FIITJEE

BATCH – AII 1719

PHYSICS, CHEMISTRY & MATHEMATICS

CPT2 | **CODE: 120722** | **PAPER - 1**

Time Allotted: 3 Hours **Maximum Marks: 300**

- 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 three parts: **Part-A, B & 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 ***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 – 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+5 marks** for correct answer and **– 2 mark** for wrong answer.

(ii) **Part-A (05 – 10)** contains 6 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(iii) **Part-B (01 - 04)** contains 4 Matrix Match Type question containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 mark** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking

(iv) **Part-C (01 – 06)** contains 6 Numerical based questions with single digit integer as answer, ranging from 0 to 9 and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate :_____

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

Enrolment Number :_____

SECTION-I: PHYSICS

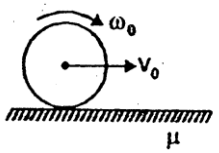
Part-A: Only One Option Correct Type

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

1. A parallel plate capacitor having a separation between the plates d, plate area A and material with dielectric constant K has capacitance C_0. Now one – third of the material is replaced by another material with dielectric constant 2K, so that effectively there are two capacitors one with area 1/2A, dielectric constant 2K and another with area 2/3A and dielectric constant K. If the capacitance of this new capacitor is C then $\frac{C}{C_0}$ is

(A) 1/3 (B) 4/3 (C) 1 (D) 2/3

2. A solid sphere of mass M and radius R is moving on a rough fixed surface, having co-efficient of friction μ as shown in figure. It will attain a minimum linear velocity after a time $(v_0 > \omega_0 R)$



(A) $\frac{V_0}{\mu g}$ (B) $\frac{\omega_0 R}{\mu g}$ (C) $\frac{(V_0 - \omega_0 R)}{\mu g}$ (D) $\frac{2(V_0 - \omega_0 R)}{7\mu g}$

3. A gas molecule of mass M at the surface of the earth has kinetic energy equivalent to 0°C. If it were to group straight without colliding with any other molecules, how high it would rise? Assume that the height attained is much less than radius of the earth (k_s is Boltzmann constant)

(A) $\frac{564k_g}{3Mg}$ (B) $\frac{273k_B}{2Mg}$ (C) $\frac{546k_g}{3Mg}$ (D) $\frac{819k_g}{2Mg}$

4. In figure shown, m_1 vertically oscillates with angular frequency ω_1. Now the system is inverted to that m_2 is at top. If oscillated vertically it oscillates with angular frequency ω_2. If it is kept on smooth ground as shown in figure -2, what is new angular frequency?

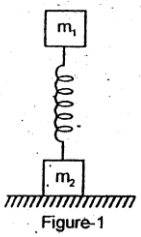


Figure-1

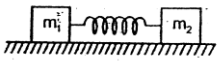


Figure-2

(A) $\frac{\omega_1 + \omega_2}{2}$ (B) $\sqrt{\omega_1 \omega_2}$ (C) $\sqrt{\omega_1^2 \omega_2^2}$ (D) $\frac{\omega_1 \omega_2}{\omega_1 + \omega_2}$

space for rough work

Part-A: One or More Than One Options Correct Type

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

5. A model rocket rests on a frictionless horizontal surface and is joined by a string of length ℓ to a fixed point so that the rocket moves in a horizontal circular path of radius ℓ. The string will break if its tension exceeds a value T. The rocket engine provides a thrust F of constant magnitude along the rocket's direction of motion. The rocket has a mass m that does not change appreciably with time (Ignore any air resistance). Starting from rest at t = 0 at later time t_1 the rocket is travelling so fast that the string breaks. Mark the correct option.

(A) $t_1 = \left(\frac{m\ell T}{F^2}\right)^{1/2}$

(B) The magnitude of instantaneous net acceleration at time $\frac{t_1}{2}$ is $\frac{\left[T^2 + 16F^2\right]^{1/2}}{4m}$

(C) The magnitude of instantaneous net acceleration at time $\frac{t_1}{2}$ is $\frac{\left[T^2 + 16F^2\right]^{1/2}}{2m}$

(D) $t_1 = \left(\frac{2m\ell T}{F^2}\right)^{1/2}$

6. A force of constant magnitude F acts on a particle (mass m) moving in a plane such that it always perpendicular to the velocity $\vec{v}\left(\left|\vec{v}\right| = v\right)$ of the body. Select the correct options.

(A) The time taken by the particle to cover a distance S is t = S/v

(B) The angle turned by the velocity vector of the particle during a distance S is $\left(\frac{FS}{mv^2}\right)$

(C) The magnitude of change in velocity vector during the time t is 2v sin $\left(\frac{Ft}{mv}\right)$

(D) The magnitude of change in velocity vector during the time t is 2v sin $\left(\frac{Ft}{2mv}\right)$

7. A transparent slab of thickness t and refractive indeed μ is inserted in front of upper slit of YDSE apparatus. The wavelength of light used is λ. Assume that there is no absorption of light by the slab. Select the correct statement(s) :

(A) The intensity of dark fringes will be 0, if slits are identical

(B) The change in optical path due to insertion of plate is μt

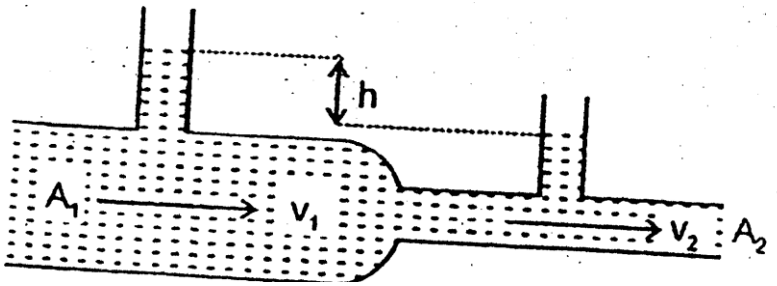
(C) The change in optical path due to insertion of plate is $(\mu - 1)t$

(D) For making intensity zero at the centre of screen, then thickness could be $\frac{5\lambda}{2(\mu - 1)}$

space for rough work

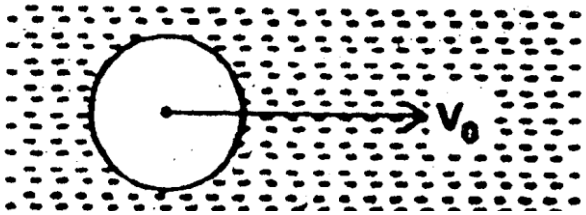
8. A single conservative force acts on a 1 kg particle that moves along x – axis. The potential energy of the particle varies with x as $U = 20 + (x - 2)^2$, here U is in joules and x is in joules and x is in meters. When the particle is at x = 5 m, its kinetic energy is 20 J. Then which of the following is/are correct?
(A) Mechanical energy of particle is 49 J.
(B) Least and greatest value of x between which particle can move is $\left(2-\sqrt{29}\right)\text{m}$ and $\left(2+\sqrt{29}\right)\text{m}$ respectively.
(C) Maximum kinetic energy of the particle is 29 J.
(D) At $x = 2$, the body is in equilibrium

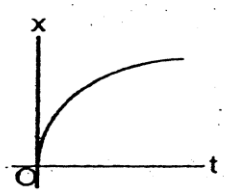
9. A liquid flows through a horizontal tube. The velocity of the liquid in the two sections, which have areas of cross section A_1 and A_2 are $v_1 v$ and v_2 respectively. The difference in the levels of the liquid in the two vertical tubes is h. Then

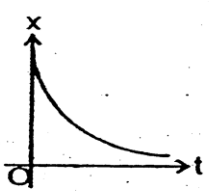


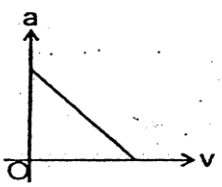
(A) The volume of the liquid flowing through the tube in unit time is $A_1 v_1$
(B) $v_2 - v_1 = \sqrt{2gh}$
(C) $v_2^2 - v_1^2 = 2gh$
(D) The total energy per unit mass of the liquid is the same in both sections of the tube

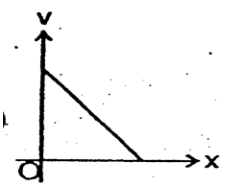
10. Which of the following graphs is/are valid for the motion of a solid sphere projected with a velocity v_0 in a gravity free viscous liquid? (x, v, a, t are displacement, velocity, acceleration, time respectively)



(A) 

(B) 

(C) 

(D) 

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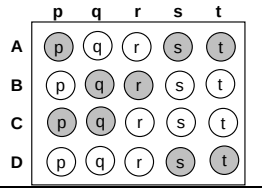
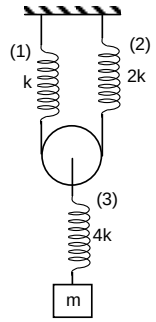
Part-B : Matrix-Match Type Questions

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.

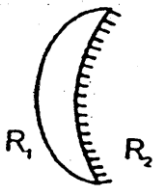
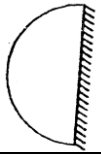


1. A spring block system is arranged as shown in figure Spring is idle & pulley is light. When block is in equilibrium then match the following,



Column – I		Column – II	
(A)	Extension in spring (1)	(P)	$\frac{Mg}{4k}$
(B)	Extension in spring (2)	(Q)	$\frac{Mg}{2k}$
(C)	Extension in spring (3)	(R)	$\frac{5mg}{8k}$
(D)	Initially the springs were at their natural length then displacement of block to reach equilibrium position	(S)	$\frac{mg}{4k}$

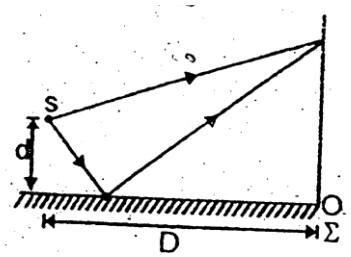
2. Optical system of glass $\left(\mu = \frac{3}{2}\right)$ placed in air

Column-I		Column-II	
(A)	 Equi – convex lens polished on one surface	(P)	Image may be virtual when object is real
(B)	 Convexo – concave lens, surface of larger curvature radius polished	(Q)	Image may be real when object is virtual
(C)	Concave lens with different curvature radii 	(R)	Image may form on real object itself
(D)	Plano convex lens mirror on plane surface 	(S)	Image may be real with object real
		(T)	Image may be at ∞

3. Match the following:

Column-I		Column-II	
(A)	Block of mass 2 kg on a rough horizontal surface pulled by a horizontal force of 20 N, coefficient of friction = 0.5	(P)	Tension at the mid point of block is 10 N
(B)	Block of mass 2 kg pulled with constant speed up an incline of inclination 30^o and coefficient of friction $\frac{1}{\sqrt{3}}$	(Q)	Acceleration of block is $5,/s^2$
(C)	Block of mass 0.75 kg pulled by a constant force of 7.5 N up on incline of inclination 30^o and coefficient of friction $\frac{1}{\sqrt{3}}$	(R)	Force of friction acting is 15N
(D)	Block of mass 2 kg pulled vertically by a force 20N	(S)	Resultant force on the block is zero
		(T)	Force of friction is 10N

4. A narrow slit S transmitting light of wavelength λ is placed a distance d above a large plane mirror as shown in the figure. The light coming directly from the slit and that coming after the reflection interfere at the screen $\sum$ placed at a distance D from the slit. Assume that the mirror is 100% reflecting and d << D. Match the quantities in column – I with their corresponding values in column – II (Given : D = 1 meter, d = 100 λ)



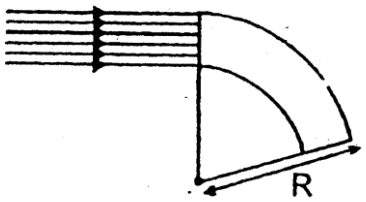
Column-I		Column-II	
(A)	Distance from O, where first interference maximum is formed on screen	(P)	0
(B)	Distance from O, where closest interference minimum is formed on screen	(Q)	1/4 cm
(C)	Fringe width of the interference pattern	(R)	1/2 cm
(D)	Closest point to O on screen where waves interfere with a phase difference of $\pi/2$	(S)	1 cm
		(T)	1/8 cm

space for rough work

Part –C: Single digit integer

This section contains **6 questions.** The answer to each question is a single digit integer ranging from 0 to 9 (both inclusive).

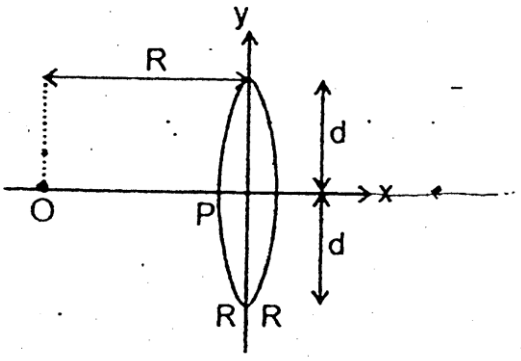
1. A portion of straight glass rod of square cross – section of side 3 cm and refractive intex 1.5 is bent into an arc of circle of outer radius R cm and a parallel beam of light is incident on it as shown in the figure. Find the smallest R (in cm) which permits all the light to pass around the arc.



2. A thermally insulated vessel containing one mole oxygen at $27^{o}C$ under the 1 atm pressure is accelerated from rest with an acceleration $a_0\left(\text{in } m/s^2\right)$ and is suddenly stopped at the end of 5^{th} second of its motion, thereby the temperature of oxygen is increased by $3^{o}C$. The acceleration $a_0 = \frac{50}{x}\left(m/s^2\right)$, find x (Treat oxygen as ideal gas)

3. A biconvex thin lens of radius of curvature R is made up of variable refractive index $\mu = 2\left(1+\frac{|y|}{d}\right)$.

Assume very small aperture $(2d << R)$. A point object O is placed at a distance R = 7.5 m on the principal axis from the lens (as shown). Due to variable refractive indeed of lens, there are infinite numbers of image on the principal axis. These image are spreaded over the length l. Find the value of l (in m).



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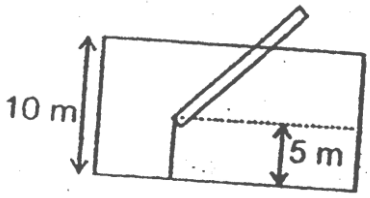
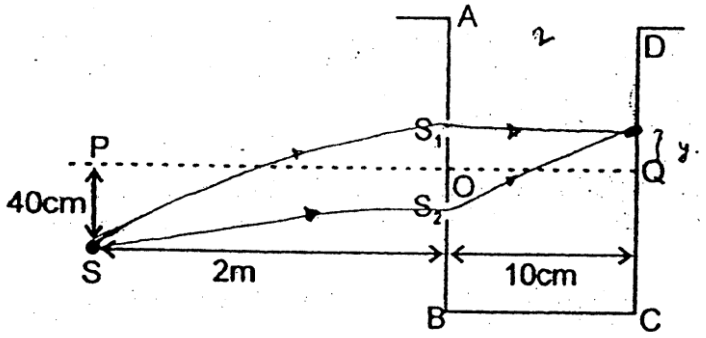
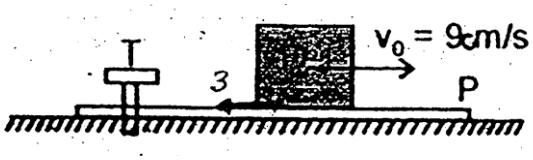
4. A rod of length 6 m has specific gravity p (= 25/36). One end of the rod is tied to a 5 m long rope, which is turn is tied to the floor of a pool 10 m deep, as shown. If length of the part of rod which is out of water is $\frac{6}{x}$ meter, find the value of 'x'.



5. A vessel ABCD of 10 cm width has two small slits S_1 and S_2 sealed with identical glass plates of equal thickness. The distance between the slits is 0.8 mm. POQ is the line perpendicular to the plane AB and passing through O, the middle point of S_1 and S_2. A monochromatic light source is kept as S, 40 cm below P and 2 m from the vessel, to illuminate the slits as shown in the figure below: Calculate the position of the central bright fringe (in cm) on the other wall CD with respect to the line OQ.



6. A solid block (mass = 1 kg) is moving with a constant speed (v_0 = 9 cm/s) on a plank P of mass 3/2 kg under some external force. The friction coefficient between the upper surface of P and the block is μ = 0.3 while the lower surface of P is smooth and rest on the ground. Initially, P is fixed to the ground by a pin T. If T is suddenly removed, find the acceleration (in m/s^2) of P.



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SECTION-II: CHEMISTRY

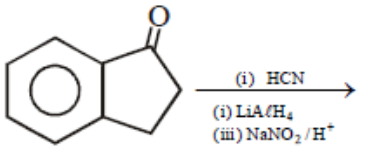
Part-A: Only One Option Correct Type

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

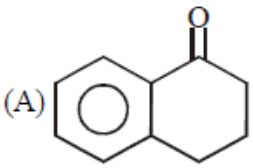
1. At 300 K temperature a compound 'C' (g) forms dimer in gaseous phase. The atoms of dimer are held together by intermolecular H-bonding at same temperature with a total strength of 37.2 kJ/mol under standard conditions. Equilibrium constant for dimerisation reaction is 10^3 at given temperature. $\Delta S°$ for this conversion is : **[Given : R = 8.3 J/mole-K]**
(A) – 0.167 kJ K^{-1} (B) – 1.67 kJ K^{-1} (C) 0.067 kJ K^{-1} (D) – 0.067 kJ K^{-1}

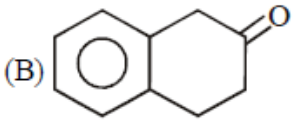
2. 60 ml of a mixture of equal volume of Chlorine gas & an oxide of chlorine was sparked till increment in volume is stop. The resulting gaseous mixture was found to have volume of 75ml. The resulting gaseous mixture was passed through aqueous KOH solution, the volume contracted to 15ml. Assume that all measurements are made at the same T & P. The oxide of Chlorine on sparking decomposes quantitatively to $O_2(g)$ & $Cl_2(g)$. The simplest formula of oxide of Chlorine is
(A) Cl_2O_3 (B) ClO_2 (C) Cl_2O (D) None of these

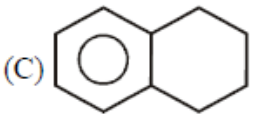
3. Which of the following oxides is / are not acidic in nature?
(A) ClO_2 (B) N_2O (C) Cl_2O (D) NO_2

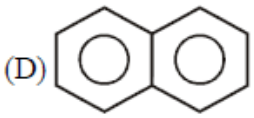
4. 

. Product (A) will be

(A) 

(B) 

(C) 

(D) 

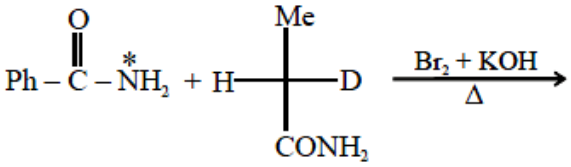
Part-A: One or More Than One Options Correct Type

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

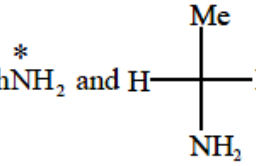
5. 1 litre 0.5 M aqueous NaCl solution is electrolysed till all the chloride ions are oxidised to Cl_2 along with production of some amount of O_2 gas. If 2 gm of H_2 is only product at cathode then
(A) Equivalents of Cl_2 at anode are 0.50
(B) Volume of O_2 produced at NTP is 8.4 litre
(C) Equivalents of O_2 produced is 0.5.
(D) Amount of electricity consumed is 2 Faraday.

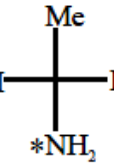
space for rough work

6. Which is true regarding colloidal solution :
(A) The boiling point of colloidal solution is smaller than the true solution under similar condition.
(B) Colloidal particles can be coagulated by electrophoresis.
(C) Brownian movement is shown by colloidal particles.
(D) Sodium salt of fatty acids forms colloid at higher concentration.

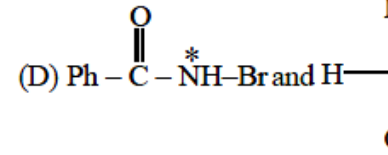
7. 

Which of the following statement(s) is/are correct regarding the given reaction?

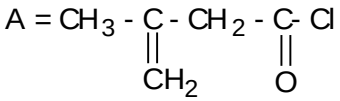
(A)  and are produced.

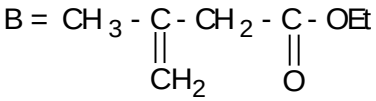
(B) Cross over products $PhNH_2$ and  are also produced.

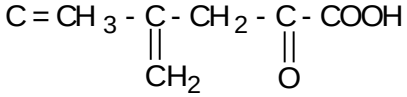
(C) Migration of –R(alkyl group or aryl) of $R–CONH_2$ takes place with retention of configuration.

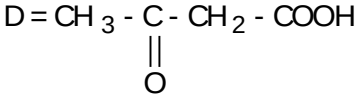
(D)  are the intermediates formed.

8. Compound A(C_5H_7OCl) reacts rapidly with ethanol and catalytic amount of acid to form a pleasant smelling substance B($C_7H_{12}O_2$). A also reacts with H_2O to form C with neutralization equivalent of 100. A, B and C all react with Br_2 water. Acid C, which can also be obtained by acidic hydrolysis of B is oxidized to new acid D($C_4H_6O_3$) and CO_2. D on heating with soda lime gives acetone. Identify A to D.

(A) 

(B) 

(C) 

(D) 

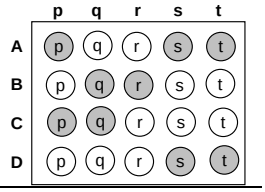
space for rough work

9. Choose the correct statement.
(A) d_{yz} orbital lies in the xz plane
(B) p_z orbital lies along the x axis
(C) Lobes of $d_{x^2-y^2}$ orbital are at 90° with the z axis
(D) Lobes of d_{xy} orbital are at 90° with the z axis

10. Identify the correct statement(s) :
(A) At critical condition liquid passes into gaseous state imperceptibly and continuously.
(B) If equal moles two different gases are taken in two identical vessels at same temperature then their mean free paths will be different.
(C) At Boyle's temperature a gas will always behave ideally.
(D) At low pressure generally attractive force dominates.

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.



1. Match the following:

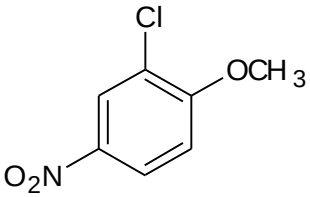
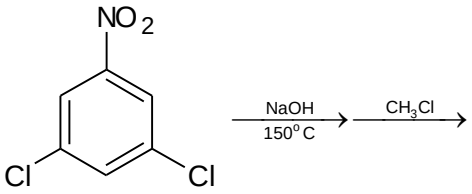
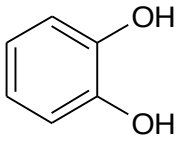
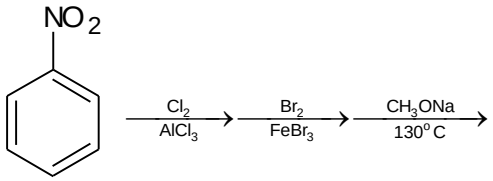
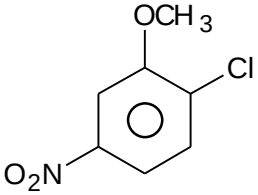
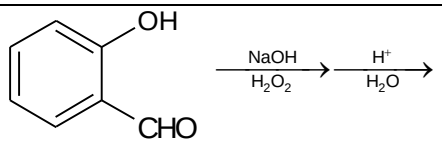
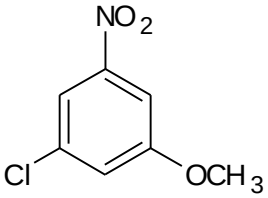
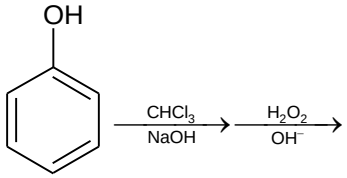
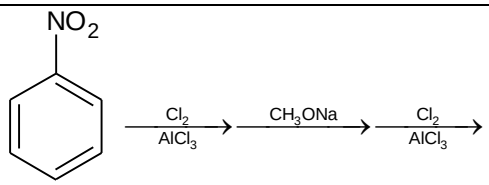
Column – I		Column – II	
(A)	Glucose	(P)	Amide linkage
(B)	DNA	(Q)	Glycosidic linkage
(C)	Protein	(R)	Contain acidic group
(D)	Sucrose	(S)	Polymeric structure

2. Match the following:

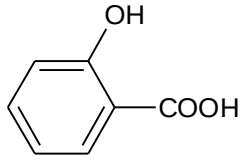
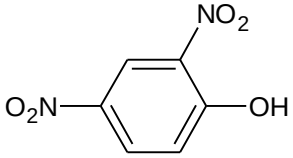
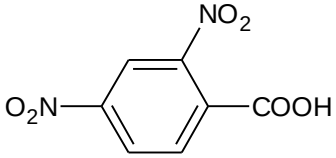
Column – I		Column – II	
(A)	Cubic	(P)	$a = b \neq c \quad \alpha = \beta = \gamma = 90^o$
(B)	Tetragonal	(Q)	$a = b = c \quad \alpha = \beta = \gamma = 90^o$
(C)	Orthorombic	(R)	$a \neq b \neq c \quad \alpha = \gamma = 90^o, \beta \neq 90^o$
(D)	Monoclinic	(S)	$a \neq b \neq c \quad \alpha = \beta = \gamma = 90^o$

space for rough work

3. Match the columns:

Column – I		Column – II	
(A)		(P)	
(B)		(Q)	
(C)		(R)	
(D)		(S)	
		(T)	

4. Match the following

List – I		List – II	
(A)		(P)	$NaHCO_3$ test
(B)		(Q)	Neutral $FeCl_3$ test
(C)		(R)	Alkaline $FeCl_3$ test
(D)	$HOOCCH_2COOH$	(S)	Lassaigne's test
		(T)	Decarboxylation on heating

space for rough work

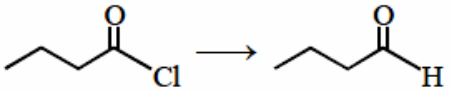
Part –C: Single digit integer

This section contains **6 questions.** The answer to each question is a single digit integer ranging from 0 to 9 (both inclusive).

1. When equal volume of 0.2 M $AgNO_3$ and 0.6 M KCN solutions were mixed then at equilibrium concentration of Ag^+ was found to be 10^{-6} M. While when equal volume of 0.4 M $Zn(NO_3)_2$ solution and of 1.8 M KCN were mixed then at equilibrium, concentration of Zn^{+2} ion was found to be 10^{-11} M then find the equilibrium constant of the following reaction.

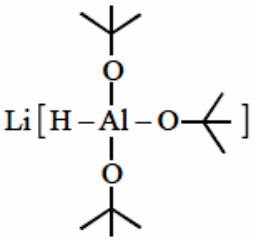
$$2[Ag(CN)_2]^-(aq) + Zn^{+2}(aq) \rightleftharpoons [Zn(CN)_4]^{2-}(aq) + 2Ag^+(aq)$$

2. Consider following conversion.



Write number of reagent or combination of reagents among following which can be used for above conversion.

(I) H_2 / Pd

(II) 

(III) $NaBH_4$

(IV) $LiAlH_4$

(V) H_2 / Pd-$BaSO_4$

(VI) (a) LAH , (b) PCC

(VII) (a) NH_3 , (b) PCl_5 , (c) (i) $SnCl_2$, (ii) H^+/H_2O

3. Among the following elements, the number of elements that release H_2 on reaction with NaOH is _____.

Be, Al, B, Mg, Ca, Zn, Sn

4. $$CH_3 - CH_2 - COOH \xrightarrow{P+Br_2} \underset{(C_3H_5BrO_2)}{[A]} \xrightarrow{NH_3} \underset{(C_3H_7NO_2)}{[B]}$$

If d$\ell(\pm)$ mixture of B is heated then possible number of stereisomers formed will be:

5. Among the following, the number of cations that give precipitate with Na_2HPO_4 solution is _____.

Mg^{2+}, K^+, Mn^{2+}, Zn^{2+}, Ag^+, Fe^{3+}

6. 5 mL of 8N HNO_3, 4.8 mL of 5N HCl and a certain volume of 17 M H_2SO_4 are mixed together and made upto 2 L. 30 mL of the acid mixture exactly neutralized by 42.9 mL of Na_2CO_3 solution containing 0.1 g of $Na_2CO_3.10H_2O$ in 10 mL of H_2O. Calculate the volume of H_2SO_4 added to the mixture

space for rough work

SECTION-III: MATHEMATICS

Part-A: Only One Option Correct Type

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

1. If the length of sub – normal at any point P (x, y) on the curve passing through M (0, 1) is unity, then the area bounded by the curves equals

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$ (C) $\frac{4}{3}$ (D) $\frac{8}{3}$

2. Let $A=\begin{bmatrix} l & m & n \\ p & q & r \\ 1 & 1 & 1 \end{bmatrix}$ and $B=A^2$.

If $(l-m)^2+(p-q)^2=9,\ (m-n)^2+(q-r)^2=16,(n-l)^2+(r-p)^2=25,$ then the value of $\det.B$ equals

(A) 100 (B) 125 (C) 144 (D) 169

3. Let $\alpha,\beta\in R$. If α,β^2 be the roots of quadratic equation $x^2-px+1=0$ and α^2,β be the roots of quadratic equation $x^2-qx+8=0$, then the value of 'r' if $\frac{r}{8}$ be arithmetic mean of p and q, is

(A) $\frac{83}{8}$ (B) $\frac{83}{4}$ (C) $\frac{83}{2}$ (D) 83

4. If the normal to the curve $y=f(x)$ at x = 0 be given by the equation $3x-y+3=0,$ then the value of $\lim_{x\to 0}\frac{x^2}{f(x^2)-5f(4x^2)+4f(7x^2)}$ is

(A) $-\frac{1}{5}$ (B) $-\frac{1}{4}$ (C) $-\frac{1}{3}$ (D) $-\frac{1}{2}$

Part-A: One or More Than One Options Correct Type

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

5. A normal coin is tossed four times. Two event E and F are defined as
E : no two consecutive heads occur in 4 tosses.
F : At least 2 consecutive heads occur in 4 tosses.
The events E and F are
(A) equally likely (B) mutually exclusive
(C) exhaustive (D) such that one is twice as likely to occur as other.

space for rough work

6. Which of the following statement(s) is/are correct ?

(A) The value of $\lim\limits_{x\to 0}\dfrac{\int_0^x x e^{t^2} dt}{1+x-e^x}$ is equal to –2

(B) The points L and M are on the curve $14x^2 - 7xy + y^2 = 2$, each have x – coordinates 1. If the tangent to the curve at L and M meet at (h, k), then k is equal to 4.

(C) Let $f(x) = |x-a_1| + |x-a_2| + ... + |x-a_n|$ where $a_i \in R$ and $a_i < a_{i+1}\ \forall i$. If n is even then $f(x)$ has minimum value at exactly one point.

(D) If LMVT is known to be applicable for a quadratic function $y = px^2 + qx + r$ in $[x_1, x_2]$ then 'c' of LMVT occurs at $c = \dfrac{x_1 + x_2}{3}$.

7. Which of the following is/are correct?

(A) $(\tan x)^{\ln(\sin x)} > (\cot x)^{\ln(\sin x)}, \forall x \in \left(0, \dfrac{\pi}{4}\right)$ (B) $4^{\ln\operatorname{cosec} x} < 5^{\ln\operatorname{cosec} x}, \forall x \in \left(0, \dfrac{\pi}{2}\right)$

(C) $\left(\dfrac{1}{2}\right)^{\ln(\cos x)} < \left(\dfrac{1}{2}\right)^{\ln(\cos x)}, \forall x \in \left(0, \dfrac{\pi}{2}\right)$ (D) $2^{\ln(\tan x)} > 2^{\ln(\sin x)}, \forall x \in \left(0, \dfrac{\pi}{2}\right)$

8. Consider the function f(x) = $\sin^5 x + \cos^5 x - 1$, $x \in \left[0, \dfrac{\pi}{2}\right]$. Which of the following is/are correct?

(A) f is monotonic increasing in $\left(0, \dfrac{\pi}{4}\right)$ (B) f is monotonic decreasing in $\left(\dfrac{\pi}{4}, \dfrac{\pi}{2}\right)$

(C) $\exists$ some $c \in \left[0, \dfrac{\pi}{2}\right]$ for which $f'(c) = 0$ (D) The equation f(x) = 0 has two roots in $\left[0, \dfrac{\pi}{2}\right]$

9. Let f:[–1, 1] onto [3, 5] be a linear polynomial. Which of the following can be **true**?

(A) $f\left(\dfrac{-1}{2}\right) = \dfrac{7}{2}$ (B) $f^{-1}\left(\dfrac{15}{4}\right) = \dfrac{1}{4}$ (C) $f(0) \neq 4$ (D) $f\left(\dfrac{1}{2}\right) + f\left(\dfrac{-1}{2}\right) = 8$

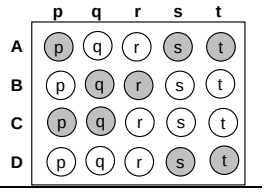
10. If in a triangle ABC, BC = 5, CA = 4, AB = 3 and D, E are point on BC such that BD = DE = EC, $\angle CAE = \theta$, then:

(A) $AE^2 = \dfrac{73}{8}$ (B) $AE^2 = \dfrac{73}{9}$ (C) $\tan\theta = \dfrac{3}{8}$ (D) $\cos\theta = \dfrac{3}{\sqrt{73}}$

space for rough work

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.



1. Match the following

Column-I		Column-II	
(A)	If the equations $x + y = 1$, $(c + 2)x + (c + 4)y = 6$, $(c + 2)^2x + (c + 4)^2y = 36$ are consistent, then 'c' can be	(P)	1
(B)	Number of solutions(s) satisfying the equation $\frac{1}{\sin x} - \frac{1}{\sin 2x} = \frac{2}{\sin 4x}$ in $[0, 4\pi]$	(Q)	2
(C)	If $\vec{a}, \vec{b}$ are any two unit vectors, then the least value of $\frac{2}{\left\|\vec{a}+\vec{b}\right\|^2} + \frac{2}{\left\|\vec{a}-\vec{b}\right\|^2}$ equals	(R)	3
(D)	a, b and c are all different and non-zero real numbers in arithmetic progression. If the roots of quadratic equation $ax^2 + bx + c = 0$ are α and β such that $\frac{1}{\alpha}+\frac{1}{\beta}, \alpha+\beta$ and $\alpha^2+\beta^2$ are in geometric progression, then the value of $\frac{a}{c}$ will be	(S)	4
		(T)	5

2. Match the following

Column-I		Column-II	
(A)	If $\|z_1\| = 2$ and $(1 - i)z_2 + (1 + i)\ \overline{z_2} = 8\sqrt{2}$, then the minimum value of $\left\|z_1 - z_2\right\|$ equals	(P)	5
(B)	The value of the definite integral $\int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \frac{dx}{\left(\sin x + \cos x + 2\sqrt{\sin x \cos x}\right)\sqrt{\sin x \cos x}}$ equals	(Q)	4
(C)	If $f(x) = \sqrt[3]{\frac{9}{\log_2(3-2x)} - 1}$ then the value of 'a' which satisfies $f^{-1}(2a-4) = \frac{1}{2}$, is	(R)	3
(D)	The locus of the point (h, 2k – 3) where (h, k) lies on the curve $x^2 - y^2 = 16$ is a conic C. the square of electricity of the conic C equals	(S)	2
		(T)	1

space for rough work

3. Match the equations in column I with the properties in Column 2

Column-I		Column-II	
(A)	$a<b<c<d$ and equation is $(x-a)(x-c)+\pi(x-b)(x-d)=0$	(P)	real roots
(B)	$a>0, a+b+c<0$ and equation is $ax^2+bx+c=0$	(Q)	distinct real roots
(C)	$b,c,\in I$ and the equation $x^2+bx+c=0$ has rational roots	(R)	Integral roots
(D)	$a,b,c,d\in R$ are in G.P. and equation is $(a^2+b^2+c^2)x^2+2(ab+bd+ca)x+b^2+c^2+d^2=0$	(S)	discriminant ≥ 0

4. Suppose the tangent at point P $(a\cos\theta, b\sin\theta)\left(0<\theta<\frac{\pi}{2}\right)$ to the ellipse $E:\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ meet the x – axis at T and y – axis at T_1 and normal at point P to the ellipse E meets the x – axis at N and y – axis at N_1. Match the expressions in column I with appropriate expressions in column II

Column-I		Column-II	
(A)	$\frac{a^2}{OT^2}+\frac{b^2}{OT_1^2}$	(P)	2ab
(B)	$\min\limits_{0\leq\theta\leq\frac{\pi}{2}}(OT)(OT_1)$	(Q)	ab
(C)	$\max\limits_{0\leq\theta\leq\frac{\pi}{2}}(ON)(ON_1)$	(R)	1
(D)	$\min\limits_{0\leq\theta\leq\frac{\pi}{2}}$ (Area of ΔOTT_1)	(S)	$\frac{(a^2-b^2)^2}{2ab}$

space for rough work

Part –C: Single digit integer

This section contains **6 questions.** The answer to each question is a single digit integer ranging from 0 to 9 (both inclusive).

1 If $z_1, z_2, z_3 \in C$ satisfy the system of equation given by
$|z_1| = |z_2| = |z_3| = 1$
$z_1 + z_2 + z_3 = 1$ and $z_1 \cdot z_2 \cdot z_3 = 1$
such that $\text{Im}(z_1) < \text{Im}(z_2) < \text{Im}(z_3)$, then
find the value of $\left[\left|z_1 + {z_2}^2 + {z_3}^3\right|\right]$ where [ ] denotes the greatest integer function.

2 Let $A = \begin{bmatrix} 1 & \frac{3}{2} \\ 1 & 2 \end{bmatrix}, B = \begin{bmatrix} 4 & -3 \\ -2 & 2 \end{bmatrix}$ and $C_r = \begin{bmatrix} r \cdot 3^r & 2^r \\ 0 & (r-1)3^r \end{bmatrix}$ be given matrices.

If $\sum_{r=1}^{50} \text{tr.}\left((AB)^r C_r\right) = 3 + a \cdot 3^b$ where tr.(A) denotes trace of matrix A, then find the value of $\frac{(a+b)}{20}$.
[Where a and b are relatively prime]

3 Let $f(\alpha) = \int_{\alpha^{-1}}^{\alpha} \frac{1}{x} \cot^{-1}\left(\frac{x^2 - x + 1}{2x - 3x^2} + \frac{x^2 - x + 1}{3 - 2x}\right) dx$

and $g(\alpha) = \int_{\ell n \frac{1}{\alpha}}^{\ell n \alpha} \left(\frac{\left|x^2 - 3x + 2\right| - \left|(x+1)(x+2)\right| + |x+1| + |x-1|}{|x+1| + |x-1|}\right) dx$

where $\alpha \in (0, \infty) - \left\{\frac{2}{3}, \frac{3}{2}\right\}$. If $f(200) - \frac{\pi}{2} g(50) = \frac{a\pi}{3} \ell n\, b$, then the value of a + b is.

4. If the sum of all possible integral value(s) of 'p' for which the equation $\left|x + \frac{1}{x} - 3\right| = p - 3$ has exactly two distinct solutions is K, then $\frac{K}{7}$ is

5. In a sequence of circles $C_1, C_2, C_3, \ldots\ldots C_n$; the centres lie along positive x-axis with abcissae forming an arithmetic sequence of first term unity and common difference 3. The radius of these circles are in geometric sequence with first term unity and common ratio 2. If the tangent lines with slope m_1 and m_2 of C_3 are intersected at the centre of C_5, then compute the value of $2010|m_1 m_2| - 1600$ is

6. Unit digit of the number $N = 2^{81} + 3^{81} + 4^{81} + \ldots\ldots + 99^{81}$ is _____

space for rough work