

SAMPLE PAPER-3

PAPER-1

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

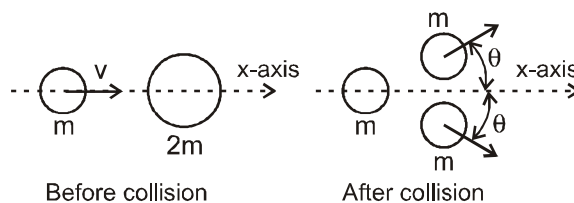
BEWARE OF NEGATIVE MARKING

PART-1 : PHYSICS

SECTION-I(i) : (Maximum Marks : 18)

- This section contains **SIX** questions.
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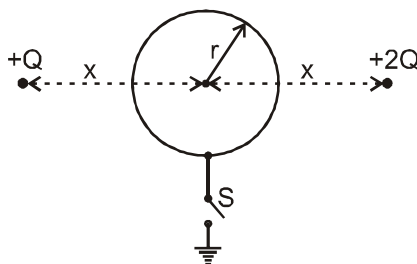
1. A particle of mass m is moving along the x -axis with speed v when it collides with a particle of mass $2m$ initially at rest. After the collision, the first particle has come to rest and the second particle has split into two equal-mass pieces that are shown in the figure. Which of the following statements correctly describes the speeds of the two pieces ? ($\theta > 0$)



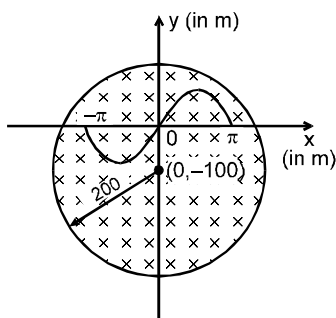
- (A) Each piece moves with speed v .
 (B) Each piece moves with speed $v/2$.
 (C) One of the pieces moves with speed $v/2$, the other moves with speed greater than $v/2$.
 (D) Each piece moves with speed greater than $v/2$.

Space for Rough Work

- 2 Two particles having positive charges $+Q$ and $+2Q$ are fixed at equal distance x from centre of a conducting sphere having zero net charge and radius r as shown. Initially the switch S is open. After the switch S is closed, the net charge flowing out of sphere is



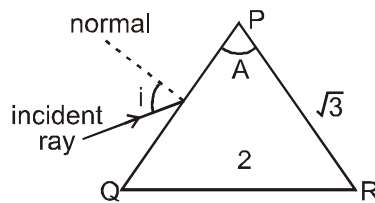
- (A) $\frac{Qr}{x}$ (B) $-\frac{Qr}{x}$ (C) $\frac{3Qr}{x}$ (D) $-\frac{3Qr}{x}$
3. A time varying uniform magnetic field, varying at constant rate 1 T/sec exists in a circular region of radius 200 m centered at $(0, -100)$. A conducting wire is placed along $y = \sin kx$, where $k = 1 \text{ rad/m}$, from $x = -\pi$ to $+\pi$. Find the magnitude of e.m.f. generated in the wire.



- (A) 157 V (B) 314 V (C) 628 V (D) Zero

Space for Rough Work

4. A stick of uniform cross-sectional area, length 3 m and relative density 0.4 is hinged, to one of its ends at a point 1 m deep inside water. When a weight of 600 g is suspended at the other end, it rests in equilibrium making an angle of 60° with the vertical. Determine the cross-section area of the stick.
 (A) 90 cm^2 (B) 180 cm^2 (C) 45 cm^2 (D) 22.5 cm^2
5. A prism of angle A and refractive index 2 is surrounded by medium of refractive index $\sqrt{3}$. A ray is incident on side PQ at an angle of incidence i ($0 \leq i \leq 90^\circ$) as shown. The refracted ray is then incident on side PR of prism. The minimum angle A of prism for which ray incident on side PQ does not emerge out of prism from side PR (for any value of i) is



- (A) 30° (B) 45° (C) 60° (D) 120°
6. Find the temperature of equilibrium of a perfectly black disc exposed normally to the Sun's ray on the surface of Earth. Imagine that it has a nonconducting backing so that it can radiate only to hemisphere of space. Assume temperature of surface of Sun = 6200 K, radius of sun = $6.9 \times 10^8 \text{ m}$, distance between the Sun and the Earth = $1.5 \times 10^{11} \text{ m}$. Stefan's constant = $5.7 \times 10^{-8} \text{ W/m}^2\text{K}^4$
 (A) 420.5 K (B) 430 k (C) 210 k (D) 105 k

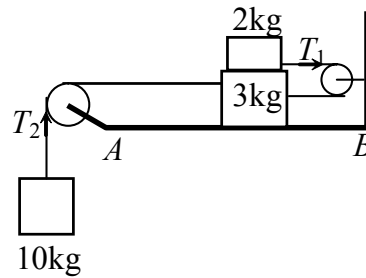
Space for Rough Work

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

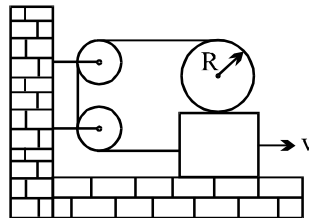
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Partial Marks : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option.
Zero 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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7. If the potential difference applied across a Coolidge tube is decreased,
- (A) the wavelength of the K_{α} line will remain same
 - (B) the wavelength of the K_{β} line will increase
 - (C) the difference in wavelength between the K_{α} and K_{β} lines will remain same
 - (D) none of the above

Space for Rough Work

8. Coefficient of friction between the two blocks is 0.3 whereas the surface AB is smooth. ($g = 10 \text{ ms}^{-2}$)



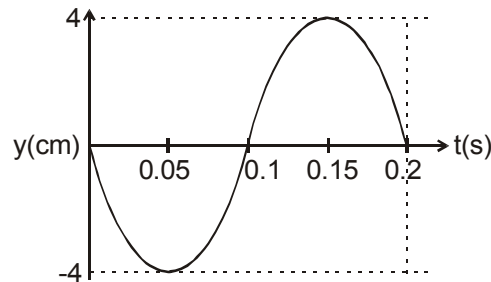
- (A) Acceleration of the system of masses is 5.866 ms^{-2}
 (B) Tension T_1 in the string is 17.7 N
 (C) Tension T_2 in the string is about 41.4 N
 (D) Acceleration of 10 kg mass is 7.55 ms^{-2}
9. In the figure shown, the plank is being pulled to the right with a constant speed v . If the cylinder does not slip then :



- (A) the speed of the centre of mass of the cylinder is $2v$.
 (B) the speed of the centre of mass of the cylinder is zero.
 (C) the angular velocity of the cylinder is v/R .
 (D) the angular velocity of the cylinder is zero.
10. A cylindrical block of density ρ is partially immersed in a liquid of density 3ρ . The plane surface of the block remains parallel to the surface of the liquid. The height of the block is 60cm. The block performs SHM when displaced from its mean position. [Use $g = 9.8 \text{ m/s}^2$]
 (A) The maximum amplitude is 20 cm (B) The maximum amplitude is 40 cm
 (C) The time period will be $2\pi/7$ seconds (D) None

Space for Rough Work

11. For a certain transverse standing wave on a long string, an antinode is formed at $x = 0$ and next to it, a node is formed at $x = 0.10$ m. The displacement $y(t)$ of the string particle at $x = 0$ is shown in figure.



- (A) Transverse displacement of the particle at $x = 0.05$ m and $t = 0.05$ s is $-2\sqrt{2}$ cm.
 (B) Transverse displacement of the particle at $x = 0.04$ m and $t = 0.025$ s is $-2\sqrt{2}$ cm.
 (C) Speed of the travelling waves that interfere to produce this standing wave is 2 m/s.
 (D) The transverse velocity of the string particle at $x = \frac{1}{15}$ m and $t = 0.1$ s is 20π cm/s
12. A ball tied to the end of a string swings in a vertical circle under the influence of gravity
- (A) When the string makes an angle 90° with the vertical, the tangential acceleration is zero & radial acceleration is somewhere between maximum and minimum
 (B) When the string makes an angle 90° with the vertical, the magnitude of tangential acceleration is maximum & radial acceleration is somewhere between maximum and minimum
 (C) At no place in the circular motion, tangential acceleration is equal to radial acceleration
 (D) Throughout the path whenever radial acceleration has its extreme value, the tangential acceleration is zero.

Space for Rough Work

SECTION-II : (Maximum Marks: 24)

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- 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 darken the corresponding bubbles in the ORS.

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

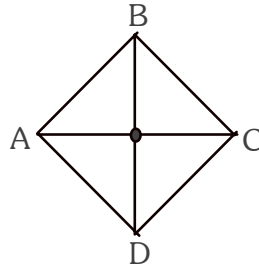
<p style="text-align: center;">+</p> <p>● ● 0 0 • 0 0</p> <p>① ① ① ① • ① ①</p> <p>② ② ② ② • ● ②</p> <p>③ ③ ③ ③ • ③ ③</p> <p>④ ④ ④ ④ • ④ ④</p> <p>⑤ ⑤ ⑤ ⑤ • ⑤ ●</p> <p>⑥ ⑥ ⑥ ⑥ • ⑥ ⑥</p> <p>⑦ ⑦ ● ● • ⑦ ⑦</p> <p>⑧ ⑧ ⑧ ⑧ • ⑧ ⑧</p> <p>⑨ ⑨ ⑨ ⑨ • ⑨ ⑨</p>	<p style="text-align: center;">-</p> <p>● ● ● 0 • 0 ●</p> <p>① ① ① ① • ① ①</p> <p>② ② ② ② • ● ②</p> <p>③ ③ ③ ③ • ③ ③</p> <p>④ ④ ④ ④ • ④ ④</p> <p>⑤ ⑤ ⑤ ● • ⑤ ⑤</p> <p>⑥ ⑥ ⑥ ⑥ • ⑥ ⑥</p> <p>⑦ ⑦ ⑦ ⑦ • ⑦ ⑦</p> <p>⑧ ⑧ ⑧ ⑧ • ⑧ ⑧</p> <p>⑨ ⑨ ⑨ ⑨ • ⑨ ⑨</p>
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1. Sharp image of extended object which is placed perpendicular to the principle axis of a lens is η times that of the object for a particular position of object on a screen. Without disturbing the position of object and screen, by shifting lens a position can be obtained where the sharp image is $1/\eta$ times that of object. Ratio of difference between the two positions of lens to the focal length of lens for $\eta = 5$ is:

Space for Rough Work

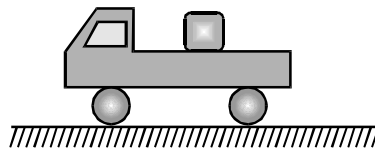
2. In the figure shown, segments AB, BC, CD and DA, as well as the diagonal segments AC and BD have a resistance 2Ω each. The mid points of the diagonal wires are soldered with each other. Find the effective resistance between the mid points of sides AD and CD.



3. A capacitor of capacitance $10\mu\text{F}$ is charged up to a potential difference of 2 V and then the cell is removed. Now it is connected to a cell of emf 4 V and is charged fully. In both cases the polarities of the two cells are in the same directions. Total heat produced in the charging process by 4 V cell is : (in mJ)

Space for Rough Work

4. In order to impart an angular velocity to an earth satellite, the geomagnetic field can be used. Find the maximum possible angular velocity (in 10^{-2} rad/s) about its own axis gained by the satellite if a storage battery with a capacity of $Q = 5$ Amp–hours is discharged suddenly through a coil of $N = 20$ turns wound around the satellite's surface along the circumference of the largest circle. The satellite has a mass of $m = 10^3$ kg and is a thin walled uniform sphere. The geomagnetic field is parallel to the winding plane and its flux density is $B = 0.5$ Gauss. (1 Gauss = 10^{-4} Tesla)
5. Interference fringes were produced using white light in a double slit arrangement. When a mica sheet of uniform thickness of refractive index 1.6 (relative to air) is placed in the path of light from one of the slits, the central fringe moves through some a distance. This distance is equal to the width of 30 interference bands if light of wavelength 4800 \AA is used. The thickness (in μm) of mica is :
6. A box of dimensions $1.5 \text{ m} \times 0.75 \text{ m} \times 0.75 \text{ m}$ and mass 250 kg rests on a truck with the smaller face down. If the acceleration of the truck is gradually increased what is the minimum value of friction coefficient for which the box topples before it slides ?



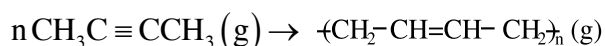
Space for Rough Work

PART-2 : CHEMISTRY

SECTION-I(i) : (Maximum Marks : 18)

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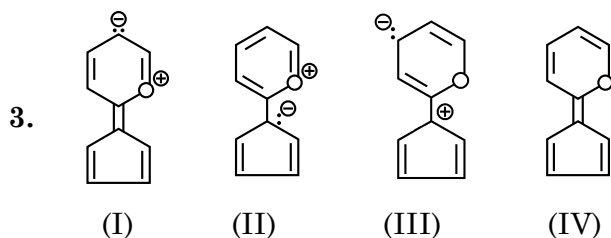
1. The bond enthalpies of C–C, C=C and C≡C bonds are 348, 610 and 835 kJ/mol, respectively, at 298 K and 1 bar. The enthalpy of polymerization per mole of 2-Butyne at 298 K and 1 bar, as shown below, is



- (A) -123 kJ (B) -132 kJ (C) -139 kJ (D) -37 kJ
2. Consider the following statements:
 (I) Halogen have highest 1st Ionization energy in the respective period
 (II) Electron gain enthalpy of alkali metal has positive value
 (III) CrO₃ and Mn₂O₇ are acidic oxide
 (IV) In sp³d² hybridization set of d_{x²-y²} and d_{z²} orbitals is involved

Which of the above statement incorrect one ?

- (A) II and IV (B) III and IV (C) I, II and III (D) I and II



The correct order of stability for the given canonical structure is

- (A) IV > II > III > I (B) IV > II > I > III
 (C) II > IV > III > I (D) II > IV > I > III

Space for Rough Work

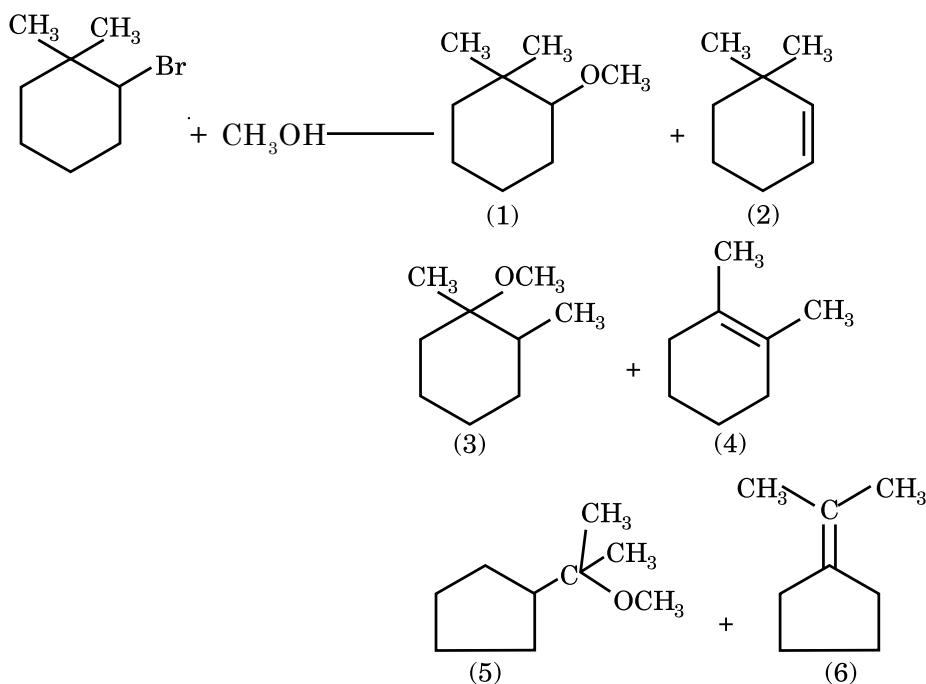
4. For the reaction $2\text{NO}(\text{g}) + \text{H}_2(\text{g}) \longrightarrow \text{N}_2\text{O}(\text{g}) + \text{H}_2\text{O}(\text{l})$

Experiment 1: The value of $-\frac{dp}{dt}$ was, obtained by experiment(s), 2.25 torr/sec for a pressure of 450 torr of $\text{NO}(\text{g})$ and 0.25 torr/sec for a pressure of 150 torr, the pressure of $\text{H}_2(\text{g})$ being constant.

Experiment 2: The value of $-\frac{dp}{dt}$ was 1.90 torr/sec for $\text{H}_2(\text{g})$ pressure of 291 Torr and 0.951 torr/sec for $\text{H}_2(\text{g})$ pressure of 145 torr the pressure of $\text{NO}(\text{g})$ being constant.

Which analytical statement is correct on the basis of above experiment(s)

- (I) Order of reaction is 3
 - (II) Order with respect to $\text{NO}(\text{g})$ and $\text{H}_2(\text{g})$ are 3 and 0 respectively
 - (III) Order with respect to $\text{H}_2(\text{g})$ and $\text{NO}(\text{g})$ are 1 and 2 respectively
 - (IV) Rate of reaction depend upon the concentration/pressure of reactant(s)
- (A) I, II and IV (B) I and III (C) I, III and IV (D) I only
5. Which of the following pairs correctly represent the comparison of their dipole moment?
 (A) $\text{CH}_3\text{Cl} < \text{CH}_3\text{F}$ (B) $\text{CH}_3\text{Cl} < \text{CHCl}_3$ (C) $\text{NH}_3 < \text{NF}_3$ (D) $\text{HCl} < \text{HF}$
6. What are the possible product(s) in are given chemical reaction.



- (A) 1 and 2 (B) 3 and 4 (C) 3, 4, 5 and 6 (D) 1, 2, 3, 4, 5 and 6

Space for Rough Work

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

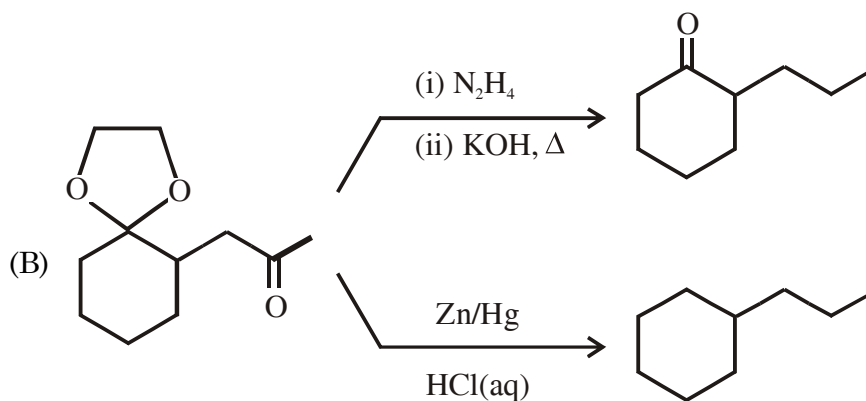
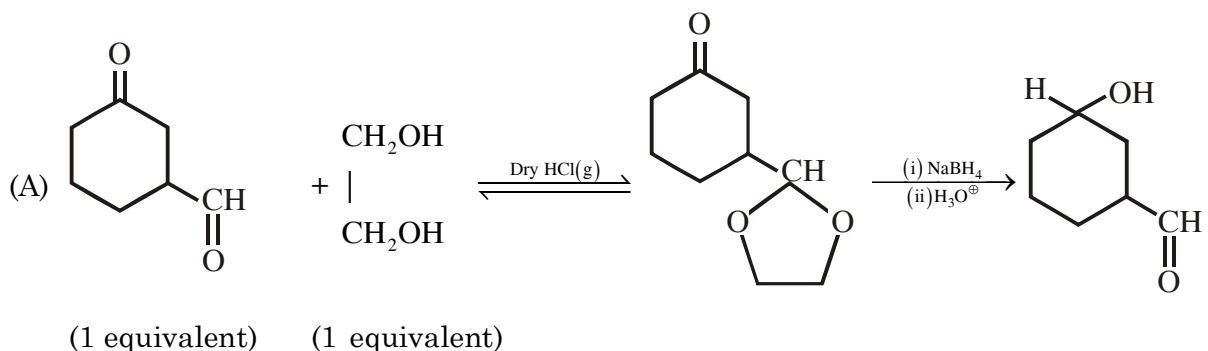
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7. Which of the following is/are correct statement(s).
- (A) Lyophilic solution are reversible whereas lyophobic solution are irreversible
(B) Dispersed phase shows no affinity with dispersion medium in case of lyophilic colloidal
(C) Dispersed phase molecules of lyophilic colloidal are large enough to be in colloidal range
(D) Dispersed phase molecules of lyophobic colloidal are large enough to be close to upper limit of colloidal range
8. Which of the following statement(s) is/are correct?
- (A) In $[\text{Fe}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}$, the ligands has satisfied only the secondary valencies of ferric ion
(B) In $[\text{Fe}(\text{NH}_3)_3(\text{CN})_3]$, the ligands has satisfied both primary and secondary valencies of ferric ion
(C) In $[\text{Fe}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}$, the ligands has satisfied only the secondary valencies of ferrous ion
(D) In $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$, the ligands has satisfied only the secondary valencies of copper ion

Space for Rough Work

9. Select the correct statement about Grignard reagent.
- (A) 3 and 4 membered cyclic ethers can not be used as a solvent in the reaction in which Grignard reagent is one of the reactant
 - (B) Aryl, vinyl, allyl group can not be taken as organic part of Grignard reagent
 - (C) Grignard reagent can not be prepared from alkyl or aryl fluorides
 - (D) The role of ether is to solvolyse RMgX and also provide medium for reaction
10. Acetone and carbon disulphide form binary liquid solution showing positive deviation from Raoult's law. The normal boiling point (T_b) of pure acetone is less than that of pure CS_2 . Pick out the **incorrect** statements among the following.
- (A) Boiling temperature of mixture is always less than boiling temperature of acetone
 - (B) Boiling temperature of Azeotropic mixture is always less than boiling temperature of pure CS_2
 - (C) When a small amount CS_2 (less volatile component) is added to excess of acetone boiling point of resulting mixture increase
 - (D) A mixture of CS_2 and CH_3COCH_3 can be completely separated by simple fractional distillation
11. Select the correct statement:
- (A) Kaolinite is the ore of aluminium
 - (B) Extraction of lead from galena involves roasting in limited supply of air at moderate temperature followed by self reduction at higher temperature (to melt the charge)
 - (C) Extraction of zinc from zinc blende involves roasting followed by reduction with carbon
 - (D) Major chemical component of 'slag' formed during the extraction of iron and copper is FeSiO_3

Space for Rough Work

12. Which of the following statement(s) and reaction(s) are correct:



(C) Lactose is a disaccharide that has one acetal and one hemiacetal unit

(D) Reaction between carbonyl compound and monohydric alcohol is not favourable in acetal formation

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

+									
●	●	○	○	○	○	○	○	○	○
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

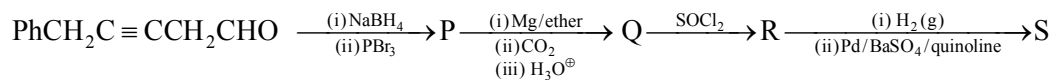
-									
●	●	●	○	○	○	○	○	○	○
①	①	①	①	①	①	①	①	①	①
②	②	②	②	●	②	②	②	②	②
③	③	③	③	③	③	③	③	③	③
④	④	④	④	④	④	④	④	④	④
⑤	⑤	⑤	●	⑤	⑤	⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨	⑨

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

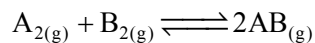
- 0.001 mM, 100 ml HCl is titrated with 0.001 mM NaOH and conductance continuously measured, what will be the molar conductance at end point of titration.
 Given that $\lambda_{H^+}^{\circ}$, $\lambda_{Na^+}^{\circ}$, $\lambda_{Cl^-}^{\circ}$ and $\lambda_{OH^-}^{\circ}$ are 349.8, 50.11, 76.34 and 198.50 Mho cm² mol⁻¹ respectively.
- Mn⁺², Fe⁺², Ni⁺², Cu⁺² ions form different type of inner and outer orbital complexes like [Mn(SCN)₆]⁴⁻, [Fe(CN)₆]⁴⁻, [Ni(NH₃)₆]⁺², [Cu(NH₃)₆]⁺². What is the maximum magnetic moment from among them.

Space for Rough Work

3. In the following sequence, product P, Q, R and S are formed, if the molar mass of S is M, then what is value of $\frac{M}{10}$.



4. Calculate $\Delta G_{\text{reaction}}$ (kJ/mol) for the given reaction at 300 K.



and at partial pressure of 10^{-2} bar, 10^{-1} bar and 10^{-4} bar respectively for A_2 , B_2 and AB.

Given:

$$\Delta H_f^\circ \text{ AB} = 180 \text{ kJ/mol ;}$$

$$\Delta H_f^\circ \text{ A}_2 = 60 \text{ kJ/mol}$$

$$\Delta H_f^\circ \text{ B}_2 = 29.5 \text{ kJ/mol ;}$$

$$\Delta S_f^\circ \text{ AB} = 210 \text{ J/K mol}$$

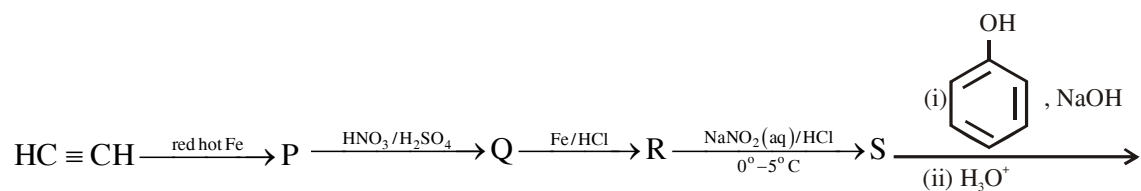
$$\Delta S_f^\circ \text{ A}_2 = 190 \text{ J/K mol ;}$$

$$\Delta S_f^\circ \text{ B}_2 = 205 \text{ J/K mol}$$

Use: $2.303 R \times 300 = 5750 \text{ J/mole}$

Space for Rough Work

5. 4 gm calcium burns in excess nitrogen to produce a white powder which dissolves in sufficient water to produce a gas (A) and an alkaline solution. The solution on bubbling dry air produces a solid (B) on the surface. Calculate amount of B in gm. (assume 100% conversion in each reaction)
6. In the following sequence the products are P, Q, R, S and T



∴ T is a red colour compound, What is the degree of unsaturation in T.

Space for Rough Work

PART-3 : MATHEMATICS
SECTION-I(i) : (Maximum Marks : 18)

- This section contains **SIX** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option 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 option is darkened.
Zero Marks : 0 If none of the bubbles is darkened.
Negative Marks : -1 In all other cases

-
1. The locus of centre of the circle of radius 3 which touches the locus of P obtained by $2PA = 3PB$ {where $A(9\sqrt{2}, 9\sqrt{2})$ and $B(4\sqrt{2}, 4\sqrt{2})$ are given fixed points} externally, is :
- (A) $x^2 + y^2 = 81$ (B) $x^2 + y^2 = 144$ (C) $x^2 + y^2 = 225$ (D) $x^2 + y^2 = 324$
2. The number of integral solutions for a, b, c and d of the equation $a \cdot b \cdot c \cdot d = 2021$ is :
- (A) 16 (B) 32 (C) 64 (D) 128
3. Suppose a, b denote the distinct real roots of the quadratic polynomial $x^2 + 20x - 2020$ and suppose c, d denote the distinct complex roots of the quadratic polynomial $x^2 - 20x + 2020$. Then the value of
- $$ac(a - c) + ad(a - d) + bc(b - c) + bd(b - d)$$
- is
- (A) 0 (B) 8000 (C) 8080 (D) 16000

Space for Rough Work

SECTION-I(ii) : (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.

-
7. DG and CF are two poles of same height situated 5m apart from each other such that D and C are the top of the poles and G and F are the feet of poles on the ground. Two observers stand on the line joining the feet of poles on opposite sides of the poles at points A and B, at a distance 23 m from each other, such that A-G-F-B, in order, are collinear. If the distance between A and C is 25m and B and D is 17 m, then

- (A) the distance between A & D will be $15\sqrt{2}$ m
(B) the distance between A & D will be $15\sqrt{3}$ m
(C) the distance between B & C will be $9\sqrt{3}$ m
(D) the distance between B & C will be $3\sqrt{26}$ m

Space for Rough Work

8. The value of $\frac{1}{2}\cos^{-1}\frac{3}{5} + \frac{1}{2}\tan^{-1}\frac{12}{5}$ is equal to

(A) $\tan^{-1}\frac{1}{2} + \tan^{-1}\frac{2}{3}$

(B) $\sin^{-1}\frac{1}{\sqrt{5}} + \cos^{-1}\frac{3}{\sqrt{13}}$

(C) $\cos^{-1}\frac{2}{\sqrt{5}} + \sin^{-1}\frac{2}{\sqrt{13}}$

(D) $\tan^{-1}\frac{1}{4} + \tan^{-1}\frac{2}{9} + \cot^{-1}\frac{3}{2}$

9. Let $y = x^2 + ax + 1$ be a parabola such that no point of it lies below x axis. A tangent to this parabola at its point of intersection with the y axis also touches the circle $x^2 + y^2 = r^2$. Then -

(A) The number of integral values of 'a' is 3

(B) The radius of the circle when 'a' attains its maximum value is $\frac{1}{\sqrt{5}}$

(C) The slope of the tangent when radius of the circle is maximum is 0

(D) The minimum area bounded by the tangent and the coordinate axes is $\frac{1}{4}$

10. Let $z_1, z_2 \in \mathbb{C}$ such that $|z_1 - z_2| = 4$ and $|z_1| < |z_2|$, then -

(A) $|z_1| + |z_2| = 4 \Rightarrow \arg\left(\frac{z_1}{z_2}\right) = \pi$

(B) $|z_1| + |z_2| = |z_1 + z_2| \Rightarrow \arg\left(\frac{z_1}{z_2}\right) = 0$

(C) $|z_1| - |z_2| = -4 \Rightarrow \arg\left(\frac{z_1}{z_2}\right) = \pi$

(D) $|z_2| - |z_1| = |z_1 + z_2| \Rightarrow \arg\left(\frac{z_1}{z_2}\right) = 0$

Space for Rough Work

11. An instructor has a question bank consisting of 300 easy true/false type questions, 200 difficult true/false type questions, 500 easy multiple choice questions and 400 difficult multiple choice questions. If a question is selected at random from the question bank then the probability that the selected question is
- (A) an easy question given that it's a multiple choice question is $\frac{8}{9}$
- (B) a multiple choice question given that it's an easy question is $\frac{5}{8}$
- (C) a difficult question given that it's a true/false type question is $\frac{2}{5}$
- (D) an easy true-false question is $\frac{3}{14}$
12. Let A and B be invertible square matrices of order 'n' where $n \geq 3$, is an odd number. Then which of the following statement(s) is / are true ?
- (A) $\text{adj}(\text{adj}A) = |A|^{n-2} A$
- (B) $\text{adj}(AB)^T = (\text{adj} A)^T (\text{adj} B)^T$
- (C) $|\text{adj}(\text{adj} A)| = |A|^{n-3}$
- (D) $A^2B^2 - B^2A^2$ will be an invertible matrix if A and B are skew symmetric and symmetric matrices respectively.

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.

	+	●			
●	●	0	0	0	0
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

			-		
●	●	●	0	0	●
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.

1. A cone is made from a circular sheet of radius $\sqrt{3}$ by cutting out a sector and keeping the cut edges of the remaining piece together. Find the maximum volume attainable for the cone.
2. If $x \ln x > k(x-1) - \ln x \quad \forall x > 1$, then find the greatest possible such integral value of k.
3. Let $f(x) = \int_0^x \frac{2t+1}{t^2-2t+2} dt \quad \forall x \in [-1,1]$. If the range of $f(x)$ be $[a, b]$ where $a, b \in \mathbb{R}$ then $a + b = \ln\left(\frac{m}{n}\right) + 3 \tan^{-1}\left(\frac{p}{q}\right)$ where $m, n, p, q \in \mathbb{N}$ such that m & n are coprime to each other so as p & q . Evaluate $m + n + p + q$.

Space for Rough Work

4. Let $P(x_0, y_0)$ be a point on the curve $C : (x^2 - 11)(y + 1) + 4 = 0$ where $x_0, y_0 \in \mathbb{N}$. Find the area of the triangle formed by the normal drawn to the curve C at P and the coordinate axes.
5. The solution of differential equation $\frac{dy}{dx} = 3x^2y^2 - \frac{6y}{x}$ such that $y(1) = \frac{1}{3}$ is given by $y = \frac{1}{x^m(1 + n \cdot x^p)}$ where $m, n, p \in \mathbb{N}$. Find the value of $m^2 + n^2 + p^2$.
6. In a triangle PQR , let $\vec{a} = \overrightarrow{QR}, \vec{b} = \overrightarrow{RP}$ and $\vec{c} = \overrightarrow{PQ}$. If

$$|\vec{a}| = 3, |\vec{b}| = 4 \text{ and } \frac{\vec{a} \cdot (\vec{c} - \vec{b})}{\vec{c} \cdot (\vec{a} - \vec{b})} = \frac{|\vec{a}|}{|\vec{a}| + |\vec{b}|}, \text{ then the value of } |\vec{a} \times \vec{b}|^2 \text{ is } \underline{\hspace{2cm}}$$

Space for Rough Work

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 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)	Single correct option	6	+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	18
I(ii)	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

NAME OF THE CANDIDATE	
FORM NO.	
I have read all the instructions and shall abide by them. <hr style="width: 80%; margin: 0 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: 0 auto;"/> Signature of the Invigilator