VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Advanced Booster Test - 1 | 2024

Date: 08/08/2022 **Maximum Marks: 180**

Timing: 04:00 PM - 07:00 PM **Duration: 3.0 Hrs**

General Instructions

1. The question paper consists of 3 Parts (Part I: **Physics**, Part II: **Chemistry**, Part III: **Mathematics**). Each Part has **four** sections **(Section 1: Part-A, Part-B, Part-C and Section 2).**

2. **Section 1 | Part-A** contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

Section 1 | Part-B contains **2 Paragraphs containing 2 Questions** on each paragraph**.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

Section 1 | Part-C contains **2 Column-Match sets**. Each set contains statements given in two columns (I and II). One or more statements in column II can be matched with a statement in column I. Each set has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

Section 2 contains **6 Numerical Value Type Questions**. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08)

3. For answering a question, an ANSWER SHEET (OMR SHEET) is provided separately. Please fill your **Test Code, Roll No.** and **Group** properly in the space given in the ANSWER SHEET.

Syllabus

Physics : Vectors & Its Forces
Chemistry : Stoichiometry-I
Mathematics : Quadratic Equations

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

Candidate's Signature : _____ **Invigilator's Signature** _____

MARKING SCHEME

SECTION 1 | Part-A

- This section consists of **SIX (06)** Questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks:	+4 If only (all) the correct option(s) is(are) chosen
Partial Marks:	+3 If all the four options are correct but ONLY three options are chosen
Partial Marks:	+2 If three or more options are correct but ONLY two options are chosen and both of which are correct
Partial Marks:	+1 If two or more options are correct but ONLY one option is chosen, and it is a correct option
Zero Mark:	0 if none of the options is chosen (i.e. the question is unanswered)
Negative Marks:	–1 In all other cases.

SECTION 1 | Part-B

- This section has **TWO (02) Paragraphs containing TWO (02) Questions** on each paragraph**.** Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks:	+3 If ONLY the correct option is chosen
Zero Marks:	0 If none of the options is chosen (i.e. the question is unanswered)
Negative Marks:	–1 In all other cases.

SECTION 1 | Part-C

- This section has **TWO (02)** Column-Match sets. Each set contains statements given in two columns. Statements in column I have to be matched with statements in column II. One or more than one statements in column II can be matched with a statement in column I.
- Each set has **FOUR** options. **ONLY ONE** of these four options is the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks:	+3 If ONLY the option corresponding to the correct combination is chosen
Zero Marks:	0 If none of the options is chosen (i.e., the question is unanswered)
Negative Marks:	–1 In all other cases.

SECTION 2

- This section contains **6 Integer Type Questions**. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the $\oplus$ sign for positive values. However, for negative values, $\ominus$ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08)
- Answer to each question will be evaluated according to the following marking scheme:

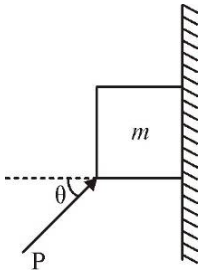
Full Marks:	+3 If ONLY the correct Integer value is entered. There is **NO negative marking.**
Zero Marks:	0 In all other cases.

PART I : PHYSICS 60 MARKS

SECTION 1 | Part-A

This section consists of SIX (06) Questions. Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).

1. A block of mass *m* is supported on a rough wall by applying a force P as shown in figure. Coefficient of static friction between block and wall is μ. The block remains in static equilibrium for which of the following values of P (minimum and maximum values).



(A) Minimum value of $P=\dfrac{mg}{\sin\theta+\mu\cos\theta}$

(B) Minimum value of $P=\dfrac{2mg}{\sin\theta-\mu\cos\theta}$

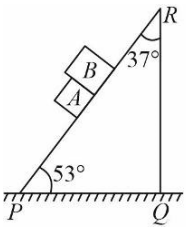
(C) Maximum value of $P=\dfrac{2mg}{\sin\theta-\mu\cos\theta}$

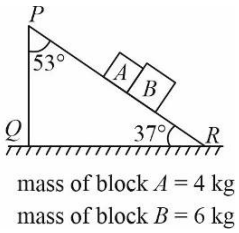
(D) Maximum value of $P=\dfrac{mg}{\sin\theta-\mu\cos\theta}$

2. $\vec{A}+\vec{B}=\vec{C}$. Vector $\vec{A}$ and $\vec{B}$ are rotated by angle θ in the same sense to form $\vec{A}'$ and $\vec{B}'$ $(\theta\neq 0)$. Choose the correct options.

(A) $\vec{A}'+\vec{B}'=\vec{C}$ **(B)** $\vec{A}'+\vec{B}'\neq\vec{C}$ **(C)** $\vec{A}'\bullet\vec{B}'=\vec{A}\bullet\vec{B}$ **(D)** $|\vec{A}'+\vec{B}'|=|\vec{C}|$

3.





Triangular wedge *PQR* is kept in two different orientations (refer figure) with two blocks *A* and *B* placed on face *PR* of the wedge. Coefficient of friction between block *B* and face *PR* of the wedge is 4/3 whereas block *A* is completely smooth. When the wedge rests on floor about face *PQ*, friction force on B is f_1. And when the wedge rests on floor about face *QR*, friction force on B is f_2. Then choose the correct options.

(A) f_1 is 48 *N* **(B)** f_2 is 64 *N*

(C) Ratio of f_1 and f_2 is 4 : 5 **(D)** Ratio of f_1 and f_2 is 3 : 4

4. Given two vectors $\vec{A}=3\hat{i}+4\hat{j}$ and $\vec{B}=\hat{i}+\hat{j}$. θ is the angle between $\vec{A}$ and $\vec{B}$. Which of the following statements is/are correct?

(A) $|\vec{A}|\cos\theta\left(\dfrac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$ is the component of $\vec{A}$ along $\vec{B}$.

(B) $|\vec{A}|\sin\theta\left(\dfrac{\hat{i}-\hat{j}}{\sqrt{2}}\right)$ is the component of $\vec{A}$ perpendicular to $\vec{B}$.

(C) $|\vec{A}|\cos\theta\left(\dfrac{\hat{i}-\hat{j}}{\sqrt{2}}\right)$ is the component of $\vec{A}$ along $\vec{B}$.

(D) $|\vec{A}|\sin\theta\left(\dfrac{\hat{i}-\hat{j}}{2}\right)$ is the component of $\vec{A}$ perpendicular to $\vec{B}$.

5. Two forces $\vec{F}_1$ and $\vec{F}_2$ lie in one plane while another force $\vec{F}_3$ lies in different plane. Then $\vec{F}_1+\vec{F}_2+\vec{F}_3$:

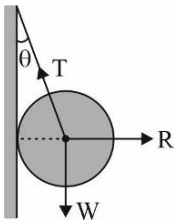
(A) Can be zero

(B) Cannot be zero

(C) Lies in a plane different from that at any of the three forces

(D) Lies in the plane of $\vec{F}_1$ or $\vec{F}_2$

6. A metal sphere is hung by a string fixed to a wall. The forces acting on the sphere are shown in figure. Which of the following statements are correct?



(A) $\vec{R}+\vec{T}+\vec{W}=0$ **(B)** $T^2=R^2+W^2$ **(C)** $T=R+W$ **(D)** $R=W\tan\theta$

SECTION 1 | Part-B

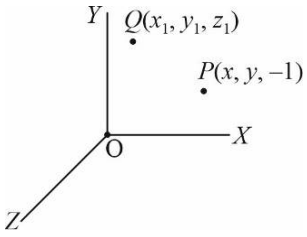
This section has TWO (02) Paragraphs containing TWO (02) Questions on each paragraph. Each question has FOUR options. ONLY ONE of these four options is the correct answer.

Paragraph for Q-7 to Q-8

Suppose that a point mass '*m*' is moving under a constant force $\vec{F}=2\hat{i}-\hat{j}+\hat{k}$ newton. At some instant, $t=0$, point $P(x,\ y,-1)$ is the instantaneous position of the mass (coordinates are in metres). We know that torque can be expressed as the cross-product of position vector and force vector, i.e.,

$$\vec{\tau}=\vec{r}\times\vec{F}$$

At *P*, torque about '*O*' can be expressed as $\vec{\tau}=(-4\hat{j}-4\hat{k})$ Nm. At some other instant, $t=3$ sec, the point mass has another instantaneous position $Q(x_1,\ y_1,\ z_1)$ such that *x*-component of torque at *Q* about '*O*' is zero and *y* and *z*-components are equal in magnitude and directed along the negative directions of the respective axes. If we construct a parallelogram with the position vector of *Q* and the given force $\vec{F}$ as its adjacent sides, area of this parallelogram is $10\sqrt{2}$ sq. units.



7. Coordinates of *P* are:

(A) $(1,\ 1,\ -1)$ **(B)** $(1,\ 2,\ -1)$ **(C)** $(2,\ 1,\ -1)$ **(D)** $(2,\ 2,\ -1)$

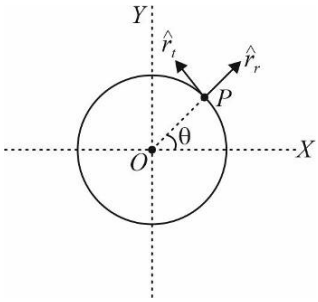
8. At *Q*, torque acting on the mass about '*O*' can be expressed as:

(A) $-5\hat{j}-5\hat{k}$ newton-metre **(B)** $-8\hat{j}-8\hat{k}$ newton-metre

(C) $-10\hat{j}-10\hat{k}$ newton-metre **(D)** $-12\hat{j}-12\hat{k}$ newton-metre

Paragraph for Q-9 to Q-10

Consider a point object of mass '*m*' moving in a circle of radius *a*. For any instantaneous position of the object, θ is the angle that the radial line joining the object and the centre makes with the positive *X*-axis of a Cartesian coordinate system with the centre of the circle *O* as the origin. $\hat{i}$ and $\hat{j}$ are unit vectors along *X*-axis and *Y*-axis, respectively. Suppose that the sense of rotation is counterclockwise with $\theta = 0$ at $t = 0$ so the value of θ will increase with time. For an object which moves in a circle, it is usually convenient to introduce two mutually perpendicular unit vectors $\hat{r}_r$ and $\hat{r}_t$, as shown in figure. Here $\hat{r}_r$ is the radial unit vector and $\hat{r}_t$, the tangential unit vector.



Answer the following questions:

9. For any instantaneous position of the object *P*, the radial unit vector $\hat{r}_r$ can be expressed as:

(A) $\hat{r}_r = \hat{i}\sin\theta + \hat{j}\cos\theta$ **(B)** $\hat{r} = \hat{i}\cos\theta + \hat{j}\sin\theta$

(C) $\hat{r} = \hat{i}\sin\theta - \hat{j}\cos\theta$ **(D)** $\hat{r}_r = -\hat{i}\cos\theta - \hat{j}\sin\theta$

10. For any position of the object *P*, the tangential unit vector can be expressed as:

(A) $\hat{r}_t = \hat{i}\cos\theta - \hat{j}\sin\theta$ **(B)** $\hat{r}_t = \hat{i}\sin\theta - \hat{j}\cos\theta$

(C) $\hat{r}_t = -\hat{i}\cos\theta + \hat{j}\sin\theta$ **(D)** $\hat{r}_t = -\hat{i}\sin\theta + \hat{j}\cos\theta$

SECTION 1 | Part-C

This section contains 2 Column-Match sets. Each set contains statements given in two columns (I and II). One or more statements in column II can be matched with a statement in column I. Each set has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

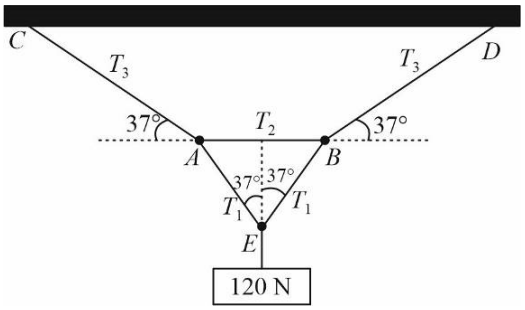
11. Consider three vectors $\vec{A}, \vec{B}$ and $\vec{C}$ having magnitudes 4, 5 and 3 and their directions can be varied. These vectors are of similar nature, e.g., these could be three displacement. Apply your understanding of vector algebra to match Column-I with Column-II.

Column -I		Column -II	
(A)	Maximum magnitude of $\vec{A} - \vec{B}$ will be	**(P)**	Zero
(B)	Minimum magnitude of $\vec{A} + \vec{B} - \vec{C}$ will be	**(Q)**	12
(C)	Maximum magnitude of $\vec{A} \cdot (\vec{B} - \vec{C})$ will be	**(R)**	9
(D)	Maximum magnitude of $\vec{A} + \vec{B} - \vec{C}$ will be	**(S)**	32

(A) A-R, B-P, C-Q, D-S **(B)** A-S, B-R, C-P, D-Q

(C) A-S, B-P, C-Q, D-R **(D)** A-R, B-P, C-S, D-Q

12. In figure, the whole system is in equilibrium. Tensions in different strings are shown. Match the following.



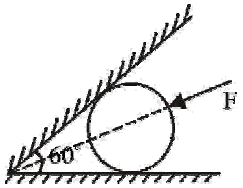
Column -I		Column -II	
(A)	$\lvert \vec{T}_1 + \vec{T}_2 \rvert$ is	**(P)**	T_2
(B)	$T_1 - T_2$ is	**(Q)**	T_3
(C)	$\lvert \vec{T}_1 + \vec{T}_3 \rvert$ is	**(R)**	$\leq 40N$
(D)	$T_1 + T_2$ is	**(S)**	$\geq 100N$

(A) A-Q, S; B-R; C-P, R; D-S **(B)** A-Q, S; B-R; C-P, R; D-Q
(C) A-Q, R; B-S; C-P, R; D-Q **(D)** A-Q, R; B-S; C-P, S; D-R

SECTION 2

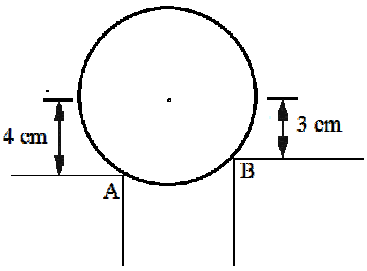
This section has Six (06) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. ***In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, ⊖ sign should be bubbled*****.**
(Example: 6, 81, 1.50, 3.25, 0.08)

1. A spherical ball is kept on a horizontal floor against a corner in a room where walls are inclined to each other at an angle of 60°, with the help of a force F acting along the angle bisector of the walls, (the top view of the ball is as shown in figure). Find the ratio of magnitude of normal force applied by any of the walls on the ball to the magnitude of force F.



2. When two forces of magnitudes F_1 and F_2 act on a body with an angle $\theta_1 = 60°$ between them, the magnitude of their resultant is R_1. If the angle between the forces is changed to $\theta_2 = 120°$ without changing their magnitudes, the magnitude of their resultant becomes R_2. If the ratio $\frac{R_1}{R_2}$ is equal to $\sqrt{\frac{19}{7}}$, the ratio $\frac{F_1}{F_2}$ is equal to _____. (Given $F_1 > F_2$)

3. A sphere of radius 5 cm and mass 4 kg rests on two point supports as shown, such that the points A, B and the centre of the sphere are in the same vertical plane. Friction is absent. The height difference between the supports and the centre of the sphere is shown in the figure. The force acting on the sphere from the support A is _____N. $\left(g = 10\ \text{m/s}^2\right)$



4. Initially, particle A is 10 m due East of particle B. Now, particle A moves $6\sqrt{2}$ m North-East and then moves 8 m West. Particle B moves 4m East and then moves $2\sqrt{2}$ m South-West. The final distance between A and B is _____ m.

5. If $\vec{P}, \vec{Q}$ & $\vec{R}$ are such that $\vec{P}\cdot\vec{Q} = Q$, $\left|\vec{Q}-\vec{P}\right| = 2\sqrt{2}$

Angle between $(\vec{P}\times\vec{R})$ & $\vec{Q}$ is 30° then magnitude of $(\vec{P}\times\vec{R})\times\vec{Q}$ is $\frac{n}{2}$.

$\vec{P} = 2\hat{i}+\hat{j}-2\hat{k}$, $\vec{R} = \hat{i}+\hat{j}$. Value of n is _____.

6. If ABC is a right angled triangle with hypotenuse $AB = P$. Then

$\overrightarrow{AB}\cdot\overrightarrow{AC}+\overrightarrow{BC}\cdot\overrightarrow{BA}+\overrightarrow{CA}\cdot\overrightarrow{CB} = mp^2$. Find m.

SPACE FOR ROUGH WORK

PART II : CHEMISTRY 60 MARKS

SECTION 1 | Part-A

This section consists of SIX (06) Questions. Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).

1. 35.5 gm of tribasic arsenic acid (H_3AsO_4, $M° = 142\,g/mole$) is treated with excess of H_2S in the presence of conc. HCl (assuming 100% conversion) as per the following reaction.

$$2H_3AsO_4 + 5H_2S \longrightarrow As_2S_5 + 8H_2O$$

Which of the following is/are correct?

(A) 0.125 mole of As_2S_5 is obtained **(B)** 18 gm H_2O is formed

(C) 1.25 equivalent of H_2S are used **(D)** Equivalent mass of H_3AsO_4 is 47.3

2. Which of the following is/are correct for 2 mole of equimolar mixture of $NaHCO_3$ and Na_2CO_3?

(A) 31 gm maximum loss in mass is observed on heating this mixture

(B) 159 gm residue is obtained on heating to constant weight

(C) Residue obtained in (B) required 300 mL of 1 M HCl using methyl orange indicator for neutralization

(D) Mixture required 1 L of 1 M HCl using phenolphthalein indicator for end point

3. Consider the reaction $2A + 3B \longrightarrow 4C + 5D$.

In the above reaction if one mole of A and one mole of B are reacted then identify correct statement(s) for mole fraction (χ) of A, B, C and D in the final mixture.

(A) $\chi_C = 0.4$ **(B)** $\chi_D = 0.5$ **(C)** $\chi_A = 0.0$ **(D)** $\chi_B = 0.0$

4. In which of the following reaction equivalent mass of protic acid is equal to its molecular mass?

(A) $H_3PO_2 + NaOH \longrightarrow NaH_2PO_2 + H_2O$

(B) $H_3PO_3 + CaO \longrightarrow CaHPO_3 + H_2O$

(C) $H_2C_2O_4 + KOH \longrightarrow KHC_2O_4 + H_2O$

(D) $2H_3PO_4 + Ca(OH)_2 \longrightarrow Ca(H_2PO_4)_2 + H_2O$

5. 5 mL of 16 M H_3PO_2, 4.8 mL of 10 M HCl and x mL of 10 M H_3PO_4 are mixed together and made upto 2 L. 30 mL of the acid mixture exactly neutralises 42.9 mL of solution containing 0.1 gm of $Na_2CO_3 \cdot 10H_2O$ in 10 mL of solution. Which of the following is/are correct?

[Given : Molar mass $H_3PO_4 = 98\,g/mole$, $Na_2CO_3 = 106\,g/mole$]

(A) Volume of H_3PO_4 added is 2.4 mL

(B) Strength of Na_2CO_3 solution is 10 g/L

(C) Normality of H^+ in acid mixture is 0.1 N

(D) Mass of phosphate ion in the acid mixture is 2.35 gm

6. Equal masses of $A(M° = 200\,g/mole)$ and $B_2(M° = 254\,g/mole)$ are allowed to react completely to form AB_2 and A_2B_2. Which of the following is/are correct?

(A) Mole of A taken are more than the mole of B_2 taken

(B) Mole of A unused are less than the mole of B_2 unused at the end of reaction

(C) Mole of A used are more than the mole of B_2 used

(D) Mole of A_2B_2 formed are more than the mole of AB_2 formed

SECTION 1 | Part-B

This section has TWO (02) Paragraphs containing TWO (02) Questions on each paragraph. Each question has FOUR options. ONLY ONE of these four options is the correct answer.

Paragraph for Q-7 to Q-8

Chemical industry is traditionally viewed more as a cause than a solution to pollution, chemistry does offer unique solution in the area of waste prevention. One of the most fundamental of these solutions is the application of the green chemistry principle of atom economy to chemical reactions. Atom economy means maximizing the material from the starting materials or reagents into the final product.

$$\text{Percent atom economy} = \frac{\text{Mass of desired product}}{\text{Total mass of all products}} \times 100$$

7. Oxygen can be produced by a number of processes. Two processes are shown below:

I. Electrolysis of water : $2H_2O \longrightarrow 2H_2 + O_2$

II. Catalytic decomposition of hydrogen peroxide : $2H_2O_2 \longrightarrow 2H_2O + O_2$

By calculating the percentage atom economy of each process, identify which of the following is correct?

(A) Process I is better for producing oxygen

(B) Process II is better for producing oxygen

(C) Both processes are equally better for producing oxygen

(D) Can't be decided by atom economy

8. Copper can be made by either roasting copper sulphide or by the reduction of copper carbonate with carbon. The equations for the two processes are shown below.

I. $\underset{0.24 \text{ moles}}{CuS} + O_2 \longrightarrow \underset{0.18 \text{ moles}}{Cu} + SO_2$

II. $\underset{0.56 \text{ moles}}{2CuCO_3} + C \longrightarrow \underset{0.36 \text{ moles}}{2Cu} + 3CO_2$

Which of the following is correct? [Atomic mass C = 12, O = 16, S = 32, Cu = 63.5]

(A) I reaction has higher atom economy and lower percentage yield

(B) I reaction has higher atom economy as well as higher percentage yield

(C) II reaction has higher atom economy as well as higher percentage yield

(D) II reaction has lower atom economy and higher percentage yield

Paragraph for Q-9 to Q-10

Benjamine Franklin conducted an experiment for the simple estimation of molecular size and Avogadro's number through oil spread on water.

He fetched out one table spoon (5 mL) of an oil of density 0.95 gm cm^{-3} on the water of a large pond. He saw it spread itself with surprising swiftness upon the surface. Such a small quantity of oil produced an instant calm over an area of about $2 \times 10^7 \text{ cm}^2$ making it as smooth as a looking glass. The calculation may go like this, Avogadro's number is the number of molecules in a mole; So if we can estimate both the number of molecules and the number of moles in Franklin's teaspoon of oil, we can calculate Avogadro's number.

In calculation he assumed that the oil molecules are tiny cubes that pack closely together and formed a layer only one molecule thick and the molar mass to be 240 g mol^{-1}.

9. What is the total number of molecules of oil?

(A) 1.20×10^{19} **(B)** 3.21×10^{18} **(C)** 3.21×10^{20} **(D)** 1.20×10^{22}

10. Number of moles of oil spread out in the oil film were.

(A) 9.18×10^{-2} **(B)** 1.98×10^{-2} **(C)** 8.91×10^{-1} **(D)** 9.56×10^{-3}

SECTION 1 | Part-C

This section contains 2 Column-Match sets. Each set contains statements given in two columns (I and II). One or more statements in column II can be matched with a statement in column I. Each set has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

11. Consider statement in Column-I and numerical value in Column -II. Identify correct option for correct matching of statement from list-I with numerical value from Column -II.

Column -I		Column-II	
(P)	x gm of $H_3PO_3\,(M° = 82\,g/mol)$ is present in 1.5 L of 0.4 N H_3PO_3. The value of x is	**(I)**	1.77
(Q)	100 gm x % pure $MgCO_3\,(M° = 84\,g/mole)$ on complete decomposition gives 0.2 mole CO_2 and 8 gm MgO. The value of x is	**(II)**	24.6
(R)	1.44 gm of titanium $(M° = 48\,g/mole)$ reacted with an excess of O_2 and produced x gm of a non-stoichiometric compound $Ti_{1.44}O$. The value of x is	**(III)**	16.8
(S)	1.84 gm mixture of $CaCO_3\,(M° = 100\,g/mole)$ and $MgCO_3\,(M° = 84\,g/mole)$ when heated to constant weight produce 0.96 gm residue. The mass of $CaCO_3$ (in gm) in the original sample was	**(IV)**	1.00

Codes:

(A) P-(II); Q-(III); R-(IV); S-(I) **(B)** P-(III); Q-(II); R-(IV); S-(I)

(C) P-(II); Q-(III); R-(I); S-(IV) **(D)** P-(III); Q-(IV); R-(II); S-(I)

12. A mixture is prepared by mixing solution (Column-I). Nature of resulting solution and concentration of ions in resulting solution is given in (Column-II). Assume no change in volume on mixing, NaCl is completely soluble while AgCl is completely insoluble in water. Select the correct option.

Column-I		Column-II	
(P)	100 mL of 5.5% (w/v) HCl solution is mixed with 100 mL of 5.5% (w/v) NaOH solution	**(I)**	Acidic, $[Cl^-] = 0.75\,M$
(Q)	500 mL of 0.3 M HCl solution is mixed with 500 mL of 0.3 M CH_3COOH solution	**(II)**	Neutral, $[Na^+] = 0.15\,M$
(R)	6 gm NaOH is added to 1000 mL of 0.15 M HCl solution	**(III)**	Acidic, $[Cl^-] = 0.15\,M$
(S)	500 mL of 0.3 M NaCl is mixed with 500 mL of 0.3 M $AgNO_3$ solution	**(IV)**	$[Na^+] = [Cl^-]$

Codes:

(A) P-(I); Q-(III); R-(II); S-(IV) **(B)** P-(III); Q-(I); R-(II); S-(IV)

(C) P-(I); Q-(III); R-(IV); S-(II) **(D)** P-(II); Q-(I); R-(IV); S-(IV)

SECTION 2

This section has Six (06) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. ***In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, ⊖ sign should be bubbled*****.**

(Example: 6, 81, 1.50, 3.25, 0.08)

1. A sample of hard water contains 96 ppm SO_4^{2-} ions and 183 ppm of HCO_3^- ions with Ca^{2+} as the only cation. The molarity of Ca^{2+} ions is $x \times 10^{-3}$M. What is value of x? (Assume density of hard water = 1gm/mL) [Atomic mass : H = 1, C = 12, O = 16, S = 32, Ca = 40]

2. If palladium metal $(d = 12\,g/cc)$ dissolves hydrogen gas (H_2) 936 times of its own volume at STP to form solid solution having molality of hydrogen atoms equal to $x \times 10^{-2}$m. Find the value of x_____.
(In nearest integer)

3. $P \times 10^{22}$ oxygen atoms are present in 2.16 gm of $CaHAsO_4 \cdot 2H_2O$. Find the value of P _____.
[Avogadro's number $= 6 \times 10^{23}$] [Atomic mass : Ca = 40, As = 75]

4. The molarity of H_2O_2 in a solution that is 30.7% by mass hydrogen peroxide and has a density of 1.11 g cm^{-3} is x M. Find the value of x _____. (Round off to nearest integer)

5. A 5 gm mixture of potassium sulphide and potassium chloride contains 3 gm potassium. If x% by mass of the mixture is potassium sulphide, then the value of x (nearest integer) is _____.
[Atomic mass K = 40, S = 32]

6. A solution is prepared with a final concentration of $Na^+ = 0.50\,M$ and a final concentration of $HCO_3^- = 0.10\,M$ by taking x mole NaOH and y mole trona $(Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O)$ and diluting with water to a final volume of 1.00 L. Find the sum of x and y _____.

SPACE FOR ROUGH WORK

PART III : MATHEMATICS 60 MARKS

SECTION 1 | Part-A

This section consists of SIX (06) Questions. Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).

1. Let $\left(\log_2 x\right)^2 - 4\log_2 x - m^2 - 2m - 13 = 0$ be an equation in x and $m \in R$, then which of the following must be correct?

(A) For any $m \in R$, the equation has two distinct solutions

(B) The product of the solutions of the equation does not depend on m

(C) One of the solutions of the equation is less than 1 while the other is greater than 1 for $\forall m \in R$

(D) The minimum value of the larger solution is 2^6 and maximum value of the smaller solution is 2^{-2}

2. Let $a,b,c \in Q^+$ satisfying $a > b > c$. Which of the following statement(s) hold true for the quadratic polynomial $f(x) = (a+b-2c)x^2 + (b+c-2a)x + (c+a-2b)$?

(A) The graph of the parabola $y = f(x)$ opens upwards.

(B) Both roots of the equation $f(x) = 0$ are rational

(C) $x-$ coordinate of vertex of the graph is positive.

(D) Product of the roots is always negative.

3. If p,q,r are positive rational numbers such that $p > q > r$ and the quadratic equation $(p+q-2r)x^2 + (q+r-2p)x + (r+p-2q) = 0$ has a root in $(-1,0)$ then which of the following statement hold(s) good?

(A) $\dfrac{r+p}{q} < 2$

(B) Both roots of the give quadratic equation are rational.

(C) The equation $px^2 + 2qx + r = 0$ has real and distinct roots.

(D) The equation $px^2 + 2qx + r = 0$ has no real roots.

4. Let $(a-1)\left(x^2 + \sqrt{3}x + 1\right)^2 - (a+1)\left(x^4 - x^2 + 1\right) \le 0 \ \forall x \in R$, then which of the following is/are correct?

(A) $a \in \left[-\dfrac{1}{\sqrt{3}}, \dfrac{4}{\sqrt{3}}\right]$

(B) Largest possible value of a is $\sqrt{3}$

(C) Number of possible integral values of a is 3

(D) Sum of all possible integral values of a is '0'

5. If a,b,c are sides of ΔABC and $a > b > c$, then the equation

$a(x-b)(x+c) + b(x-a)(x+c) - c(x-a)(x-b) = 0$ has

(A) Real and unequal roots **(B)** Roots with opposite sign

(C) Exactly one root in (b,a) **(D)** Imaginary roots

6. Let $u: ax^2+bx+c=0$

$v: dx^2+ex+f=0$

$w: gx^2+hx+i=0$

are the quadratic equations in x.

Consider a quadratic equation in y as

$E: uy^2+vy+w=0$

Which of the following alternative(s) is/are correct?

(A) If for some value of x say $x=x_1$, the equation $E=0$ has one root infinite and other root a non zero finite quantity then $u=0$ and $v=0$ will have a common root.

(B) If for some value of x say $x=x_2$, the equation $E=0$ has both root infinite then $u=0$ and $v=0$ will have a common root.

(C) If for some value of x say $x=x_3$, the equation $E=0$ becomes an identity in y then $u=0, v=0$ and $w=0$ must have root, common to all of them.

(D) If for some value of x say $x=x_4$, the equation $E=0$ has both roots real and distinct then $v=0$ and $w=0$ must have common root.

SECTION 1 | Part-B

This section has TWO (02) Paragraphs containing TWO (02) Questions on each paragraph. Each question has FOUR options. ONLY ONE of these four options is the correct answer.

Paragraph for Q-7 to Q-8

Consider a rational function $f(x)=\dfrac{x^2+3x+1}{x^2+x+1}$ and a quadratic function $g(x)=x^2-(m+1)x+m-1$, where m is a parameter.

7. Number of integral value(s) of 'm' so that $g(x)$ is always positive, is

(A) 0 **(B)** 1 **(C)** 2 **(D)** More than 2

8. If both roots of $g(x)=0$ are greater than the smallest value of the funtion $f(x)$, then 'm' lies in the interval.

(A) $(-\infty,-2)$ **(B)** $\left(-\infty,-\dfrac{1}{4}\right)$ **(C)** $(-2,\infty)$ **(D)** $\left(-\dfrac{1}{2},\infty\right)$

Paragraph for Q-9 to Q-10

Consider the quadrtic polynomial $f(x)=x^2-4ax+5a^2-6a$.

9. The value of 'a' for which roots of $f(x)=0$ are equal in magnitude and opposite in sign, is:

(A) 0 **(B)** 1 **(C)** 2 **(D)** None of these

10. The largest integral value of 'a' for which range of $f(x)$ is $[-5,\infty)$ for every real x, is:

(A) 1 **(B)** 5 **(C)** 7 **(D)** 10

SECTION 1 | Part-C

This section contains 2 Column-Match sets. Each set contains statements given in two columns (I and II). One or more statements in column II can be matched with a statement in column I. Each set has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

11. Match the Column:

	Column-I		Column-II
(A)	The value of $'k'$ for which the equation $x^3+kx^2+3=0$ and $x^2+kx+3=0$ have a common root, is	**(P)**	–2
(B)	Possible integral values of k for which exactly one root of the equation $5x^2+(k+1)x+k=0$ lies in the interval $(1,3)$ is equal to	**(Q)**	–4
(C)	Possible integral value(s) of $'x'$ for which $x^2+13x+44$ is a perfect square, can be	**(R)**	–5
		(S)	–8

(A) **A**-Q; **B**-Q, R, S; **C**-R, S **(B)** **A**-Q; **B**-Q, R; **C**-P, R, S

(C) **A**-Q, R; **B**-Q, R, S; **C**-R,S **(D)** **A**-Q; **B**-Q, S; **C**-P, R, S

12. Match the Column:

	Column-I		Column-II
(A)	If $a \in R$ then numbers of distinct real solutions of $x^2-\lvert x\rvert+a=0$ can be	**(P)**	1
(B)	Let $y=\dfrac{x^2-6x+8}{x^2-3x+2}$. The value of $'y'$ for which the value of $'x'$ obtained is real	**(Q)**	2
(C)	The value(s) of x satisfying the inequality $\log_2\sqrt{x}-2\log_{1/4}^2 x+1>0$ can be	**(R)**	3
(D)	Let $f(x)=\log_2(x-1)-\log_2(x+2)-\log_2(3x-1)$. If solution set of the inequality $f(x)<1$ is (a_1,a_2), then (a_2-a_1) is divisible by	**(S)**	4

(A) **A**-Q, R,; **B**-R,; **C**-P, Q, R; **D**-P, Q **(B)** **A**-Q, S; **B**- S; **C**-P, Q, R; **D**-P, S

(C) **A**-Q, R, S; **B**-R, S; **C**-P, Q, R; **D**-P, Q, S **(D)** **A**-R, S; **B**-R, S; **C**-P, R; **D**-P, Q, S

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SECTION 2

This section has Six (06) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. ***In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*****.**
(Example: 6, 81, 1.50, 3.25, 0.08)

1. Find the number of integral values of $'a'$ so that the inequation $x^2-2(a+1)x+3(a-3)(a+1)<0$ is satisfied by atleast one $x\in R^+$.

2. Find the number of integral values of $'a'$ for which, $f(x)=\left(a^2+a-2\right)x^2-(a+5)x-2$ is non positive for every $x\in[0,1]$.

3. The set of values of $'c'$ for which the equation $x^2-4x-c-\sqrt{8x^2-32x-8c}=0$ has exactly two distinct real solutions, is (a,b) then find the value of $(b-a)$.

4. Let α and β be the roots of a quadratic equation $4x^2-(5p+1)x+5p=0$. If $\beta=1+\alpha$, then find the integral value of p.

5. Suppose that a parabola $y=ax^2+bx+c,$ where $a>0$ and $(a+b+c)$ is an integer has vertex $\left(\frac{1}{4},\frac{-9}{8}\right)$. If the minimum possible value of $'a'$ can be written as $\frac{p}{q}$ where p and q are relatively prime positive integers, then find $(q-p)$.

6. Find sum of all possible values of the real parameter $'b'$ if the difference between the largest and smallest values of the function $f(x)=x^2-2bx+1$ in the segment $[0,1]$ is 4.

SPACE FOR ROUGH WORK

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