mass m are placed on a T shaped smooth rod as shown in figure. Ring (1) & (3) is joined through string & ring (1) & (2) joined through string (take $g = 10 \text{ m/s}^2$) then match the following



| Column - I | | Column - II | |
|------------|----------------------------------|-------------|---------------------------|
| (A) | Acceleration of ring - (1) a_1 | (P) | $\frac{\sqrt{3} g}{13}$ |
| (B) | Acceleration of ring - (2) a_2 | (Q) | $3 \frac{g}{13}$ |
| (C) | Acceleration of ring - (3) a_3 | (R) | $6mg \frac{\sqrt{3}}{13}$ |
| (D) | Tension T_1 | (S) | $3\sqrt{3} \frac{g}{13}$ |

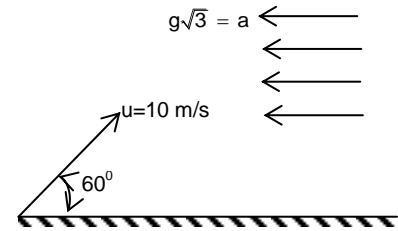
2. All surface are smooth & rod does not leave contact with wedge then match the following column



| Column - I | | Column - II | |
|------------|---------------------------------|-------------|---|
| (A) | Normal force on rod by wedge | (P) | $a = \frac{g \sin \theta \cos \theta}{1 + \cos^2 \theta}$ |
| (B) | Acceleration of wedge | (Q) | $a = \frac{g \sin^2 \theta}{1 + \cos^2 \theta}$ |
| (C) | Acceleration of rod | (R) | $N = \frac{mg \cos \theta}{1 + \cos^2 \theta}$ |
| (D) | Normal force by ground on wedge | (S) | $N = \frac{mg(1 + 2 \cos^2 \theta)}{1 + \cos^2 \theta}$ |

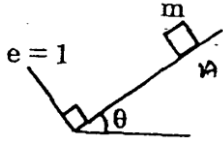
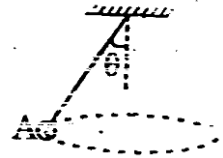
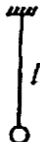
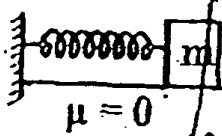
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3. Air is blowing in horizontal direction due to which it imparts a horizontal acceleration $g\sqrt{3}$ to any particle in Air. A projectile is projected with velocity $u = 10$ m/s at an angle 60° with horizontal. Then match the following



| Column - I | | Column - II | |
|------------|--|-------------|------------------|
| (A) | Horizontal range of the projectile | (P) | 15 m |
| (B) | Maximum height reached by projectile | (Q) | $10\sqrt{3}$ m |
| (C) | Radius of curvature of projectile at highest point | (R) | $\frac{15}{4}$ m |
| (D) | Radius of curvature of projectile at the point of projection | (S) | 10 m |

4.

| Column-I | | Column-II | |
|----------|---|-----------|--|
| (A) | Periodic motion | (P) | Simple pendulum with small amplitude A is mean position of bob |
| (B) | Simple harmonic motion | (Q) | Block released on a smooth fixed inclined plane. Collision with wall is elastic. A is starting point  |
| (C) | Body crosses point A when its acceleration is zero | (R) | Conical pendulum. A is a point on circular path  |
| (D) | Centripetal acceleration is zero at least at some point of the motion | (S) | Ball tied to a string and projected horizontally with $v = \sqrt{6g\ell}$. A is top most point of circular path.  |
| | | (T) | A block connected to a spring is pulled to right and released. A is position corresponding to natural length of the spring  |

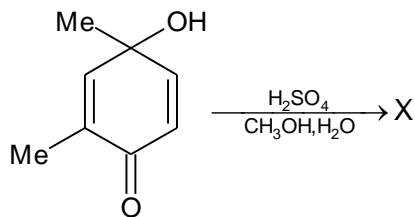
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SECTION-II: CHEMISTRY

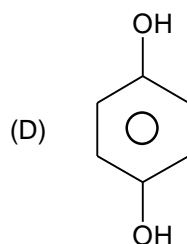
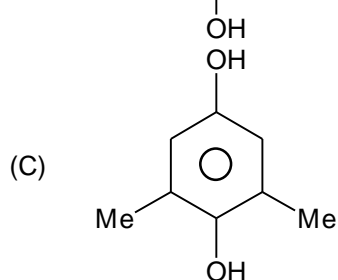
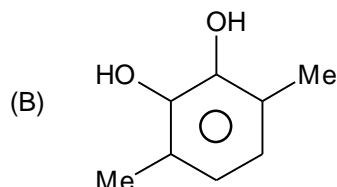
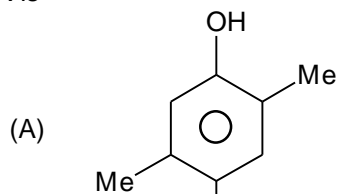
Part-A: Only One Option Correct Type

This section contains **8 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **Only One Option is correct**.

1.

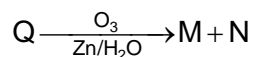
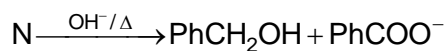
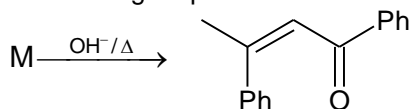


X is

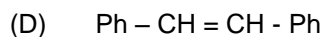
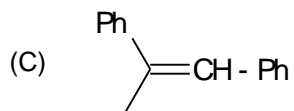
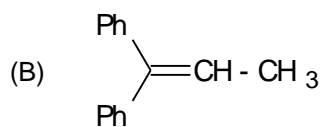
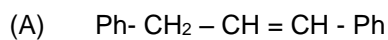


2.

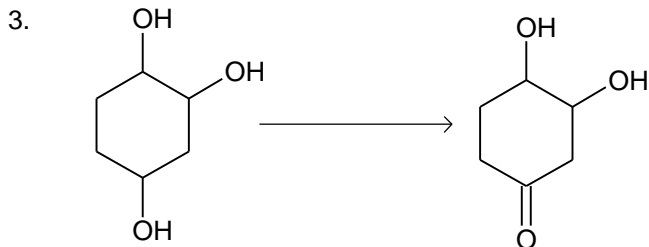
In the following sequence of reactions



The compound Q is



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This conversion can be achieved by

- (A) $\text{Me}_2\text{CO}/\text{H}^+$, H_3O^+ , $\text{KMnO}_4/\text{H}_2\text{O}^-$ (B) $\text{Me}_2\text{CO}/\text{H}^+$, KMnO_4 , H_3O^+
 (C) $\text{KMnO}_4/\text{NaIO}_4$, $\text{Me}_2\text{CO}/\text{H}^+$, H_3O^+ (D) $\text{KMnO}_4/\text{NaIO}_4$, H_3O^+ , $\text{Me}_2\text{CO}/\text{H}^+$

4. 10 mol of an ideal gas is heated at constant pressure of 1 atmosphere from 27°C to 127°C . If $C_{v,m} = 20 + 10^{-2} T \text{ JK}^{-1} \text{ mol}^{-1}$ then ΔH for the process is :

- (A) 23500 J (B) 25500 J (C) 31814 J (D) Data insufficient

5. Ethanol and water form binary liquid solution showing large deviation from Raoult's law - The normal boiling point (T_b) of pure Ethanol is less than that of pure water. Select the correct statement among the following for given solution:

- (A) Boiling temperature of mixture of any composition is always less than boiling temperature of Ethanol.
 (B) Boiling temperature of Azeotropic mixture is always less than boiling temperature of pure water.
 (C) When a small amount of Ethanol is added to pure water, boiling point of resulting mixture increases.
 (D) A mixture of Ethanol and water can be completely separated by simple fractional distillation.

6. The structure of glycine (amino acid) is $\text{H}_3\text{N}^+\text{CH}_2\text{COO}^-$ (Zwitter ion)

Select the correct statement of the following.

- (A) Glycine, as well as other amino acids are amphoteric.
 (B) The acidic functional group in amino acids is $-\text{NH}_3^+$
 (C) The basic functional group in amino acids is $-\text{CO}_2^-$
 (D) All the statements are correct

7. Which gas will form if hydrazoic acid is treated with nitrous acid?

- (A) $\text{N}_2 + \text{N}_2\text{O}$ (B) only N_2O
 (C) only N_2 (D) $\text{NO} + \text{N}_2\text{O}$

8. The compound formed by dissolving gold and platinum in aqua-regia is

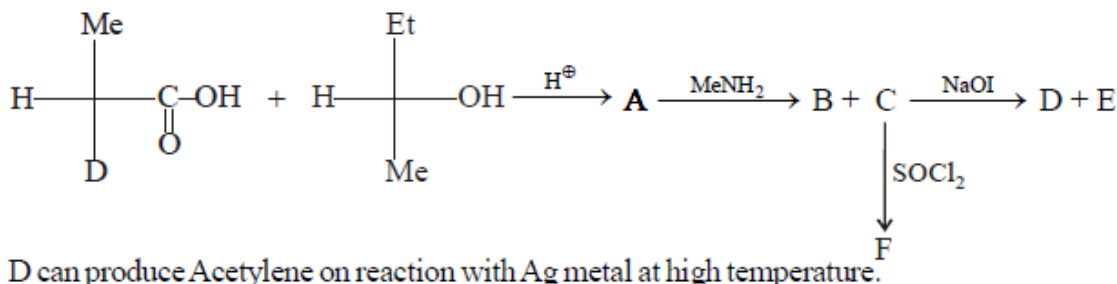
- (A) $[\text{AuCl}_4]^{3-}$ and $[\text{PtCl}_6]^{2-}$ (B) $[\text{AuCl}_4]^-$ and $[\text{PtCl}_6]^{4-}$
 (C) $[\text{AuCl}_4]^-$ and $[\text{PtCl}_6]^{2-}$ (D) $[\text{AuCl}_4]^-$ and $[\text{PtCl}_6]^{2-}$

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Paragraph Type Questions

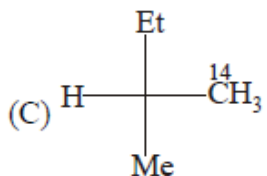
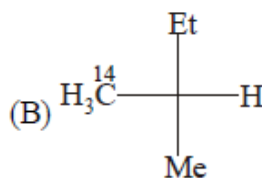
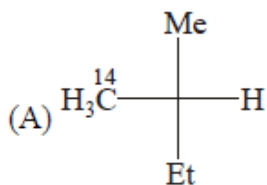
This section contains 4 paragraphs. Based upon each paragraph, 2 Multiple Choice Questions have to be answered. Each question has **Only One Correct** answer.

Paragraph for question nos. 09 & 10



D can produce Acetylene on reaction with Ag metal at high temperature.

9. F on reaction with $\text{CH}_3^{14}\text{-MgBr}$ gives major product.



(D) Mixture of (A) and (B)

10. B on basic hydrolysis gives a Nitrogen containing compound. Which statement is incorrect about that compound.
- (A) It can form a compound having unpleasant smell on reaction with $\text{CHCl}_3/\text{OH}^-$
 (B) It is more basic than Ph-NH_2
 (C) It can evolve H_2 on reaction with Na-metal
 (D) It can form base insoluble product on reaction with Heinsberg's reagent.

Paragraph for question nos. 11 to 12

An isotope of hydrogen atom is represented as X which follows Bohr's model and exists as diatomic gaseous molecule X_2 . Also the normal boiling point of a compound X_2O liquid is found to be 101°C and that of a solution obtained on dissolving 0.1 moles of NaCl in 1 kg of X_2O liquid is 101.4°C . It is also known that the ionization energy of X (g) is equal to 13.6 eV and bond dissociation energy of X_2 (g) is 15.83 eV/molecule.

11. The value of ebullioscopic constant of X_2O is given by—
 (A) 4 K kg mol^{-1} (B) 2 K kg mol^{-1} (C) $0.4 \text{ K kg mol}^{-1}$ (D) 1 K kg mol^{-1}
12. The energy required to dissociate one X_2 (g) molecule to X(g) atoms, all X(g) are in second excited state is:
 (A) 31.66 eV (B) 24.17 eV (C) 40 eV (D) 27.9 eV

space for rough work

Paragraph for question 13 to 14

Each oxy-acid contains at least one X – OH unit (X is non-metal). The H-atom of X – OH unit is ionisable and the number of –OH groups directly attach to non-metal decides the basicity of oxy-acid.

13. Which of the following hypoform of oxy-acid can exhibit tautomerism?
 (A) $\text{H}_2\text{N}_2\text{O}_2$ (B) $\text{H}_4\text{P}_2\text{O}_6$
 (C) $\text{H}_2\text{S}_7\text{O}_6$ (D) H_3PO_3
14. Which of the following oxyanion of pyro acid has different oxidation state of central atom?
 (A) $\text{S}_3\text{O}_6^{2-}$ (B) $\text{Si}_2\text{O}_7^{6-}$
 (C) $\text{S}_2\text{O}_5^{2-}$ (D) None of these

Paragraph for question 15 to 16

Aqueous solution of a salt 'A' when mixed with NaOH solution and warmed a black precipitate is formed. Black ppt. is filtered and dissolved in dil. H_2SO_4 solution. The resulting gives a coloured precipitate with potassium ferrocyanide solution. The filtrate obtained after filtering off the black precipitate, upon warming with Zn and NaOH evolves a pungent smelling gas. The resulting solution also responds to the ring test. The filtrate does not evolve any gas when it is boiled with urea in the presence of H_2SO_4 .

15. Salt 'A' consists of
 (A) Cu^{2+} (B) Hg^{2+}
 (C) Cu^+ (D) Pb^{2+}
16. The filtrate obtained after filtered off the black precipitate consists of
 (A) NO_2^- (B) NO_3^-
 (C) CO_3^{2-} (D) Cl^-

Part-B : Matrix-Match Type Questions

This Section contains 4 Matrix Match Type Questions. Each question has four statements (A, B, C and D) given in Column I and five statements (p, q, r, s and t) in Column II. Any given statement in Column I can have correct matching with ONE or MORE statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.

| | p | q | r | s | t |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| B | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| D | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

1. Match the columns:

| Column – I | | Column – II | |
|------------|---|-------------|--|
| (A) | $\text{XeF}_6 + \text{SiO}_2 \rightarrow$ | (P) | One of the product has pyramidal shape |
| (B) | $\text{P}_4(\text{white}) + \text{SO}_2\text{Cl}_2 \rightarrow$ | (Q) | One of the product has sp^3 hybridization |
| (C) | $\text{H}_2\text{SO}_4 + \text{P}_4\text{O}_{10} \rightarrow$ | (R) | One of the product has $\text{p}\pi\text{-d}\pi$ overlapping |
| (D) | $\text{XeF}_6 + \text{H}_2\text{O} \rightarrow$ | (S) | One of the product has zero dipole moment |

space for rough work

2. Match the following

| Column - I | | Column - II | |
|------------|---------------|-------------|---|
| (A) | Haematite | (P) | Self reduction |
| (B) | Copper pyrite | (Q) | Roasting |
| (C) | Carnalite | (R) | Electrolytic reduction |
| (D) | Bauxite | (S) | Calcination |
| | | (T) | Reduction by carbon monoxide(mainly) as well as carbon at different temperature |

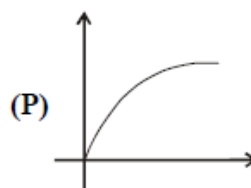
3.

For the reaction of type $A_{(g)} \longrightarrow 2B_{(g)}$ [Given $[A]$ = concentration of A at t^{th} time, $[B]$ = concentration of B at t^{th} time]

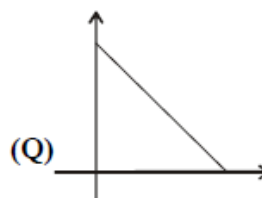
Column - I

Column - II

(A) If given reaction follow zero order kinetics

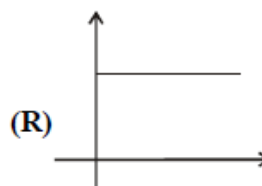
then $\frac{d[B]}{dt}$ Vs $-\frac{d[A]}{dt}$ curve

(B) If given reaction follow first order kinetics

then $[B]$ Vs t curve

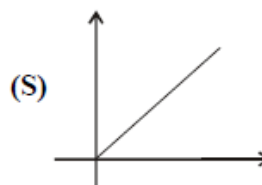
(C) If given reaction follow first order kinetics

then half life Vs time curve



(D) If given reaction follow zero order kinetics

then half life Vs time curve



4. All solution are at 25°C

| Column I | Column II (Comment on final solution) |
|--|--|
| (A) A solution containing weak acid 0.1 M HA ($K_a = 10^{-5}$) & 0.1 M NaA | (P) Buffer solution |
| (B) In a mixture of 200 ml 0.5 M Na_3PO_4 and 400 ml 0.5 M HCl (For H_3PO_4 $K_1 = 10^{-3}$, $K_2 = 10^{-7}$, $K_3 = 10^{-12}$) | (Q) pH = 10 |
| (C) An aqueous solution of sparingly soluble $\text{A}(\text{OH})_3$ ($K_{\text{SP}} = 27 \times 10^{-40}$) | (R) Acidic solution |
| (D) 0.1 M Na_2A ($K_{a_1}(\text{H}_2\text{A}) = 10^{-3}$, $K_{a_2}(\text{H}_2\text{A}) = 10^{-7}$) solution | (S) pH is closer to 7 (T) pH = 5 |

space for rough work

SECTION-III: MATHEMATICS**Part-A: Only One Option Correct Type**

This section contains **8 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **Only One Option is correct**.

- Let $f(x)$ is a continuous function which takes positive values for $x \geq 0$ and satisfy $\int_0^x f(t) dt = x\sqrt{f(x)}$ with $f(1) = \frac{1}{2}$. Then the value of $f(\sqrt{2} + 1)$ equals
 (A) 1 (B) $\sqrt{2} - 1$ (C) $\frac{1}{4}$ (D) $\frac{1}{\sqrt{2} - 1}$
- The number of points at which the function $f(x) = (x - |x|)^2 (1 - x + |x|)^2$ is not differentiable in the interval $(-3, 4)$ is
 (A) zero (B) one (C) two (D) three
- Mr. A has five children, and Mr. B has 3 children. Of the either children it is known that there are five girls and three boys. If $\frac{m}{n}$ is the probability that atleast one of the families have only girls as their children, where 'm' and 'n' are relatively prime positive integers, then the value of $(m + n)$ equals
 (A) 17 (B) 37 (C) 67 (D) 77
- The angle between pair of tangents drawn to the curve $7x^2 - 12y^2 = 84$ from $M(1, 2)$ is
 (A) $2 \tan^{-1} \frac{1}{2}$ (B) $2 \tan^{-1} 2$
 (C) $2 \left(\tan^{-1} \frac{1}{3} + \tan^{-1} \frac{1}{2} \right)$ (D) $2 \tan^{-1} 3$
- The position vector of point vector of a point in which in line through the origin perpendicular to the plane $2x - y - z = 4$ meets the plane $\vec{r} \cdot (3\hat{i} - 5\hat{j} + 2\hat{k}) = 6$, is
 (A) $(1, -1, -1)$ (B) $(-1, -1, 2)$ (C) $(4, 2, 2)$ (D) $\left(\frac{4}{3}, \frac{-2}{3}, \frac{-2}{3} \right)$
- Consider a parabola $y = \frac{x^2}{4}$ and the point $F(0, 1)$.
 Let $A_1(x_1, y_1), A_2(x_2, y_2), A_3(x_3, y_3), \dots, A_n(x_n, y_n)$ are 'n' points on the parabola such $x_k > 0$ and $\angle OFA_k = \frac{k\pi}{2n}$ ($k = 1, 2, 3, \dots, n$). Then the value of $\lim_{n \rightarrow \infty} \frac{1}{n} \sum_{k=1}^n \angle FA_k$, is
 (A) $\frac{2}{\pi}$ (B) $\frac{4}{\pi}$ (C) $\frac{\pi}{2}$ (D) $\frac{\pi}{4}$

space for rough work

7. If the 4th term in the expansion $\left(ax + \frac{1}{x}\right)^n$ is $\frac{5}{2}$, then:
 (A) $a = \frac{1}{2}$ (B) $a = 8$ (C) $a = \frac{2}{3}$ (D) $a = 6$
8. If Δ is the area of a triangle with sides of lengths a, b, c , then which of the following is always true,
 (A) $\Delta \leq \frac{1}{4}\sqrt{(a+b+c)abc}$ (B) $\Delta = \frac{1}{4}\sqrt{(a+b+c)abc}$
 (C) $\Delta \geq \frac{1}{4}\sqrt{(a+b+c)abc}$ (D) $\Delta = \frac{1}{4}abc\sqrt{(a+b+c)}$

Paragraph Type Questions

This section contains **4 paragraphs**. Based upon each paragraph, 2 Multiple Choice Questions have to be answered. Each question has **Only One Correct** answer.

Paragraph for Question Nos. 9 to 10

Consider the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ and the parabola $y^2 = 2x$. They intersect at P and Q in the first and fourth quadrants respectively. Tangents to the ellipse at P and Q intersect the x – axis at R and tangent to the parabola at P and Q intersect the x – axis at S.

9. The ratio of the area of the triangle PQS and PQR, is
 (A) 1 : 3 (B) 1 : 2 (C) 2 : 3 (D) 3 : 4
10. The area of quadrilateral PQRS, is
 (A) $\frac{3\sqrt{15}}{2}$ (B) $\frac{15\sqrt{3}}{2}$ (C) $\frac{5\sqrt{3}}{2}$ (D) $\frac{5\sqrt{15}}{2}$

Paragraph for Question Nos. 11 to 12

Consider two lines $L_1 : \vec{r}_1 = 2\hat{i} + \hat{j} - \hat{k} + \lambda(\hat{i} + 2\hat{k})$ and $L_2 : \vec{r}_2 = 3\hat{i} + \hat{j} + \mu(\hat{i} + \hat{j} - \hat{k})$.

Let Π be the plane which contains the line L_1 and is parallel to L_2 and intersecting coordinates axes at A, B, C respectively.

11. The shortest distance between the lines L_1 and L_2 , is
 (A) $\frac{1}{\sqrt{5}}$ (B) $\frac{1}{\sqrt{6}}$ (C) $\frac{1}{\sqrt{8}}$ (D) $\frac{1}{\sqrt{14}}$
12. Image of origin in the plane Π , is
 (A) $\left(\frac{2}{7}, \frac{-3}{7}, \frac{-1}{7}\right)$ (B) $\left(\frac{4}{7}, \frac{-6}{7}, \frac{-2}{7}\right)$ (C) $\left(\frac{-2}{7}, \frac{3}{7}, \frac{1}{7}\right)$ (D) $\left(\frac{-4}{7}, \frac{6}{7}, \frac{2}{7}\right)$

space for rough work

Paragraph for question 13 to 14

Tangents are drawn to the parabola $y^2 = 4x$ from the point $P(6, 5)$ to touch the parabola at Q and R . C_1 is a circle which touches the parabola at Q and C_2 is a circle which touches the parabola at R . Both the circles C_1 and C_2 pass through the focus of the parabola.

13. Area of the ΔPQR equals
 (A) $\frac{1}{2}$ (B) 1 (C) 2 (D) $\frac{1}{4}$
14. Radius of the circle C_2 is
 (A) $5\sqrt{5}$ (B) $5\sqrt{10}$ (C) $10\sqrt{2}$ (D) $\sqrt{210}$

Paragraph for question 15 to 16

If $A(z_1), B(z_2), C(z_3)$ are the affixes of vertices of a triangle ABC inscribed in the circle $|z| = 2$. The internal bisector of the angle A , meet the circumcircle again at $D(z_4)$, then

15. Which of the following is correct?
 (A) $z_4^2 = z_2 z_3$ (B) $z_4 = \frac{z_2 z_3}{z_1}$ (C) $z_4 = \frac{z_1 z_2}{z_3}$ (D) $z_4 = \frac{z_1 z_3}{z_2}$
16. If an altitude is drawn from A to side BC and it meets the circumcircle at $E(z_5)$, then:
 (A) $z_5 = \frac{z_2 z_3}{z_1}$ (B) $z_5 = \frac{z_2 z_3}{z_1}$ (C) $z_5 = \frac{z_1 z_3}{z_5}$ (D) $z_5 = \frac{z_1 z_3}{z_5}$

Part-B : Matrix-Match Type Questions

This Section contains 4 Matrix Match Type Questions. Each question has four statements (A, B, C and D) given in Column I and five statements (p, q, r, s and t) in Column II. Any given statement in Column I can have correct matching with ONE or MORE statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given in q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.

| | p | q | r | s | t |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| B | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| D | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

1. Match the following.

| Column-I | | Column-II | |
|----------|---|-----------|-----|
| (A) | If $I = \int_2^3 \left((x-1)^3 + (4-x)^3 + x \right) \cos \pi x \, dx$, then $ 50 \pi^2 I $ is equal to | (P) | 0 |
| (B) | If $J = \int_0^{10} \operatorname{sgn}(\sin \pi x) \, dx$, then $10J$ is equal to | (Q) | 100 |
| (C) | If $K = \int_0^{102} [\cot^{-1} x] \, dx$, then $[K]$ is equal to (here $[.]$ denotes G.I.F.) | (R) | 50 |
| (D) | If $L = \frac{\int_0^{51} [x+25] \, dx}{\int_0^{51} \{x+25\} \, dx}$, then $\frac{L}{2}$ is equal to (here $[.]$ and $\{.\}$ denote greatest integer function and fractional part function respectively) | (S) | 70 |
| | | (T) | 20 |

space for rough work

2. Let $f(x) = (x-1)(x-2)(x-3)\dots(x-n)$, $n \in \mathbb{N}$ and $\int \frac{f(x)f''(x) - (f'(x))^2}{(f(x))^2} dx = g(x) + C$, where C is an arbitrary constant.

| | Column-I | | Column-II |
|-----|--|-----|-----------|
| (A) | If $f'(n) = 5040$, then n is divisible by | (P) | 3 |
| (B) | If $g(x)$, $x \in \mathbb{R}$ is discontinuous at 9 points, then n is divisible by | (Q) | 4 |
| (C) | If $g(x) = 5$ has 8 solutions, then n may be equal to | (R) | 6 |
| (D) | If the number of roots of the equation $f'(x) = 0$ be $(n-5)^2(n-1)$, $n > 1$, then the possible values of n are | (S) | 8 |
| | | (T) | 9 |

3. Match the columns

| | Column-I | | Column-II |
|-----|---|-----|-----------|
| (A) | The number of positive integral solutions of the equation $x^2 - y^2 = 352706$ | (P) | 12^2 |
| (B) | The number of one – to – one functions from $\{6,5,3,7,0,2\}$ to $\{a,b,c,d,e,f\}$ | (Q) | 120 |
| (C) | The number of integral solutions of $x + y + z = 270$ is | (R) | 720 |
| (D) | There is five different balls to be put in five different boxes. Number of ways this can be done is | (S) | zero |
| | | (T) | Infinite |

4. Match the principal values of $\cos^{-1}(8x^4 - 8x^2 + 1)$ given in column-I with the corresponding intervals of x given in column-II, for which it holds

| | Column-I | | Column-II |
|-----|-----------------------|-----|--------------------------------------|
| (A) | $4\cos^{-1} x$ | (P) | $0 \leq x \leq \frac{1}{\sqrt{2}}$ |
| (B) | $4\cos^{-1} x - 2\pi$ | (Q) | $\frac{1}{\sqrt{2}} \leq x \leq 1$ |
| (C) | $2\pi - 4\cos^{-1} x$ | (R) | $-1 \leq x \leq -\frac{1}{\sqrt{2}}$ |
| (D) | $4\pi - 4\cos^{-1} x$ | (S) | $-\frac{1}{\sqrt{2}} \leq x \leq 0$ |

space for rough work