

**SAMPLE PAPER-3**

**PAPER-2**

Time : 3 Hours

Maximum Marks : 198

**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 **28** 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 : (Maximum Marks: 24)**

- This section contains **SIX** 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* : -2 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 -2 marks.

1. A solid sphere of mass  $M$  is placed on a smooth horizontal surface. A sudden blow is given horizontally to the sphere at a height  $h = 4R/5$  above the centre line. If  $I$  is the impulse of the blow.

(A) The minimum time after which the highest point will touch the ground is  $\frac{MR\pi}{2I}$

(B) The displacement of the centre of mass during this interval is  $\frac{R\pi}{2}$

(C) Angular velocity of sphere just after impulse provide is  $\frac{I}{MR}$

(D) Velocity of sphere just after impulse provide is  $\frac{I}{M}$

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2. The mechanical energy of a system is given by  $E = Ax^2 + Bv^2$  where  $x$  is the displacement from ( $x = 0$ ) and  $v$  is the velocity of the body at  $x$  then choose the correct statement(s). Assume  $A$  and  $B$  positive constant.

(A) The maximum  $x$  coordinate is  $\sqrt{\frac{E}{A}}$

(B) Maximum velocity of the particle during motion is  $2\sqrt{\frac{E}{B}}$

(C)  $x = 0$  is the equilibrium position.

(D) The acceleration of the system at any point is  $\frac{-Ax}{B}$

3. A particle of mass  $m$  moves in circular orbits with potential energy  $V(r) = Fr$ , where  $F$  is a positive constant and  $r$  is its distance from the origin. Its energies are calculated using the Bohr model. If the radius of the particle's orbit is denoted by  $R$  and its speed and energy are denoted by  $v$  and  $E$ , respectively, then for the  $n^{\text{th}}$  orbit (here  $h$  is the Planck's constant)-

(A)  $R \propto n^{1/3}$  and  $v \propto n^{2/3}$

(B)  $R \propto n^{2/3}$  and  $v \propto n^{1/3}$

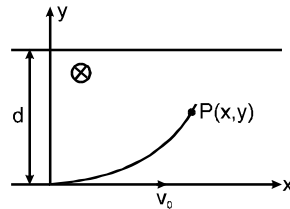
(C)  $E = \frac{3}{2} \left( \frac{n^2 h^2 F^2}{4\pi^2 m} \right)^{1/3}$

(D)  $E = 2 \left( \frac{n^2 h^2 F^2}{4\pi^2 m} \right)^{1/3}$

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4. A non-uniform magnetic field  $\vec{B} = B_0 \left(1 + \frac{y}{d}\right) \hat{k}$  is present in region of space in between  $y = 0$  &  $y = d$ . The lines are shown in the diagram. A particle of mass 'm' and positive charge 'q' is moving. Given an initial velocity  $\vec{v} = v_0 \hat{i}$ . Find the components of velocity of the particle when it leaves the field.



(A)  $V_y = \sqrt{V_0^2 - \left(V_0 - \frac{3qB_0d}{2m}\right)^2}$

(B)  $V_y = \sqrt{V_0^2 - \left(V_0 - \frac{qB_0d}{2m}\right)^2}$

(C)  $V_x = V_0 - \frac{qB_0d}{2m}$

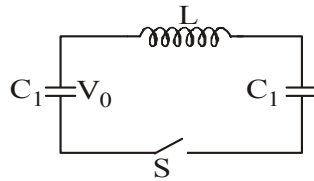
(D)  $V_x = V_0 - \frac{3qB_0d}{2m}$

5. A parallel plate capacitor of capacitance 10 mF is connected to a cell of emf 10 Volt and fully charged. Now a dielectric slab ( $k = 3$ ) of thickness equal to the gap between the plates, is very slowly inserted to completely filled in the gap, keeping the cell connected. During the filling process:
- (A) the increase in charge on the capacitor is 200 mC.
  - (B) the heat produced is non- zero.
  - (C) energy supplied by the cell = increase in stored potential energy + work done on the person who is filling the dielectric slab.
  - (D) energy supplied by the cell = increase in stored potential energy + work done by the person who is filling the dielectric slab + heat produced.

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6. A capacitor of capacitance  $C_1$  charged to a voltage  $V_0$  is connected to another uncharged identical capacitor and an inductor of inductance  $L$  with switch  $S$  as shown in the figure. At  $t = 0$ , the switch  $S$  is closed. Then



- (A) the natural frequency of oscillations is  $\sqrt{\frac{2}{LC_1}}$
- (B) the natural frequency of oscillations is  $2\sqrt{\frac{2}{LC_1}}$
- (C) the charge on the capacitor on the right is  $\frac{C_1 V_0}{2} (1 + \cos \omega t)$
- (D) the charge on the capacitor on the left is  $\frac{C_1 V_0}{2} (1 + \cos \omega t)$

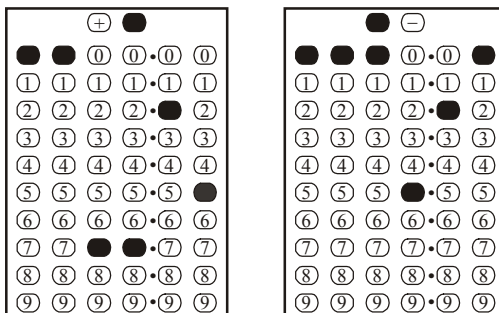
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SECTION-II : (Maximum Marks: 24)

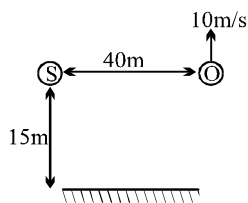
- This section contains **SIX** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30, if answer is 11.36777..... 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.



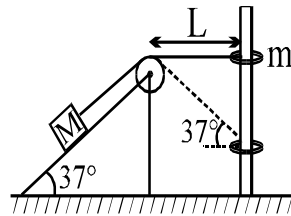
- Answer to each question will be evaluated according to the following marking scheme:  
*Full Marks* : +4 If **ONLY** the correct numerical value is entered as answer.  
*Zero Marks* : 0 In all other cases.

1. Raindrops are falling with a velocity  $10\sqrt{2}$  m/s making an angle of  $45^\circ$  with the vertical. The drops appear to be falling vertically to a man running with constant velocity. The velocity of rain drops change such that the rain drops now appear to be falling vertically with  $\sqrt{3}$  times the velocity it appeared earlier to the same person running with same velocity. The angle (in degrees) between the initial and the final velocity vectors of the raindrops with respect to the ground is?
2. S is a stationary source of sound emitting waves of frequency 440 Hz. These waves are reflected by a stationary wall & heard by observer O moving away with  $v = 10$  m/s. Find beat frequency (in Hz) heard by observer in the position shown (due to superposition between reflected & direct waves) ( $V_{\text{sound}} = 330$  m/s)

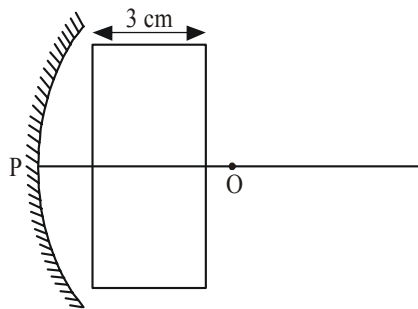


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3. A ring of mass  $m = 1$  kg can slide over a smooth vertical rod. A light string attached to the ring passing over a smooth fixed pulley at a distance of  $L = 0.7$  m from the rod as shown in the figure. At the other end of the string mass  $M = 5$  kg is attached, lying over a smooth fixed inclined plane of inclination angle  $37^\circ$ . The ring is held in level with the pulley and released. Determine the instantaneous power of the gravitational force acting on the ring (in watts) when the string makes an angle ( $\alpha = 37^\circ$ ) with the horizontal. [ $\sin 37^\circ = 0.6$ ]



4. An object is placed 21 cm in front of a concave mirror of radius of curvature 10 cm. A glass slab of thickness 3 cm and refractive index 1.5 is then placed close to the mirror in the space between the object and the mirror. Find the position of the final image (in cm) formed. (You may take the distances of the nearer surface of the slab from the mirror to be 1.0 cm).

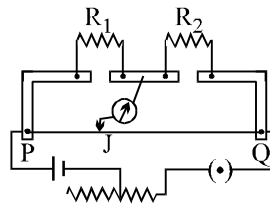



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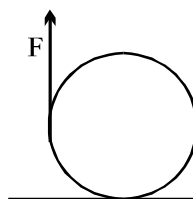
**Space for Rough Work**



5. The circuit diagram given in the figure shows the experimental setup for the measurement of unknown resistance by using a meter bridge. The wire connected between the points P & Q has non-uniform resistance such that resistance per unit length varies directly as the distance from the point P. Null point is obtained with the jockey J with  $R_1$  and  $R_2$  in the given position. On interchanging the positions  $R_1$  and  $R_2$  in the gaps the jockey has to be displaced through a distance  $\Delta$  from the previous position along the wire to establish the null point. If the ratio of  $\frac{R_1}{R_2} = 3$ , find the value of  $\Delta$  (in cm). Ignore any end corrections. [Take  $\sqrt{3} = 1.7$ ]



6. Figure shows a vertical force  $F$  that is applied tangentially to a uniform cylinder of weight  $W$ . The coefficient of static friction between the cylinder and all surfaces is 0.5. The maximum force that can be applied without causing the cylinder to rotate is  $\frac{3W}{n}$ . Find 'n'.



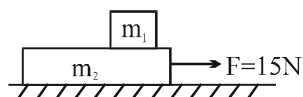

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## SECTION-III : (Maximum Marks : 18)

- This section contains **SIX** questions.
- The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9, both inclusive.
- For each question, darken the bubble corresponding to the correct integer in the ORS.
- For each question, marks will be awarded in one of the following categories :  
*Full Marks* : +3 If only the bubble corresponding to the correct answer is darkened.  
*Zero Marks* : 0 If none of the bubbles is darkened.  
*Negative Marks* : -1 In all other cases

1. A slab of mass  $m_2$  ( $= 10$  kg) is resting on a frictionless floor with a second mass  $m_1$  ( $= 1$ kg) on its top. The coefficient of friction between  $m_1$  and  $m_2$  is  $\mu = 0.1$ . A horizontal force of 15 N is applied to the lower block at  $t = 0$ . The time required by the smaller block to move a distance of 1 m on the bigger block is  $(\sqrt{n})$  sec. Find 'n'. [Take  $g = 10$  m/s<sup>2</sup> ]

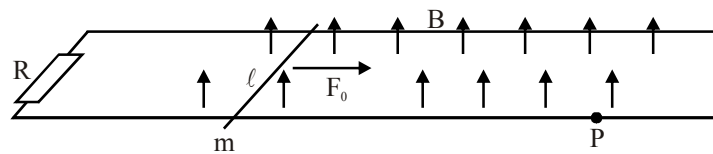


2. A hydrogen like atom is in an excited state '2n' can emit a maximum energy photon of 204eV. If it makes a transition to a quantum state 'n', a photon of energy 40.8eV is emitted. Calculate 'n'. Take ground state energy of hydrogen atom to be  $-13.6\text{eV}$ .

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**Space for Rough Work**

3. 2 moles of a diatomic gas undergoes a thermodynamic process  $\frac{PT^2}{V} = \text{constant}$ . The molar heat capacity of the gas is  $\frac{nR}{2}$ . Find  $n$ .
4. The long, horizontal pair of rails shown in the figure is connected using resistance  $R$ . The distance between the rails is  $\ell$ , the electrical resistance of the rails is negligible. A conducting wire of mass  $m$  and length  $\ell$  can slide without friction on the pair of rails, in a vertical, homogeneous magnetic field of induction  $B$ . A force of magnitude  $F_0$  is exerted for sufficiently long time onto the conducting wire, so that the speed of the wire becomes nearly constant. The force  $F_0$  is now removed at a certain point  $P$ . The distance the conducting wire cover on rails from point  $P$  before stopping is  $(316 + n)$  meters. Find 'n'. (Given :  $F_0 = 20\text{N}$ ,  $m = 1.6 \text{ gm}$ ,  $R = 0.01\Omega$ ,  $\ell = 10 \text{ cm}$ ,  $B = 0.1 \text{ T}$ )



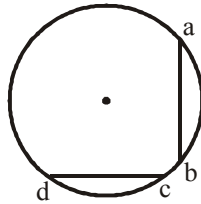

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**Space for Rough Work**

5. The dipole moment of a system of charge  $+q$  distributed uniformly on an arc of radius  $R$  subtending an angle  $\pi/2$  at its centre where another charge  $-q$  is placed is (In SI unit)

Given (  $q = 1\text{C}$  ,  $R = \sqrt{8}\pi\text{m}$  )

6. The two ends of a uniform thin rod of length  $\sqrt{2}R$  and of mass  $2\sqrt{2}\text{kg}$  can move without friction along a vertical circular path of radius  $R$ . The rod is released from the vertical position (ab). The force (in N) exerted by an end of the rod on the path when the rod passes the horizontal position (cd) is  $10n$ . Find 'n'. ( $g = 10\text{ m/s}^2$ )




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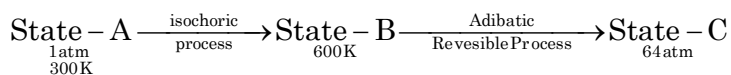
**Space for Rough Work**

## PART-2 : CHEMISTRY

## SECTION-I : (Maximum Marks: 24)

- This section contains **SIX** questions.
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- For each question, choose the correct option(s) to answer the question.
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1. One mole of an ideal monoatomic gas undergoes process from state A to C as :

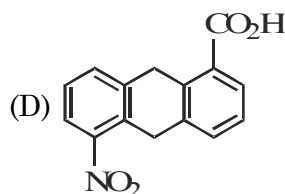
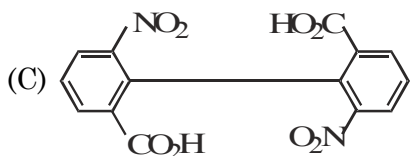
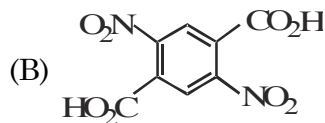
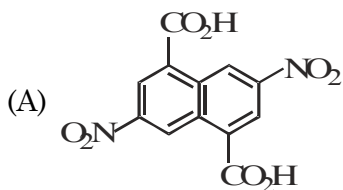


Choose the correct option(s)

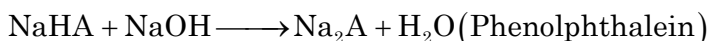
- (A) Pressure of gas at state B is 2 atm
  - (B)  $\Delta H_{AB} = 900 \text{ cal}$
  - (C)  $\Delta U_{AC} = 6300 \text{ cal}$
  - (D)  $W_{BC} = 5400 \text{ cal}$
2. Which of the following statements are correct ?
- (A) At ordinary temperature oxidising strength of  $\text{HClO} > \text{HClO}_3$
  - (B) Fluorine can decomposes water with liberation of ozonised oxygen.
  - (C) HI is a stronger acid than HBr because of the low dissociation energy of HI.
  - (D) In aqueous solution chlorine is a stronger oxidising agent than fluorine.

Space for Rough Work

3. Which of the following carboxylic acid could not be resolved by reaction with an enantiometrically pure chiral amine ?



4. 0.1 M  $H_2A$  Solution is titrated with 0.1 M NaOH solution in the presence of methyl orange and phenolphthalein indicator, reaction as followed.



given that  $K_{a1}(H_2A) = 10^{-3}$ ,  $K_{a2} = 10^{-6}$

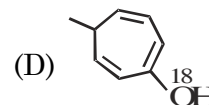
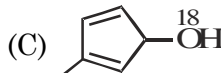
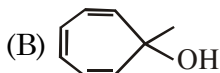
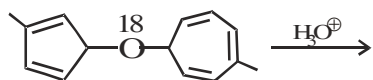
Select the correct analytical statement(s) about above titration.

- (A) 100 ml  $H_2A$  solution is titrated with 100 ml NaOH in the presence of methyl orange, final pH = 4.5
- (B) 100 ml  $H_2A$  solution is titrated with 200 ml NaOH in the presence of phenolphthalein, final pH = 9.26
- (C) 100 ml  $H_2A$  solution is titrated with 400 ml NaOH in the presence of phenolphthalein, final pH = 12.6
- (D) When 100 ml  $H_2A$  solution is added with 50 ml NaOH solution, buffer solution will be formed

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**Space for Rough Work**

5. Which of the following statements are correct :-
- (A) Anhydrous  $MgCl_2$  can not be prepared by heating  $MgCl_2 \cdot 6H_2O$
  - (B) Anhydrous  $CaCl_2$  is used in drying gases and organic compounds but not  $NH_3$  or ethyl alcohol.
  - (C) Solvay process is used for preparation of  $Na_2CO_3$  but not for  $K_2CO_3$
  - (D)  $KOH$  is preferably used compared to  $NaOH$  for absorption of  $CO_2$  because  $KHCO_3$  formed is soluble where as  $NaHCO_3$  is sparingly soluble and therefore choke the tubes of apparants used.
6. The product(s) obtained during reaction is/are




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Space for Rough Work

SECTION-II : (Maximum Marks: 24)

- 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* : +4 If **ONLY** the correct numerical value is entered as answer.  
*Zero Marks* : 0 In all other cases.

- By a sample of ground state atomic hydrogen, UV light of energy  $\frac{13.6 \times 48}{49} \frac{\text{eV}}{\text{quanta}}$  is absorbed. How many different wavelengths will be observed Balmer region of hydrogen spectrum?
- The spin only magnetic moment value (in Bohr magneton units) of  $\text{Cr}(\text{CO})_6$  is
- 5.00 mL of 0.10 M oxalic acid solution taken in a conical flask is titrated against NaOH from a burette using phenolphthalein indicator. The volume of NaOH required for the appearance of permanent faint pink color is tabulated below for five experiments. What is the concentration, in molarity, of the NaOH solution ?

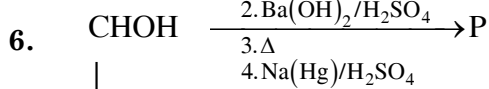
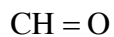
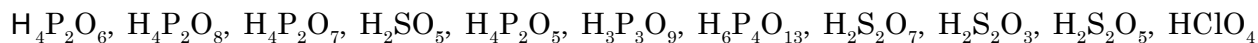
Exp. No.	Vol. of NaOH (mL)
1	12.5
2	10.5
3	9.0
4	9.0
5	9.0

Space for Rough Work



4. A real gas (X) has molar volume 1.0003 times greater than ideal gas in experimental conditions, at working pressure and temperature 1 bar and 300 K respectively. Boyle's temperature of gas was observed 200 K. What is value of excluded volume in litre/mole of gas (Consider value of  $R = 0.08 \text{ bar litre K}^{-1} \text{ mole}^{-1}$ )

5. Find the number of oxy acids having peroxy linkage



Number of carbon atoms present in P

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**Space for Rough Work**

## SECTION-III : (Maximum Marks : 18)

- This section contains **SIX** questions.
- The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9, both inclusive.
- For each question, darken the bubble corresponding to the correct integer in the ORS.
- For each question, marks will be awarded in one of the following categories :  
*Full Marks* : +3 If only the bubble corresponding to the correct answer is darkened.  
*Zero Marks* : 0 If none of the bubbles is darkened.  
*Negative Marks* : -1 In all other cases

- 
1.  $\text{KI}_{(\text{aq.})}$  and  $\text{KIO}_{3(\text{aq.})}$  mixed together in presence of HCl to form  $\text{I}_2$  and KCl and liberated  $\text{I}_2$  required 100 mL of 0.1 M  $\text{Na}_2\text{S}_2\text{O}_3$  solution for complete reduction of  $\text{I}_2$ .  
If  $x$  = millimoles of KI used in the reaction.  
and  $y$  = millimoles of HCl used in the reaction.  
then value of  $(3x - 2y)$  is :
  2. Find the number of ligands which are stronger ligand as compound to ethylenediamine(en)  
 $\text{NO}_2^-; \text{H}_2\text{O}; \text{NO}_3^-; \text{F}^-; \text{C}_2\text{O}_4^{2-}; \text{NH}_3; \text{Cl}^-; \text{CN}^-$
  3. 0.436 gm of acetyl derivative of a polyhydric alcohol requires 0.33 gm KOH for hydrolysis. Calculate number of hydroxy groups in alcohol. (Molecular weight of polyhydric alcohol=92)

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**Space for Rough Work**

4. A sample of  $U^{238}$  (half life =  $4.5 \times 10^9$  yr) ore is found to contain 23.8 g of  $U^{238}$  and 20.6 g of  $Pb^{206}$ . If the age of the ore is  $A \times 10^9$ , find the value of  $2A$ .

5. Salt of iron  $\xrightarrow{Na_2S_2O_3}$  Violet complex  $\xrightarrow{OnStanding}$  Green solution  
(X) (Y) (Z)

Write sum of the oxidation number of Fe in (X), (Y) and (Z).

6. Total number of correct statements are :

(i) Benzaldehyde cannot be obtained by Friedel craft acylation

(ii) Nitrobenzene is used as a solvent during Friedel craft reaction.

(iii) Friedel craft acylation requires higher concentration of catalyst than Friedel craft alkylation.

(iv) Benzaldehyde never reduces Fehling solution.

(v)  $(NH_4)_2S$  is used for selective reduction of only one  $-NO_2$  group into  $-NH_2$

(vi) In coupling reaction attacking electrophile is  $R-C \equiv O^{\oplus}$  and  $Ph-\overset{\oplus}{N} \equiv N$

(vii) Polyalkylation is a disadvantage during monoalkylation of aromatic compound by Friedel craft reaction.

(viii) Direct nitration of aniline gives yield of para-nitro aniline.

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Space for Rough Work

**PART-3 : MATHEMATICS**  
**SECTION-I : (Maximum Marks: 24)**

- This section contains **SIX** 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* : -2 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 -2 marks.

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1. If 'n' denotes number of planes equidistant from four non-coplanar points. Then 'n' is a factor of
- (A) 12                      (B) 14                      (C) 24                      (D) 42
2. The curve satisfying the differential equation  $(2x^2y - 2y^4)dx + (2x^3 + 3xy^3)dy = 0$  and passing through (1,1) is given by  $2\ln(xy) + \frac{y^m}{x^n} = 1$  ( $m, n \in \mathbb{N}$ ), then
- (A)  $m + n = 5$               (B)  $m + n = 4$               (C)  $m \times n = 6$               (D)  $m \times n = 4$

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Space for Rough Work

3. Let  $f$  be a differentiable function on  $\mathbb{R}$  and satisfying the integral equation

$$\int_0^x f(t)dt + \int_0^x t \cdot f(x-t)dt = -1 + e^{-x}, \text{ for all } x \in \mathbb{R}, \text{ then}$$

(A)  $f(2) = e^{-2}$       (B)  $f(0) + f'(0) = 1$       (C)  $f'(0) = 2$       (D)  $f'(0) = 1$

4. If  $f(x)$  and  $g(x)$  are differentiable functions for  $x_1 \leq x \leq x_2$  such that  $f(x_1) = 4, g(x_1) = 1, f(x_2) = 6$  and  $g(x_2) = 2$ , then for some  $C \in (x_1, x_2)$ ,  $f'(C) = \lambda g'(C)$  where  $\lambda$  equals

(A) Number of divisors of any prime number

(B) Number of ways of putting 5 identical balls in three identical boxes. (empty box not allowed)

(C) Number of values of 'x' satisfying the equation  $e^{\sin x} - x = 0, x \in \mathbb{R}$

(D) Number of into functions  $f: A \rightarrow B$  where set A has four distinct elements, and set B has two distinct elements.

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**Space for Rough Work**

5.  $f(x) = \begin{cases} a + \sin(\sin x); & x \geq 0 \\ \ln(\cos x) + bx; & x < 0 \end{cases}$  is differentiable at  $x = 0$ , then -

- (A)  $a = 1$                       (B)  $b = 0$                       (C)  $a = 0$                       (D)  $b = 1$

6. If  ${}^n C_1 - \left(1 + \frac{1}{2}\right) {}^n C_2 + \left(1 + \frac{1}{2} + \frac{1}{3}\right) {}^n C_3 - \dots + (-1)^{n-1} \left(1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n}\right) {}^n C_n = \frac{\lambda}{n}$  then  $\lambda$  ( $\lambda \in \mathbf{N}$ ) is less than

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

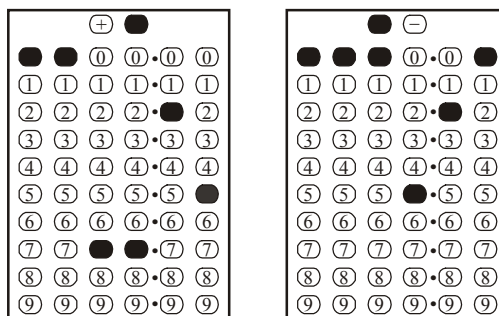
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Space for Rough Work

**SECTION-II : (Maximum Marks: 24)**

- 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.



- Answer to each question will be evaluated according to the following marking scheme:  
*Full Marks* : +4 If **ONLY** the correct numerical value is entered as answer.  
*Zero Marks* : 0 In all other cases.

1. If  $f(x) = \begin{vmatrix} \cos x & \cos x & \sec^2 x + \cot x \cdot \operatorname{cosec} x \\ \cos^2 x & \cos^2 x & \operatorname{cosec}^2 x \\ 1 & \cos^2 x & \cos^2 x \end{vmatrix}$  then find the value of  $\left| \int_0^{\frac{\pi}{2}} f(x) dx \right|$
2. Let P be the product of the non-real roots of the equation  $x^4 - 4x^3 + 6x^2 - 4x = 2020$ , then find P.
3. Let a,b,c be positive real numbers, such that,  $\frac{1}{1+a} + \frac{1}{1+b} + \frac{1}{1+c} \leq 1$ , Now if the least value of  $(1+a^2) \cdot (1+b^2) \cdot (1+c^2)$  is  $\lambda$ , then  $\frac{\lambda}{4}$  equals.

**Space for Rough Work**

4. If  $z_1^3 - 3z_1z_2^2 = 2$  and  $3z_2z_1^2 - z_2^3 = 11$ , then find the value of  $\frac{|z_1^2 + z_2^2|}{4}$
5. The slope of one of the common tangents to the hyperbolas  $\frac{x^2}{16} - \frac{y^2}{9} = 1$  and  $\frac{y^2}{16} - \frac{x^2}{9} = 1$  is  $m$ , then  $|m|$  is
6. If  $\phi_1, \phi_2, \phi_3, \phi_4$  are the eccentric angles of four concyclic points on the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ , then find the value of  $\frac{7}{4} \cos(\phi_1 + \phi_2 + \phi_3 + \phi_4)$ .

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**Space for Rough Work**



## SECTION-III : (Maximum Marks : 18)

- This section contains **SIX** questions.
- The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9, both inclusive.
- For each question, darken the bubble corresponding to the correct integer in the ORS.
- For each question, marks will be awarded in one of the following categories :  
*Full Marks* : +3 If only the bubble corresponding to the correct answer is darkened.  
*Zero Marks* : 0 If none of the bubbles is darkened.  
*Negative Marks* : -1 In all other cases

- 
1. How many tangents to the circle  $x^2 + y^2 = 3$  are there which are normal to the ellipse  $\frac{x^2}{9} + \frac{y^2}{4} = 1$
  2. The lines  $y = mx$  and  $y = nx$  intersect the line  $x + y = 4$  at points A and B respectively such that OA, AB and OB are in Arithmetic progression, where 'O' is the origin then  $|m - n| \leq K|1 + mn|$ . Find the least possible value of [K] where [·] denotes greatest integer function.
  3. Find the number of values of 'x' satisfying  $\sin x \cdot \sin\left(\frac{1}{x}\right) - 1 = 0$ ,  $x \in \mathbb{R} - \{0\}$

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**Space for Rough Work**

4. Let an ordered pair A be defined as A (x,y) where  $x \in$  prime number, such that  $x < 10$  and  $y \in$  natural numbers and  $y \leq 10$ . If the probability that the ordered pair A satisfies the relation  $x^2 - 3y^2 = 1$  is P then 60 P equals.
5. Let A and B are two non-singular matrices such that  $A^6 = I$  and  $AB^2 = BA$ . If the least value of m such that  $B^m = I$  ( $B \neq I$ ) ( $m \in \mathbb{N}$ ) is K then find the value of  $\frac{K}{9}$
6. If  $8 \int_0^{\pi/2} \frac{x^2 (\cos x - \sin x) dx}{(\cos x + \sin x)^3} = \pi(k - \pi)$ , then k is equal to

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**Space for Rough Work**

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Space for Rough Work

**QUESTION PAPER FORMAT AND MARKING SCHEME :**

- 16. The question paper has three parts : Physics, Chemistry and Mathematics.
- 17. Each part has three 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	One or more correct option(s)	6	+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	-2 In all other cases	24
II	Numerical Value Type (Up to second decimal place)	6	+4 If only the bubble corresponding to correct answer is darkened	—	0 In all other cases	—	24
III	Single digit Integer (0-9)	6	+3 If only the bubble corresponding to correct answer is darkened	—	0 If none of the bubbles is darkened	-1 In all other cases	18

NAME OF THE CANDIDATE .....	
FORM NO. ....	
I have read all the instructions and shall abide by them.   _____ 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.   _____ Signature of the Invigilator