

SAMPLE PAPER-4

PAPER-2

Time : 3 Hours

Maximum Marks : 186

READ THE INSTRUCTIONS CAREFULLY

GENERAL :

1. This sealed booklet is your Question Paper. Do not break the seal till you are told to do so.
2. Use the Optical Response sheet (ORS) provided separately for answering the questions.
3. Blank spaces are provided within this booklet for rough work.
4. Write your name, form number and sign in the space provided on the back cover of this booklet.
5. After breaking the seal of the booklet, verify that the booklet contains **36** pages and that all the **18** questions in each subject and along with the options are legible. If not, contact the invigilator for replacement of the booklet.
6. You are allowed to take away the Question Paper at the end of the examination.

OPTICAL RESPONSE SHEET :

7. The ORS will be collected by the invigilator at the end of the examination.
8. Do not tamper with or mutilate the ORS. **Do not use the ORS for rough work.**
9. Write your name, form number and sign with pen in the space provided for this purpose on the ORS. **Do not write any of these details anywhere else on the ORS.** Darken the appropriate bubble under each digit of your form number.

DARKENING THE BUBBLES ON THE ORS :

10. Use a **BLACK BALL POINT PEN** to darken the bubbles on the ORS.
11. Darken the bubble **COMPLETELY.**
12. The correct way of darkening a bubble is as :
13. The ORS is machine-gradable. Ensure that the bubbles are darkened in the correct way.
14. Darken the bubbles **ONLY IF** you are sure of the answer. There is **NO WAY** to erase or "un-darken" a darkened bubble.
15. Take **$g = 10 \text{ m/s}^2$** unless otherwise stated.

DO NOT BREAK THE SEALS WITHOUT BEING INSTRUCTED TO DO SO BY THE INVIGILATOR

SOME USEFUL CONSTANTS

Atomic No. : H = 1, B = 5, C = 6, N = 7, O = 8, F = 9, Al = 13, P = 15, S = 16,
Cl = 17, Br = 35, Xe = 54, Ce = 58

Atomic masses : H = 1, Li = 7, B = 11, C = 12, N = 14, O = 16, F = 19, Na = 23, Mg = 24,
Al = 27, P = 31, S = 32, Cl = 35.5, Ca = 40, Fe = 56, Br = 80, I = 127,
Xe = 131, Ba = 137, Ce = 140,

- | | |
|------------------------------------|--|
| • Boltzmann constant | $k = 1.38 \times 10^{-23} \text{ JK}^{-1}$ |
| • Coulomb's law constant | $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ |
| • Universal gravitational constant | $G = 6.67259 \times 10^{-11} \text{ N-m}^2 \text{ kg}^{-2}$ |
| • Speed of light in vacuum | $c = 3 \times 10^8 \text{ ms}^{-1}$ |
| • Stefan-Boltzmann constant | $\sigma = 5.67 \times 10^{-8} \text{ Wm}^{-2}\text{-K}^{-4}$ |
| • Wien's displacement law constant | $b = 2.89 \times 10^{-3} \text{ m-K}$ |
| • Permeability of vacuum | $\mu_0 = 4\pi \times 10^{-7} \text{ NA}^{-2}$ |
| • Permittivity of vacuum | $\epsilon_0 = \frac{1}{\mu_0 c^2}$ |
| • Planck constant | $h = 6.63 \times 10^{-34} \text{ J-s}$ |

Space for Rough Work

HAVE CONTROL → HAVE PATIENCE → HAVE CONFIDENCE ⇒ 100% SUCCESS

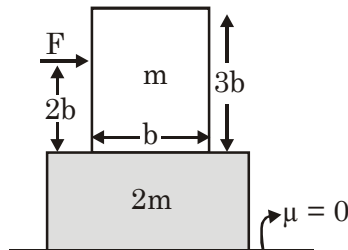
BEWARE OF NEGATIVE MARKING

PART-1 : PHYSICS

SECTION-I(i) : (Maximum Marks: 32)

- This section contains **EIGHT** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- 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, both of which are correct options.
Partial Marks : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks : -1 In all other cases.
- **For Example** : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in -1 marks.

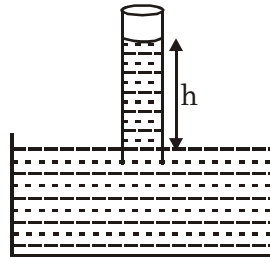
1. A block of mass m is placed on another block of mass $2m$ as shown. A horizontal force F acts on the block m at height ' $2b$ ' without any relative motion between blocks. If F_{\min} is minimum force for topple the block, a is acceleration of $2m$ and f is friction between blocks then



- (A) $F_{\min} = 3mg$ (B) $F_{\min} = mg/3$ (C) $a = \frac{g}{9}$ (D) $f = \frac{2mg}{9}$

Space for Rough Work

2. When a capillary tube of radius r is dipped in a liquid of density ρ and surface tension T , then liquid rises to height h above the liquid level. If angle of contact between liquid and tube is 60° , then



(A) $h = \frac{T}{\rho g r}$

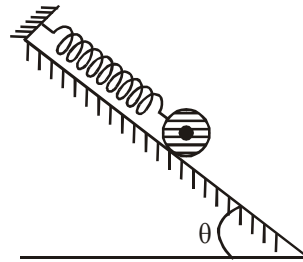
(B) Work done by surface tension = $\left(\frac{\pi T^2}{\rho g} \right)$

(C) Increase in gravitational potential energy = $\frac{\pi T^2}{\rho g}$

(D) Heat dissipated in process = $\frac{\pi T^2}{2\rho g}$

Space for Rough Work

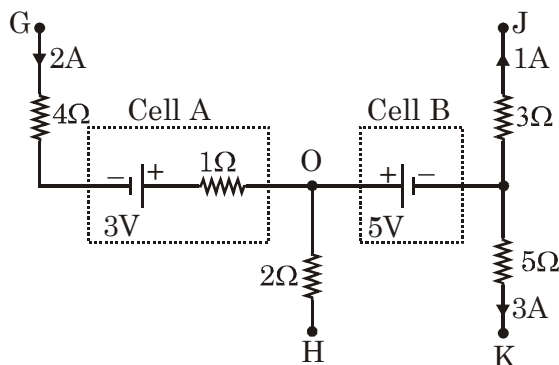
3. A disc of mass m is connected with an ideal spring of stiffness k is released from the unstretched position of the spring. The disc rolls down the inclined plane without slipping. Then



- (A) Amplitude of oscillation is $\frac{mg \sin \theta}{k}$
- (B) Time period of oscillation is $2\pi\sqrt{\frac{3m}{2k}}$
- (C) Energy of oscillation is $\frac{1}{2} \frac{m^2 g^2 \sin^2 \theta}{k}$
- (D) Friction at the extreme position is $\frac{mg \sin \theta}{3}$

Space for Rough Work

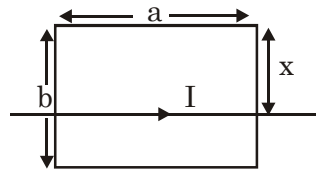
4. A part of circuit is shown in figure, then choose the **CORRECT** options.



- (A) Current in 2Ω is $2A$
 - (B) $V_G - V_H = 3V$
 - (C) Power consumed by cell B is 10 watt
 - (D) Terminal voltage across cell A is 1 volt
5. In a vernier callipers having 10 vsd, the vernier constant is 0.1 mm. When the jaws are closed, zero of vernier lies to the left of zero of main and 7^{th} vsd coincides with a main scale division. When a cylinder is placed between the jaws the main scale reading was 7.7 cm and vernier scale read 8 division. Then
- (A) Zero error is $(+ 0.7)$ mm
 - (B) Zero error is (-0.3) mm
 - (C) Diameter of cylinder is 7.81 cm
 - (D) Diameter of cylinder is 7.71 cm
6. A particle of mass 1 kg moves along x -axis in a conservative force field. It's potential energy is given by $U(x) = 2x^3 - 9x^2 + 12x$, where all quantities are in S.I. unit. Then select the **CORRECT** statement.
- (A) Equilibrium positions are $x = 1$ m and $x = 2$ m
 - (B) At $x = 0$ force is along $(-x)$ direction
 - (C) Particle can perform oscillatory motion about $x = 2$ m
 - (D) For performing oscillatory motion, total mechanical energy should be less the $4J$

Space for Rough Work

7. In a photoelectric tube, when the wavelength of incident radiation is halved, the stopping potential increases by 1V. But when wavelength of incident radiation is increased by 100 nm, the stopping potential is halved.
- (A) The original stopping potential is 0.15 V (approx.)
 (B) The original wavelength is 1240 nm.
 (C) The work function is 0.85 eV (approx.)
 (D) The stopping potential in 1st situation is 1.95 V (approx.)
8. A rectangular coil in the plane of the page has dimension a and b. A long wire that carries a current $I = 2t$ is placed directly on the coil as shown. Choose the **CORRECT** options.



- (A) Magnetic flux through coil is $\phi = \frac{\mu_0 I a}{2\pi} \ln\left(\frac{x}{b-x}\right)$ for $0 < x < b$
- (B) $x \rightarrow b$, flux ϕ is maximum
- (C) $x = \frac{b}{2}$, flux ϕ is minimum
- (D) $x = \frac{b}{4}$, induced emf $= \frac{\mu_0 a \ln 3}{\pi}$

Space for Rough Work

SECTION-I(ii) : (Maximum Marks : 12)

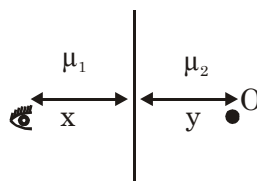
- This section contains **TWO** List-Match sets.
- Each List-Match set has **Two** Multiple Choice Questions.
- Each List-Match set has two lists : **List-I** and **List-II**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U)
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- 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

Paragraph for Q. 9 and Q. 10

When a point object, in a medium of refractive index μ_2 is observed by an observer in medium of refractive index μ_1 , along the normal incidence, then apparent distance

$= \mu_1 \left[\frac{x}{\mu_1} + \frac{y}{\mu_2} \right]$. Hence, velocity of image of object as directly seen by observer is

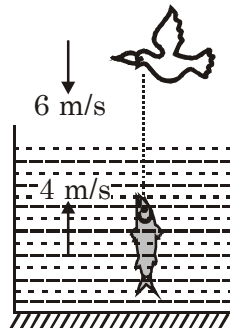
$$v = \mu_1 \left[\frac{1}{\mu_1} \cdot \frac{dx}{dt} + \frac{1}{\mu_2} \frac{dy}{dt} \right]$$



Space for Rough Work

9. Answer the following by appropriately matching the lists based on the information given in the paragraph.

A bird in air is diving vertically over a tank with speed 6 m/s and a fish in the tank is rising upward along the same line with speed 4 m/sec. Base of tank is silvered. [Take $\mu = 4/3$]



List-I

- (I) Speed of the image of fish as seen by bird directly
- (II) Speed of image of fish formed after reflection from the mirror as seen by bird
- (III) Speed of image of bird relative to fish looking upwards
- (IV) Speed of image of bird relative to the fish looking downward in the mirror

List-II

- (P) 3 m/s
- (Q) 4 m/s
- (R) $\frac{9}{2}$ m/s
- (S) 9 m/s
- (T) 12 m/s
- (U) $\frac{17}{2}$ m/s

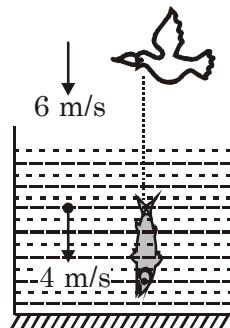
- (A) I→S ; II→P ; III→T, IV→ R
- (C) I→U ; II→P ; III→S, IV→Q

- (B) I→S ; II→P ; III→T, IV→ Q
- (D) I→U ; II→P ; III→T, IV→ R

Space for Rough Work

10. Answer the following by appropriately matching the lists based on the information given in the paragraph.

A bird in air is diving vertically over a tank with speed 6 m/s and a fish in the tank is also diving downwards along the same line with 4 m/sec. Base of tank is silvered. [Take $\mu = 4/3$]



List-I

- (I) Speed of the image of fish as seen by bird directly
- (II) Speed of image of fish formed after reflection from the mirror as seen by bird
- (III) Speed of image of bird relative to fish looking upwards
- (IV) Speed of image of bird relative to the fish looking downward in the mirror

List-II

- (P) 3 m/s
- (Q) 4 m/s
- (R) $\frac{9}{2}$ m/s
- (S) 9 m/s
- (T) 12 m/s
- (U) $\frac{17}{2}$ m/s

- (A) I→S ; II→P ; III→T, IV→ R
- (C) I→P ; II→S ; III→R, IV→T

- (B) I→P ; II→S ; III→Q, IV→ U
- (D) I→P ; II→S ; III→Q, IV→ T

Space for Rough Work

Paragraph for Q. 11 and Q. 12

From first law of thermodynamics, if some quantity of heat (Q) is supplied to a system capable of doing external work (W), then the quantity of heat absorbed by the system is equal to the sum of the increase in the internal energy (ΔU) of the system and the work done by the system

$$Q = W + \Delta U$$

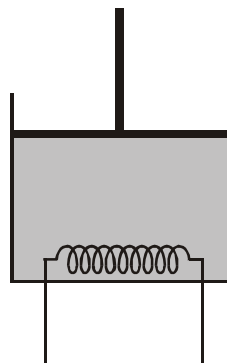
Also for an ideal gas $\Delta U = \frac{f}{2} nR\Delta T$ where ΔT : increase in temp and f : degree of freedom,

Work done by force $W = \int \vec{F} \cdot d\vec{s}$, work done by gas = $\int p \cdot dv$ and gravitational potential

energy = mgh . Take $R = \frac{25}{3} \text{ J / mol - K}$, $g = 10 \text{ m/s}^2$

11. Answer the following by appropriately matching the lists based on the information given in the paragraph.

The piston of mass 1kg and area of cross section 1 cm^2 is attached with a cylinder as shown. The piston and cylinder are thermally insulated and contain 2 mole of an ideal monoatomic gas. If piston is free to move and temp of gas is increased by 60 K, choose the correct match.



List-I

- (I) Work done by gas
- (II) Increase in internal energy of gas
- (III) Heat supplied to the gas
- (IV) Increase in gravitational potential energy of piston

List-II

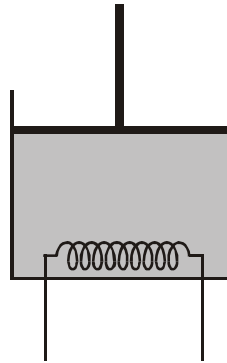
- (P) 0
- (Q) 500 J
- (R) 1000 J
- (S) 1500 J
- (T) 2000 J
- (U) 2500 J

- (A) I→R; II→S; III→T; IV→Q
- (B) I→Q ; II→R; III→S; IV→U
- (C) I→R ; II→S; III→U ; IV→Q
- (D) I→R; II→S; III→U; IV→T

Space for Rough Work

12. Answer the following by appropriately matching the lists based on the information given in the paragraph.

The piston of mass 1kg and area of cross section 1 cm^2 is attached with a cylinder as shown. The piston and cylinder are thermally insulated and contain 2 mole of an ideal monoatomic gas. If piston is fixed and temp of gas is increased by 60 K, choose the correct match.



List-I

- (I) Work done by gas
- (II) Increase in internal energy of gas
- (III) Heat supplied to the gas
- (IV) Increase in gravitational potential energy of piston

List-II

- (P) 0
- (Q) 500 J
- (R) 1000 J
- (S) 1500 J
- (T) 2000 J
- (U) 2500 J

- (A) I→P; II→P; III→S; IV→S
- (C) I→P; II→S; III→P; IV→S

- (B) I→P; II→Q; III→S; IV→P
- (D) I→P; II→S; III→S; IV→P

Space for Rough Work

SECTION-II : (Maximum Marks: 18)

- This section contains **SIX** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darkening the corresponding bubbles in the ORS.

For Example : If answer is -77.25, 5.2 then fill the bubbles as follows.

+	●				
●	●	○	○	○	○
①	①	①	①	①	①
②	②	②	②	●	②
③	③	③	③	③	③
④	④	④	④	④	④
⑤	⑤	⑤	⑤	⑤	●
⑥	⑥	⑥	⑥	⑥	⑥
⑦	⑦	●	●	⑦	⑦
⑧	⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨	⑨

-	○				
●	●	●	○	○	●
①	①	①	①	①	①
②	②	②	②	●	②
③	③	③	③	③	③
④	④	④	④	④	④
⑤	⑤	⑤	●	⑤	⑤
⑥	⑥	⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨	⑨

- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If **ONLY** the correct numerical value is entered as answer.
Zero Marks : 0 In all other cases.

- The gap between the plates of a plane parallel plate capacitor is filled with an isotropic insulator whose dielectric varies in direction perpendicular to the plates according to law

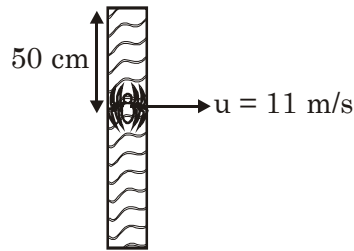
$$K = \left[1 + \sin\left(\frac{\pi x}{d}\right) \right]$$

where d is the separation between plates and A is area of each plate. If

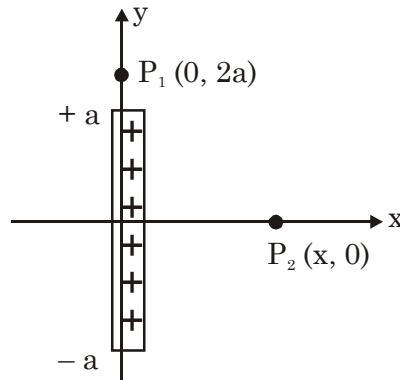
capacitance of the capacitor is $\left(\frac{\lambda A \epsilon_0}{d}\right)$ then find the value of λ .

Space for Rough Work

2. An insect of mass 2kg jumps out of a uniform rod of same mass and length 2m , perpendicular to the rod with a velocity 11 m/s relative to rod. What is the angular velocity (in rad/sec) of rod just after jumping? [Assume ground is smooth]

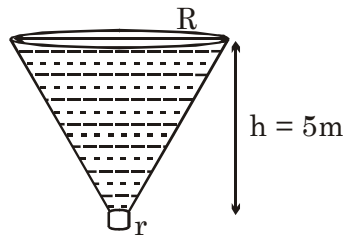


3. A thin rod of length $2a$ is placed along y -axis in the $x - y$ plane. The rod carries a charge density λ as shown in figure. If point P_1 is located at $(0, 2a)$ and P_2 at $(x, 0)$, then find $\left(\frac{x}{a}\right)$ if potential at P_1 and P_2 are equal.

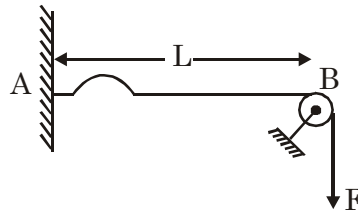


Space for Rough Work

4. A conical flask of height 5m and $R = 2m$ is completely filled with water. Find the time (in hr.) after which the total liquid will come out of flask through a small hole of radius 1 cm made at the bottom of flask.



5. Find the mean life (in hr) of ^{55}Co radionuclide if its activity is known to decrease by 4% per hour. The decay product is non-radioactive $\left[\ln\left(\frac{25}{24}\right) = 0.0408 \right]$,
6. In the given figure, a string of linear mass density 2 gm/cm and length $L = 2m$ is stretched by a force $F = kt$ where k is constant and t is in sec. If at time $t = 0$, a pulse is generated at the end A of the string and it will reach to end B in 1 sec. Find the value of k in S.I. unit.



Space for Rough Work

PART-2 : CHEMISTRY

SECTION-I(i) : (Maximum Marks: 32)

- This section contains **EIGHT** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
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-
1. In an atom, maximum no. of e^- having quantum no. $n = 4$, $|m_l| = 2$, $m_s = \pm \frac{1}{2}$ equals to :
- (A) 10
- (B) Total stereoisomers of the complex type Ma_2b_2cd
- (C) Total stereoisomers of the complex type $M(A-A)_3c$ ($A-A$ being symmetric bidentate ligand)
- (D) Total number of 5d-subshell electrons of metal in $[PtCl_4]^{-2}$
-

Space for Rough Work

2. Which of the following statement is **INCORRECT** ?

- (A) O_2 is paramagnetic , O_3 is also paramagnetic
- (B) HOMO of O_2 is gerade
- (C) B_2 is paramagnetic, C_2 is also paramagnetic
- (D) In B_2 and F_2 s-p mixing takes place

3. In thermodynamics, the P-V work done is given by

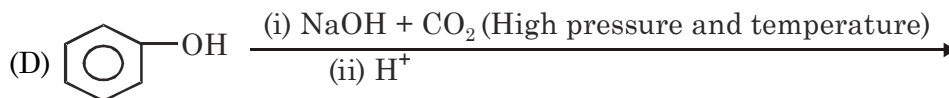
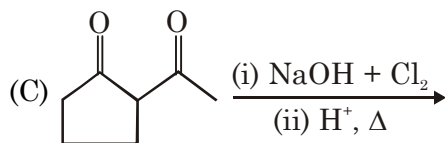
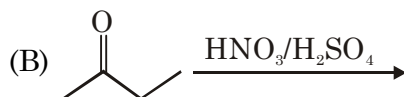
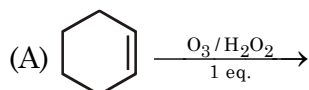
$$w = -\int dV P_{\text{ext}}$$

For a system undergoing a particular process, the work done is ,

$$w = -\int dV \left(\frac{RT}{V-b} - \frac{a}{V^2} \right)$$

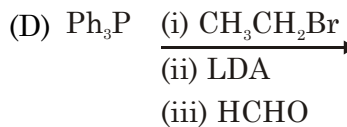
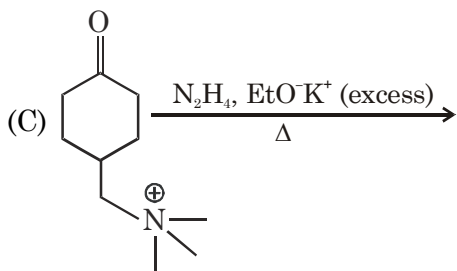
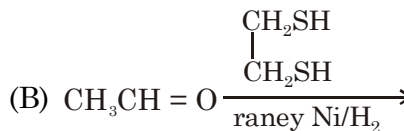
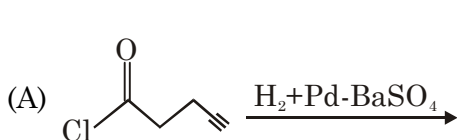
This equation is applicable to a

- (A) System that satisfies the van der Waals equation of state.
 - (B) Process that is reversible and isothermal.
 - (C) Process that is reversible and adiabatic.
 - (D) Process that is irreversible and at constant isothermal.
4. Reaction which involve formation of product which has $-CO_2H$ groups.



Space for Rough Work

5. $\Psi = Nr(6 - Zr)e^{-Zr/3} \cos \theta$, is a proposed hydrogenic wave function, where Z = atomic number, r = radial distance from the nucleus, θ = azimuthal angle, N is a constant. The correct statement(s) about Ψ is/are :
- (A) $\Psi = 0$ in the xy -plane (B) two radial nodes are present in Ψ
 (C) one angular node is present in Ψ (D) $\Psi \neq 0$ in the yz -plane
6. Which reaction out the following involve formation of a hydrocarbon (cyclic/acyclic) as a major product.



Space for Rough Work

7. Which of the following reduction reactions are actually employed in commercial extraction of metals ?
- (A) $\text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$
(B) $\text{Cr}_2\text{O}_3 + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 2\text{Cr}$
(C) $2\text{Na}[\text{Au}(\text{CN})_2] + \text{Zn} \rightarrow \text{Na}_2[\text{Zn}(\text{CN})_4] + 2\text{Au}$
(D) $\text{Cu}_2\text{S} + \text{Pb} \rightarrow \text{Cu} + \text{PbS}\downarrow$
8. In how many of the following cases gas is more compressible than ideal gas ? $\left(R = \frac{1 \text{ atm L}}{12 \text{ mol K}} \right)$
- (A) O_2 gas has density = 20 g/L at 10 atm and 300 K temperature.
(B) N_2 gas at 2 atm and 273 K occupy molar volume 6 L.
(C) Gas A at its critical temperature and pressure less than critical pressure.
(D) CH_4 gas at 333 K and in low pressure region. (Boyle's temperature T_B of $\text{CH}_4 = 60^\circ\text{C}$)

Space for Rough Work

SECTION-I(ii) : (Maximum Marks : 12)

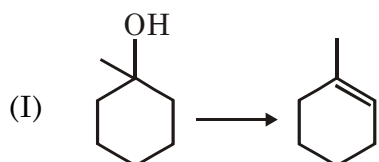
- This section contains **TWO** List-Match sets.
- Each List-Match set has **Two** Multiple Choice Questions.
- Each List-Match set has two lists : **List-I** and **List-II**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U)
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- 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

9. Answer the following by appropriately matching the lists based on the information given in the paragraph.

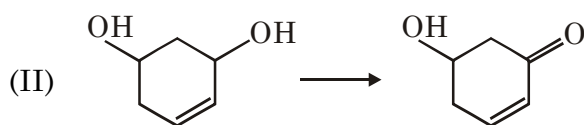
1° alcohol on oxidation by mild oxidising agent produces aldehyde while with strong oxidising agent carboxylic acid is obtained. On the other hand 2° alcohol with mild oxidising agent gives ketone. 3° alcohol is reluctant to oxidation by mild oxidising agents.

List-I (Reaction)

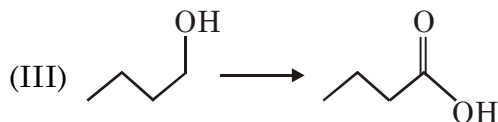
List-II (Reagents)



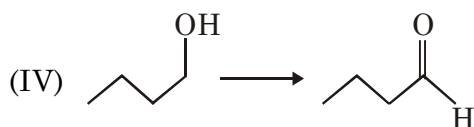
(P) PCC, CH₂Cl₂



(Q) KMnO₄ / H⁺



(R) Collin's Reagent



(S) Cu/300°C

(T) TsCl + DMSO + NaHCO₃

(U) MnO₂, Δ

Incorrectly matched among the following is :

(A) I – S

(B) II – P

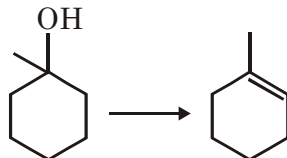
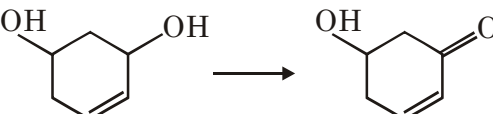
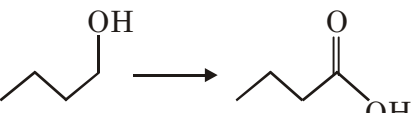
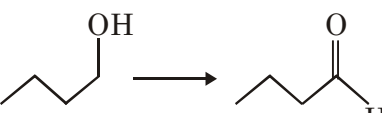
(C) IV – S

(D) III – Q

Space for Rough Work

10. Answer the following by appropriately matching the lists based on the information given in the paragraph.

1° alcohol on oxidation by mild oxidising agent produces aldehyde while with strong oxidising agent carboxylic acid is obtained. On the other hand 2° alcohol with mild oxidising agent gives ketone. 3° alcohol is reluctant to oxidation by mild oxidising agents.

List-I (Reaction)	List-II (Reagents)
(I) 	(P) PCC, CH ₂ Cl ₂
(II) 	(Q) KMnO ₄ / H ⁺
(III) 	(R) Collin's Reagent
(IV) 	(S) Cu/300°C
	(T) TsCl + DMSO + NaHCO ₃
	(U) MnO ₂ , Δ

Correctly matched away the following is :

- (A) II – P (B) II – Q (C) II – S (D) II – U

Space for Rough Work

11. Matching the following :

List-I (complex ion)

- (I) $[\text{Cr}(\text{NH}_3)_6]^{3+}$
 (II) $[\text{Cu}(\text{NH}_3)_6]^{2+}$
 (III) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
 (IV) $[\text{IrF}_6]^{3-}$

List-II (CFSE, hybridisation and magnetic nature)

- (P) $0.0 \Delta_0$, sp^3d^2 -hybridisation
 (Q) $-0.6 \Delta_0$, sp^3d^2 -hybridisation
 (R) $-1.2 \Delta_0$, d^2sp^3 -hybridisation
 (S) Diamagnetic
 (T) Paramagnetic
 (U) $0.0 \Delta_0$, d^2sp^3 hybridisation

CORRECTLY matched among the following is :

- (A) II – P (B) IV – S (C) I – S (D) III – R

12. Matching the following :

List-I (complex ion)

- (I) $[\text{Cr}(\text{NH}_3)_6]^{3+}$
 (II) $[\text{Cu}(\text{NH}_3)_6]^{2+}$
 (III) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
 (IV) $[\text{IrF}_6]^{3-}$

List-II (CFSE, hybridisation and magnetic nature)

- (P) $0.0 \Delta_0$, sp^3d^2 -hybridisation
 (Q) $-0.6 \Delta_0$, sp^3d^2 -hybridisation
 (R) $-1.2 \Delta_0$, d^2sp^3 -hybridisation
 (S) Diamagnetic
 (T) Paramagnetic
 (U) $0.0 \Delta_0$, d^2sp^3 hybridisation

CORRECTLY match among the following is :

- (A) IV – T (B) I – Q (C) II – Q (D) III – S

Space for Rough Work

SECTION-II : (Maximum Marks: 18)

- This section contains **SIX** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darkening the corresponding bubbles in the ORS.

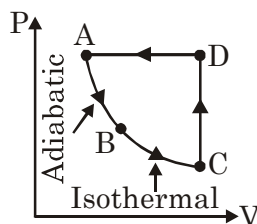
For Example : If answer is -77.25, 5.2 then fill the bubbles as follows.

+	●				
●	●	○	○	○	○
①	①	①	①	①	①
②	②	②	●	②	②
③	③	③	③	③	③
④	④	④	④	④	④
⑤	⑤	⑤	⑤	⑤	●
⑥	⑥	⑥	⑥	⑥	⑥
⑦	⑦	●	●	⑦	⑦
⑧	⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨	⑨

-	●				
●	●	●	○	○	●
①	①	①	①	①	①
②	②	②	②	●	②
③	③	③	③	③	③
④	④	④	④	④	④
⑤	⑤	⑤	●	⑤	⑤
⑥	⑥	⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨	⑨

- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If **ONLY** the correct numerical value is entered as answer.
Zero Marks : 0 In all other cases.

1. 1 mol of an ideal gas [$\gamma = 1.5$], is taken through a series of processes as shown in following in P-V curve.



Information-I : The temperature at state 'A' is 300 K.
 Information-II : The reversible isothermal expansion from B to C doubles the volume.
 Information-III : The entropy change of the system from C to D is $4 \ln 16$ cal/K.

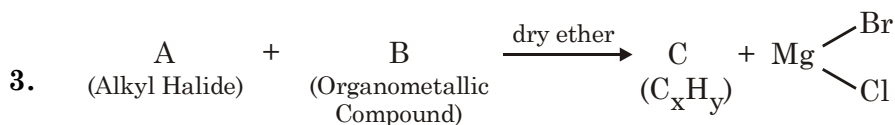
How many of the following statements are correct for above information :

- (A) The entropy change of the system from D to A is $-3R \ln 8$
- (B) the temperature at point D is 2400 K
- (C) The work done from A to B is -600 cal
- (D) The work done from B to C is $-300 \ln 2$ cal
- (E) The pressure at point A is 8 times of B
- (F) The temperature at point D is 600 K
- (G) The pressure at point C is half of pressure at point B.

Space for Rough Work

2. Small spherical ball of silver metal used in jewellery having diameter 0.1 cm, which is obtained by the electrolytic deposition. Its total number of balls in jewellery is 10,000, then calculate the applied amount of electricity in coulombs, which is used to make required number of balls. [Density of Ag = 10.5, gm/cm³]

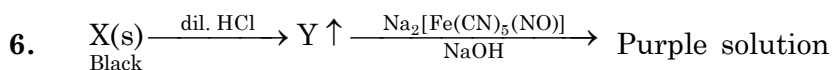
It is assumed that 3.5% electricity consumed as wastage during electrolysis [Give your answer in multiple of 10⁴] [Ag = 108]



- (a) Branched structural isomer of A i.e. A* with Mol. mass 78.5g is optically inactive.
 (b) 133 g of B when treated completely with 40g of D (acyclic Hydrocarbon) produces 1 mole of E (a Hydrocarbon)
 (c) Product C give 4 monochlorinated product on treatment with Cl₂/hν (including stereo)
 From the above information find out the Mol. mass of next successive Homologue of C.
4. A sample of ⁵³I¹³¹, as I⁻ ion, was administered to a patient in a carrier consisting 1.0 mg of stable I⁻ ion. After 4.0 days, 60% of the initial radioactivity was detected in the thyroid gland of the patient. What mass (in mg) of the stable I⁻ ion had migrated to the thyroid gland ?
 Given t_{1/2} to I¹³¹ = 8 days

Space for Rough Work

5. How many of the following statements is/are correct ?
1. Adsorbate is that substance where adsorption takes place.
 2. Lower the critical temperature of the gas, the more readily it will be adsorbed.
 3. Physical adsorption is an irreversible process.
 4. The amount of the gas adsorbed is directly proportional to the pressure, in all pressure region.
 5. By the gas masks, the poisonous gases are removed from air by charcoal, using process of adsorption.
 6. The water freed from all ions (cations and anions) is referred as mineral water.
 7. Heat of adsorption is defined as the energy liberated when 1 gram of a gas is adsorbed on the solid surface.
 8. The adsorption of hydrogen on charcoal is chemical adsorption.
 9. Froth floatation process is an application of adsorption.



Gas Y has been allowed to react with following species in neutral/acidic medium :

- (a) FeCl_3 (b) CuSO_4 (c) BaCl_2 (d) SO_2
(e) $\text{Cr}_2\text{O}_7^{2-}$ (f) CH_3COONa (g) Hg^{2+}

Then calculate value of $(P-Q)/R$:

P : Number of species which undergoes redox reaction with gas Y.

Q : Number of species with which gas Y undergoes precipitation without going into redox reaction.

R : Number of species with gas Y produce no observable change.

Space for Rough Work

PART-3 : MATHEMATICS

SECTION-I(i) : (Maximum Marks: 32)

- This section contains **EIGHT** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- 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, both of which are correct options.
Partial Marks : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks : -1 In all other cases.
- **For Example** : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in -1 marks.

1. Vertices A, B and C of a tetrahedron ABCD are (1, 1, 1), (1, 0, 0), (3, 0, 0) respectively. The altitude from vertex D to the opposite face ABC meets the median line through A of the ΔABC at a point E (where A & E lie on opposite sides of BC). If the length of side AD is 4 and volume of the tetrahedron is $\frac{2\sqrt{2}}{3}$, then the correct statement(s) is/are
- (A) the altitude from vertex D is 2 (B) $EB = \sqrt{6}$
- (C) $\text{area}(\Delta EBC) = \frac{2}{\sqrt{3}}$ (D) vector $\hat{j} - \hat{k}$ is normal to the plane ABC

Space for Rough Work

2. Consider $f(x) = \tan^{-1}\left(\frac{|x|}{\sqrt{1-x^2}}\right) + \cos^{-1}\left(\frac{1}{\sqrt{1+x^2}}\right)$ then
- (A) maximum value of $f(x)$ is $\frac{3\pi}{4}$ (B) number of integers in the range of $f(x)$ is 3
- (C) number of solutions of $f(x) = 2$ is 2 (D) if $\theta \in \left(\frac{\pi}{4}, \frac{\pi}{2}\right)$ then $f(\sin \theta) > f(\cos \theta)$
3. Consider a hyperbola $x^2 - y^2 - 2x + 4y - 7 = 0$. If its pair of asymptotes meet two tangents each of slope 2 at P, Q and R, S (in order) then
- (A) $PQ = \frac{4\sqrt{5}}{\sqrt{3}}$
- (B) Latus rectum of hyperbola is 4
- (C) area of quadrilateral PQRS is 12 sq.units
- (D) area of quadrilateral PQRS is 16 sq.units.
4. If x, y, z are three distinct real numbers such that $x, 12, y$ are in H.P. and $x, 12, z, y$ are in increasing A.P. then
- (A) $x + z = 18$
- (B) $x + z = 24$
- (C) maximum value of $\sqrt{(x-3)\sin\alpha - (y-10)\cos\beta} + 2$ is 4, where $\alpha, \beta \in \mathbb{R}$
- (D) maximum value of $\sqrt{(x-3)\sin\alpha - (y-10)\sin\alpha}$ is 10, where $\alpha \in \mathbb{R}$

Space for Rough Work

5. Let $A(z_1)$, $B(z_2)$, $C(z_3)$ and $D(z_4)$ be vertices (in anti-clockwise order) of a trapezium ($AB \parallel CD$) in an argand plane. Let $|z_1 - z_2| = 4$, $|z_3 - z_4| = 10$ and the diagonals AC and BD

intersect at P . It is given that $\arg\left(\frac{z_4 - z_2}{z_3 - z_1}\right) = \frac{\pi}{2}$ and $\arg\left(\frac{z_3 - z_2}{z_4 - z_1}\right) = -\frac{\pi}{4}$ then

(A) Area of Trapezium is $\frac{130}{3}$ sq. unit (B) $|CP - DP| = \frac{10}{\sqrt{21}}$ unit

(C) area of ΔPCB is $\frac{200}{21}$ sq. unit (D) area of ΔPCB is $\frac{100}{21}$ sq. unit

6. If in a triangle ABC , $\sum \sin \frac{A}{2} = \frac{6}{5}$ and $\sum I I_1 = 9$ (where I_1, I_2, I_3 are ex-centres and I is incentre) then

(A) the circumradius R is $15/4$

(B) the circumradius R is $15/8$

(C) the value of $\sin\left(\frac{\pi - A}{4}\right) \cdot \sin\left(\frac{\pi - B}{4}\right) \cdot \sin\left(\frac{\pi - C}{4}\right)$ is $\frac{1}{16}$

(D) the value of $\sin\left(\frac{\pi - A}{4}\right) \cdot \sin\left(\frac{\pi - B}{4}\right) \cdot \sin\left(\frac{\pi - C}{4}\right)$ is $\frac{1}{20}$

Space for Rough Work

ALLEN

7. Let two sides AB and BC of a ΔABC be represented by $x - 7y + 3 = 0$ and $x + y + 3 = 0$ respectively. Incentre I $(-3 - 3\alpha, \alpha)$, $\alpha \in \mathbb{R}$ of the triangle lies on the altitude $x - y - 1 = 0$ through A then

(A) The equation of a line representing side AC is $7x - y = 11$

(B) The equation of a line representing side AC is $7x + y = 1$

(C) The area of ΔABC is $\frac{32}{3}$ sq. unit

(D) The area of ΔABC is $\frac{32}{5}$ sq. unit

8. If $\vec{x} \times \vec{y} = \vec{a}$, $\vec{y} \times \vec{z} = \vec{b}$, $\vec{x} \cdot \vec{b} = \gamma$, $\vec{x} \cdot \vec{y} = 1$ & $\vec{y} \cdot \vec{z} = 1$ then ($|\vec{y}| \gamma \neq 0$)

(A) $\vec{y} = \frac{\vec{a} \times \vec{b}}{\gamma}$

(B) $\vec{x} = \frac{1}{y^2} [\vec{y} - \vec{a} \times \vec{y}]$

(C) $\vec{z} = \frac{1}{y^2} [\vec{y} + \vec{b} \times \vec{y}]$

(D) $\vec{x} = \frac{1}{y^2} [\vec{y} + \vec{a} \times \vec{y}]$

Space for Rough Work

SECTION-I(ii) : (Maximum Marks : 12)

- This section contains **TWO** List-Match sets.
- Each List-Match set has **Two** Multiple Choice Questions.
- Each List-Match set has two lists : **List-I** and **List-II**
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U)
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- 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

9. Answer the following by appropriately matching the lists based on the information given in the paragraph.

Let $A = \{1, 3, 5, 7\}$ and $B = \{2, 4, 6, 8\}$ and $f : A \rightarrow B$ is a function defined from set A to set B.

List-I		List-II
(I) Number of functions, that satisfy condition $i + f(i) < 10$; where $i = 1, 3, 5, 7$; is	(P)	24
(II) Number of functions, that satisfy $f(i) \neq 1 + i$, where $i = 1, 3, 5, 7$; is	(Q)	17
(III) Number of one-one and onto function, that satisfy condition $f(i) \neq 1 + i$, where $i = 1, 3, 5, 7$; is	(R)	9
(IV) If number of many one functions from $f : A \rightarrow B$ is k, then k is divisible by	(S)	29
	(T)	81
	(U)	14

Which of the following is correct combination ?

- (A) (I), (S) (B) (II), (P) (C) (III) (R) (D) (IV) (Q)

Space for Rough Work

ALLEN

10. Answer the following by appropriately matching the lists based on the information given in the paragraph.

Let $A = \{1, 3, 5, 7\}$ and $B = \{2, 4, 6, 8\}$ and $f : A \rightarrow B$ is a function defined from set A to set B.

List-I	List-II
(I) Number of functions, that satisfy condition $i + f(i) < 10$; where $i = 1, 3, 5, 7$; is	(P) 24
(II) Number of functions, that satisfy $f(i) \neq 1 + i$, where $i = 1, 3, 5, 7$; is	(Q) 17
(III) Number of one-one and onto function, that satisfy condition $f(i) \neq 1 + i$, where $i = 1, 3, 5, 7$; is	(R) 9
(IV) If number of many one functions from $f : A \rightarrow B$ is k, then k is divisible by	(S) 29
	(T) 81
	(U) 14

Which of the following is correct combination ?

- (A) (I) (T) (B) (II) (U) (C) (III) (Q) (D) (IV) (S)

11. Consider, $f(x) = \frac{x^2}{1+x^2}$ and $g(x) = px$, $p \in \mathbb{R}$.

List-I	List-II
(I) If $f(x) = g(x)$ has exactly three distinct solutions then value of $2p$ is	(P) 0
(II) If $f(x) = g(x)$ has exactly five distinct solutions then no. of integers in range of p is	(Q) 5
(III) Number of distinct tangents that can be drawn to the curve $y = f(x)$ from the origin is	(R) 1
(IV) Number of points on curve $\frac{g(x)}{f(x)}$, ($p \neq 0$) where tangent is parallel to x-axis, is	(S) 2
	(T) 4
	(U) 3

Which of the following is correct combination ?

- (A) (I)(Q) (B) (II)(T) (C) (III)(R) (D) (IV)(S)

Space for Rough Work

12. Consider, $f(x) = \frac{x^2}{1+x^2}$ and $g(x) = px, p \in \mathbb{R}$.

List-I

List-II

- | | |
|--|-------|
| (I) If $f(x) = g(x)$ has exactly three distinct solutions then value of $2p$ is | (P) 0 |
| (II) If $f(x) = g(x)$ has exactly five distinct solutions then no. of integers in range of p is | (Q) 5 |
| (III) Number of distinct tangents that can be drawn to the curve $y = f(x)$ from the origin is | (R) 1 |
| (IV) Number of points on curve $\frac{g(x)}{f(x)}, (p \neq 0)$ where tangent is parallel to x-axis, is | (S) 2 |
| | (T) 4 |
| | (U) 3 |

Which of the following is correct combination ?

- (A) (I)(U) (B) (II)(P) (C) (III)(S) (D) (IV)(T)

Space for Rough Work

SECTION-II : (Maximum Marks: 18)

- This section contains **SIX** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darkening the corresponding bubbles in the ORS.

For Example : If answer is -77.25, 5.2 then fill the bubbles as follows.

+									
●	●	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1
2	2	2	2	●	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6
7	7	●	●	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9

-									
●	●	●	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	●	2	2	2	2
3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4
5	5	5	5	●	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9

- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If **ONLY** the correct numerical value is entered as answer.
Zero Marks : 0 In all other cases.

1. If the value of $\sum_{k=0}^7 \left(\frac{{}^7C_k}{{}^{14}C_k} \sum_{r=k}^{14} ({}^rC_k) ({}^{14}C_r) \right)$ is a^b , where a and b are relative prime, then (a + b) is
2. If $\alpha, \beta, \gamma, \delta$ are the roots of the equation $x^4 - x^3 - x^2 - 1 = 0$ and consider $P(x) = x^6 - x^5 - x^3 - x^2 - x$. Then the value of $P(\alpha) + P(\beta) + P(\gamma) + P(\delta)$ is
3. If $\int \frac{\left(\frac{2}{3} + x^2\right) dx}{3 - 4\sqrt{3}x + 9x^4} = \frac{1}{6\sqrt{6}} \tan^{-1} \left(\frac{\sqrt{3}x + 1}{\sqrt{2}} \right) - \frac{1}{6\sqrt{3}} \cdot \frac{1}{f(x)} + C$, where C is constant of integration and $x \neq \frac{1}{\sqrt{3}}$, $f(0) = -1$, then value of $f(\sqrt{3})$ is

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4. Let $f : (-1, \infty) \rightarrow (0, \infty)$ be a differentiable function satisfying $f(x)f(yf(x)) = f(x + y) \forall x, y$ (for which f is well defined in given domain) and $f'(0) = -1$ and $f(0) = 1$ then area of the region bounded by the curve $y = \frac{f(x)}{x+1}$ and the coordinate axes is
5. The value of $\lim_{x \rightarrow \infty} \frac{(xe^{-x} + x^2e^{-2x} + x^3e^{-3x} + \dots \infty)}{(\ln(1+x))^{-1}}$ is equal to
6. Suppose a function $f(x)$ has an inverse function $g(x)$. If $f(3) = 4$, $f'(3) = \left(\frac{2}{5}\right)^{1/3}$ and $f''(3) = -\frac{4}{7}$, then $g''(4)$ is equal to

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QUESTION PAPER FORMAT AND MARKING SCHEME :

- 16. The question paper has three parts : Physics, Chemistry and Mathematics.
- 17. Each part has two sections as detailed in the following table.

Section	Que. Type	No. of Que.	Category-wise Marks for Each Question				Maximum Marks of the section
			Full Marks	Partial Marks	Zero Marks	Negative Marks	
I(i)	One or more correct option(s)	8	+4 If only the bubble(s) corresponding to all the correct option(s) is(are) darkened	+1 For darkening a bubble corresponding to each correct option, provided NO incorrect option darkened	0 If none of the bubbles is darkened	-1 In all other cases	32
I(ii)	Matching Lists Type (Single correct option)	4	+3 If only the bubble corresponding to the correct option is darkened	—	0 If none of the bubbles is darkened	-1 In all other cases	12
II	Numerical Value Type (Up to second decimal place)	6	+3 If only the bubble corresponding to correct answer is darkened	—	0 In all other cases	—	18

NAME OF THE CANDIDATE	
FORM NO.	
I have read all the instructions and shall abide by them. <hr style="width: 80%; margin-left: auto; margin-right: auto;"/> Signature of the Candidate	I have verified the identity, name and Form number of the candidate, and that question paper and ORS codes are the same. <hr style="width: 80%; margin-left: auto; margin-right: auto;"/> Signature of the Invigilator