CLASSROOM CONTACT PROGRAMME

(Academic Session : 2020 - 2021)

ALLEN
CAREER INSTITUTE
KOTA (RAJASTHAN)
path to success

JEE(Advanced)
UNIT TEST
11-10-2020

JEE(Main+Advanced) : ENTHUSIAST COURSE (PHASE : TOAS)

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 m/s²** unless otherwise stated.

Please see the last page of this booklet for rest of the instructions

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** — $\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9$

- **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** — $\epsilon_0 = \dfrac{1}{\mu_0 c^2}$

- **Planck constant** — $h = 6.63 \times 10^{-34} \text{ J–s}$

Space for Rough Work

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HAVE CONTROL ⟶ HAVE PATIENCE ⟶ HAVE CONFIDENCE ⟹ 100% SUCCESS

$\boxed{\textbf{BEWARE OF NEGATIVE MARKING}}$

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.

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1. An electron beam and a photon beam pass through identical slits. On a distant screen, the first dark fringe occurs at the same angle for both of the beams. The electron speed are much slower than that of light. If kinetic energy of the electron is K,

(A) energy of photon is greater than kinetic energy of electron.

(B) energy of photon = $\sqrt{2mc^2K}$ where m is mass of electron.

(C) energy of photon = $\sqrt{mc^2K}$ where m is mass of electron.

(D) the wavelength of electron and photon are equal.

Space for Rough Work

2. The energy level scheme for the hypothetical one-electron element is shown in figure. The potential energy is taken to be zero for an electron at an infinite distance from the nucleus. An 18-eV photon is absorbed by that atom in its ground level. As the atom returns to its ground level, what possible wavelength(s) can the emitted photons have? Assume that there can be transitions between all pairs of levels, (Assume hc = 1240 eV-nm)


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n = 4 ——————————— –2 eV
n = 3 ——————————— –5 eV

n = 2 ——————————— –10 eV


n = 1 ———————⬤——— –20 eV
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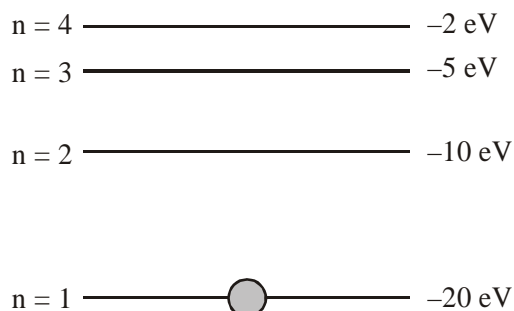
(A) 613.33 nm   (B) 124 nm   (C) 155 nm   (D) 68.89 nm

3. A molybdenum target (Z = 42) is bombarded with 35.0 keV electrons and the x-ray spectrum is emitted, here $\lambda_{K_\beta} = 63\,pm$ and $\lambda_{K_\alpha} = 71\,pm$. It is desired to filter these radiations though a material that will absorb the K_β line much more strongly than it will absorb the K_α line. What substance(s) would you use? The K-ionization energies for molybdenum and for four neighboring elements are as follows: (Assume hc = 1240 eV-nm)

Z	40	41	42	43	44
Element	Zr	Nb	Mo	Te	Ru
E_K **(keV)**	18.00	18.99	20.00	21.04	22.12

(A) $E_{K_\alpha} = 19.68\,KeV$ (B) $E_{K_\beta} = 17.46\,KeV$

(C) Zr , Nb both can be used for filtering.   (D) Te, Ru both can be used for filtering.

Space for Rough Work

4. Light is incident at an angle ϕ with the normal to a vertical plane containing two narrow slits (S_1 and S_2) at separation d. The medium to the left of slit plane is air and wavelength of the incident light is λ. The medium to the right of the slit plane has refractive index μ. Find all values of angular position (θ) of a point P where we will observe constructive interference. Wavelength of incident light is λ. $\phi = 0.02$ rad, $\lambda = 500$ nm (in air), d = 0.1 mm, $\mu = 1.6$.
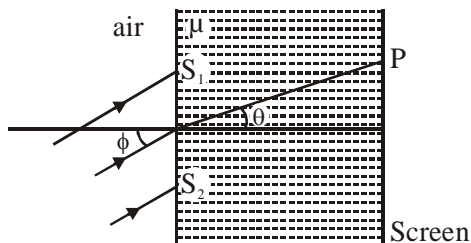

(A) $\dfrac{1}{80}$ rad   (B) 0 rad   (C) $-\dfrac{1}{320}$ rad   (D) $\dfrac{1}{240}$ rad

5. In a photoelectric experiment light of different wavelengths are vised on a metal surface. For each wavelength the stopping potential difference is recorded. The given graph shows the variation of stopping potential difference (V_s) versus the wavelength (λ) of light used. Given h = 4×10^{-15} eVs and c = 3×10^8 ms^{-1}.
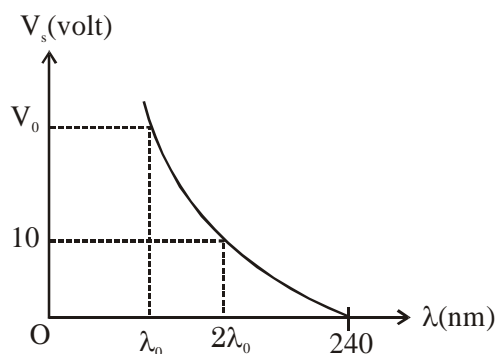
(A) V_0 = 25 volts

(B) work function ϕ = 5eV

(C) λ_0 = 40 nm

(D) for λ = 100 nm, stopping potential is 5 volts.

Space for Rough Work

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6. A hydrogen atom in ground state is moving with a kinetic energy of 30 eV. It collides with a deuterium atom in ground state at rest. The hydrogen atom is scattered at right angle to its original line of motion. Assume that energy n^{th} state in both the atoms is given by $E_n = -\dfrac{13.6}{n^2} eV$ and the mass of deuterium is twice that of hydrogen. The possible kinetic energy of deuterium atom after the collision can be :

(A) 15.75 eV   (B) 14.4 eV   (C) 16.6 eV   (D) 19 eV

7. The X-ray spectrum of a metallic target has been shown in figure. Take R = 1 × 10⁷ /m

Intensity, $1/\lambda$ (Å)⁻¹, 3.888, 5.56, 8.06
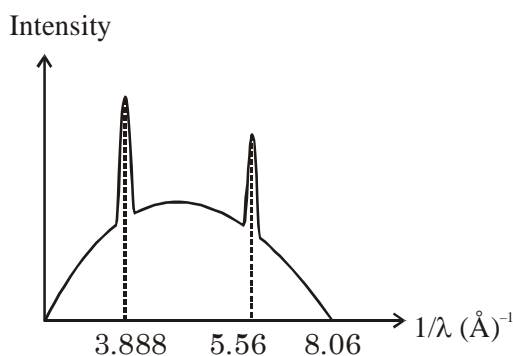
(A) The accelerating potential difference for bombarding electrons is approx 100 kV

(B) Two characteristic X-rays have been shown in the figure, if one of them is k_α X-ray and the other one is k_β X-ray. Wavelength of k_α X-ray is approx 0.26Å.

(C) The atomic number of the target atom is 73.

(D) $\dfrac{1}{\lambda} = 5.56(\text{Å})^{-1}$ refers to k_α X-ray.

Space for Rough Work

8. In a hypothetical hydrogen atom the electrostatic potential energy of interaction of proton

and electron is given by $U = U_0 \ell n \left(\dfrac{r}{r_0} \right)$ where U_0 and r_0 are constants and r is radius of circular

orbit of electron.

(A) The speed in every orbit will be the same.

(B) Radius of orbit is nR_0 where n is integer and R_0 is radius of ground state orbit.

(C) The energy in ground state is $\dfrac{U_0}{2}$.

(D) The energy required to excite the electron to n = 2 from n = 1 is $\dfrac{U_0}{4}$.

**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.

Interference experiment is conducted with light of wavelength 500 nm. We have possible set ups listed in List II and shape of interference fringes in List I. Match the appropriate entries.
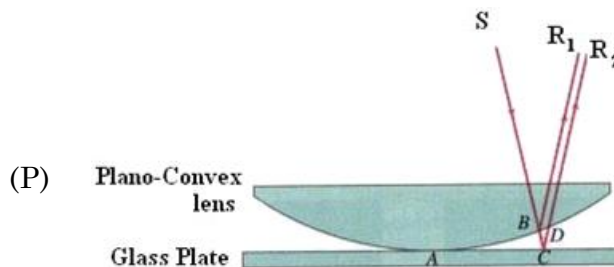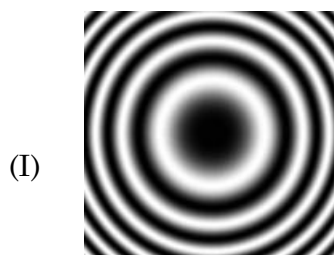
List-I   **List-II**
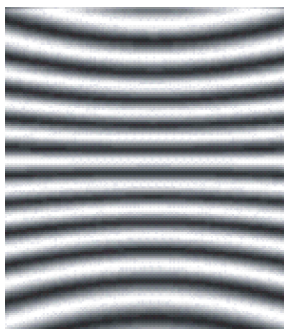
(I)

(P)

The Newton's ring experiment is conducted with light incident from the top. S is almost normal to the plate. Interference is between R_1 and R_2 reflected from top of the thin air film and bottom of the thin air film.
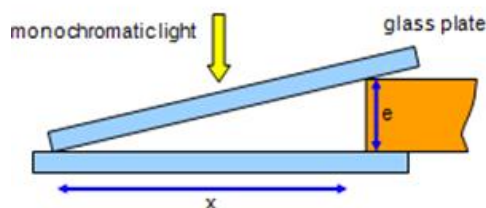
(II)
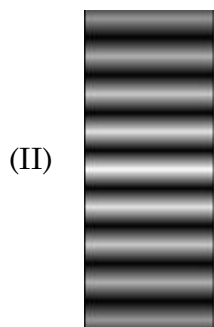
(Q) The setup is same as in option P but the interference is between transmitted waves.

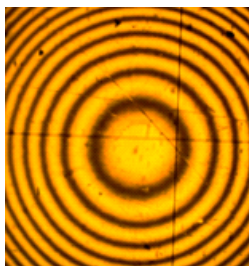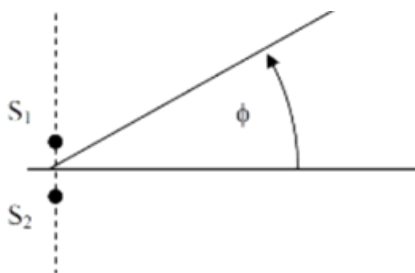**Space for Rough Work**

(III)

(R)

Light is incident normally from the top on a thin film of air between two glass plates.
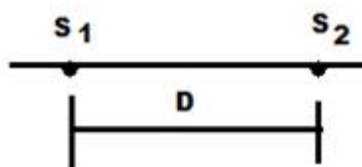
(IV)

(S)

Two point sources S_1 and S_2 are producing interference pattern on a screen parallel to line $S_1 S_2$.

(T)   Young's double slit experiment with slits perpendicular to the screen on which interference is observed.

(U)

Two coherent point sources producing an interference pattern on a screen placed perpendicular to line S_1S_2. D = 5.25 µm.

(A) I → P; II → R,S; III → T; IV → Q   (B) I → P; II → R,S,T; III → Q; IV → R

(C) I → P; II → R; III → S,T; IV → Q   (D) I → P,Q; II → R; III → T; IV → S

Space for Rough Work

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

Interference experiment is conducted with light of wavelength 500 nm. We have possible set ups listed in List II and radius/distance of second dark fringe from the centre/edge of interference pattern in List I. (If the centre or the edge is a dark point, this means the next dark fringe.) Match the appropriate entries.

List-I   **List-II**

(I) 0.86 mm   (P)

The Newton's ring experiment is conducted with light incident from the top. S is almost normal to the plate. Interference is between R_1 and R_2 reflected from top of the thin air film and bottom of the thin air film. Radius of lens is 100 cm.
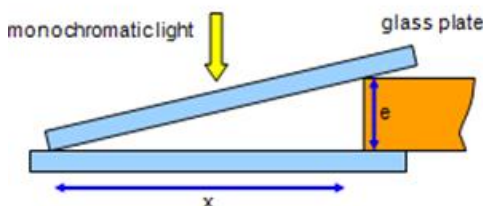
(II) 1 mm   (Q) The setup is same as in option P but the interference is between transmitted waves.
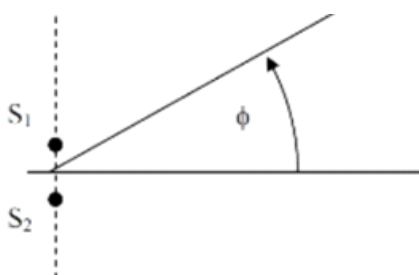
(III) 1.8 mm   (R)

Light is incident normally from the top on a thin film of air between two glass plates. e = 100 μm, x = 40 cm.
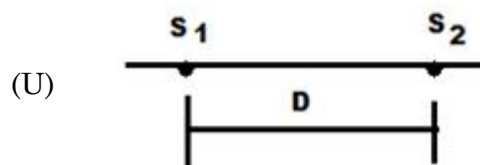
(IV) 3 mm   (S)

Two point sources S_1 and S_2 are producing interference pattern on a screen parallel to line S_1S_2. S_1S_2 = 1mm, screen is at a distance of 2.4 m

Space for Rough Work

(T) Young's double slit experiment with slits perpendicular to the screen on which interference is observed. D = 2 m, d = 0.5 mm

(U)

Two coherent point sources producing an interference pattern on a screen placed perpendicular to line S_1S_2. D = 5.25 μm. Screen is at a distance of 4 m from S_1.

(A) I → Q; II → P,R; III → S; IV → T

(B) I → P; II → Q; III → R; IV → S,U

(C) I → Q; II → P,R; III → U; IV → T

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

Space for Rough Work

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

According to Maxwell's theory, light is electromagnetic wave. Later on, Philip Lonard and his co-workers shared photoelectric effect. This could not be explained by wave theory. It could be explained only by Einstein's photoelectric effect equation. Although Maxwell's theory also predicts that a light beam exerts pressure on a surface, an easier explanation appears from photon theory.

In a photoelectric experiment, light of frequency f is incident on a metal target whose work function is $\phi = \dfrac{hf}{3}$. In list-I, KE of photoelectrons is mentioned at various location/instant and in list-II, the corresponding possible value(s).

Target ⟶ ⟶ Collector

$V = \dfrac{hf}{3e}$
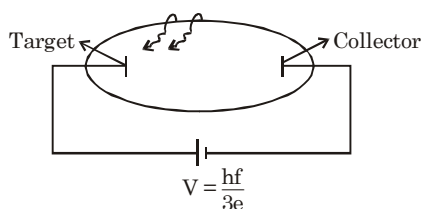
	List-I		List-II
(I)	Maximum K.E. of photoelectrons just after emission	(P)	Zero
(II)	KE of photoelectrons just after emission	(Q)	$\dfrac{hf}{3}$
(III)	KE of photoelectrons when they are halfway between target & collector	(R)	$\dfrac{hf}{2}$
(IV)	KE of photoelectrons as they reach collector	(S)	$\dfrac{2hf}{3}$
		(T)	Can be equal to or more than energy of incident photon
		(U)	Must be less than the energy of incident photon

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

Space for Rough Work

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

According to Maxwell's theory, light is electromagnetic wave. Later on, Philip Lonard and his co-workers shared photoelectric effect. This could not be explained by wave theory. It could be explained only by Einstein's photoelectric effect equation. Although Maxwell's theory also predicts that a light beam exerts pressure on a surface, an easier explanation appears from photon theory.

	List-I		**List-II**
(I)	Bichromatic light source emitting unidirectional light	(P)	Some photons have same energy & momenta
(II)	Point source of white light emitting light uniformly in all directions.	(Q)	Some photons have different energy & momenta
(III)	Point source of monochromatic light emitting light uniformly in all directions	(R)	Some photons have same energy & different momenta
(IV)	Monochromatic laser light source emitting unidirectional light	(S)	Some photons have different energy but same momenta.
		(T)	There is no net force on the light source due to emitted photons.
		(U)	The emitted photons may exert a net force on the light source.

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

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

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

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

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 darken 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   : +3 If ONLY the correct numerical value is entered as answer.
   Zero Marks   : 0 In all other cases.

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1. What must be the temperature (in kilo kelvin) of an ideal blackbody so that photons of its radiated light having the peak-intensity wavelength can excite the electron in the Bohr-model hydrogen atom from the ground state to the third excited state? $b = 2.88 \times 10^{-3}$ mK, hc = 1240 eV nm.

2. The work function of the cathode of a photocell in a circuit is 6×10^{-19} J. Ultraviolet wave of wavelength 250 nm hits the cathode perpendicularly. If we change the frequency of the radiation, at most by what factor can the linear momentum of the emitted electron be greater than that of the entering photon? (Take : $h = 6.6 \times 10^{-34}$ J sec, $m_e = 9 \times 10^{-31}$ kg.)
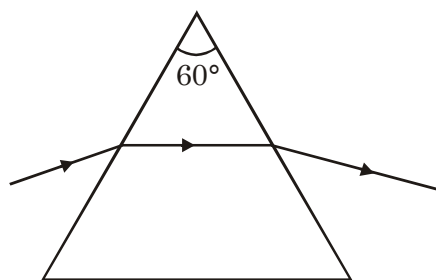

Space for Rough Work

3. A sample of hydrogen atoms are in their ground state, and stationary, when a beam of neutrons of kinetic energy 25.5 eV collides with it. Take mass of hydrogen atom = mass of neutron = 1.6×10^{-27} kg, and 1 eV = 1.6×10^{-19} J. If the collision is head-on, find the maximum possible number of photons of different wavelength that can be emitted after the collision, from the hydrogen atoms. Assume that only a single collision is possible with a hydrogen atom.

4. Assuming a particle to have the form of a sphere and to absorb all incident light, find the radius (in µm) of a particle for which its gravitational attraction to the Sun is counter balanced by the force that light exerts on it. The power of light radiated by the Sun equals

P = 4×10^{26} W and the density of the particle is ρ = 1.0 g/cm³. Use G = $\dfrac{20}{3} \times 10^{-11}$ Nm²/kg²,

$\pi = \dfrac{22}{7}$ and mass of the Sun = 2×10^{30} kg

Space for Rough Work

5. A certain crude oil has an index of refraction of 1.25. A ship dumps $1m^3$ of this oil into the ocean and oil spreads into a thin uniform film on water surface ($\mu = 1.33$). When light of wavelength 500 nm is incident on it, the reflected light shows maxima. What is the area (in km^2) covered by the spilled oil ? Assume that the thickness of film is minimum required to satisfy this criterion.

6. An equilateral glass prism kept on a table has refractive index of $\mu = \sqrt{2}$. It is illuminated by a narrow laser beam having power P_0 and wavelength λ. The path of the laser beam inside the prism is parallel to the base-of the prism. Calculate change in weight of the prism (in gm) due to the incident laser beam. (Take : $P_0 = \sqrt{(2+\sqrt{3})}$ MW)
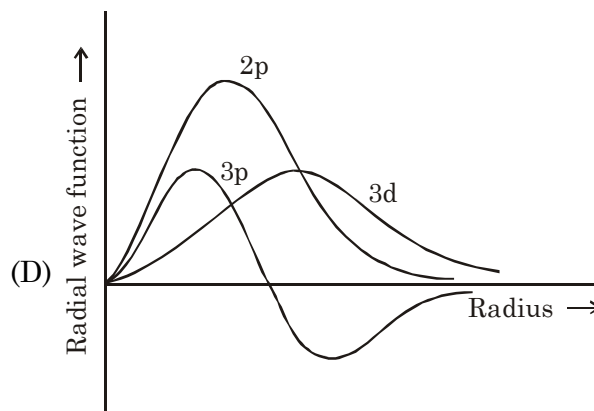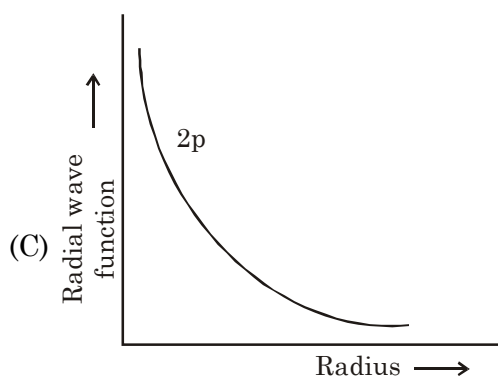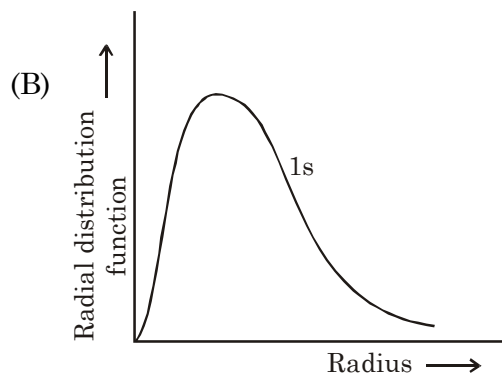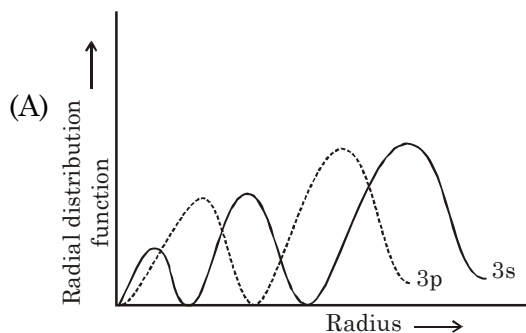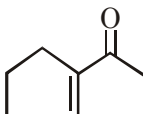

Space for Rough Work

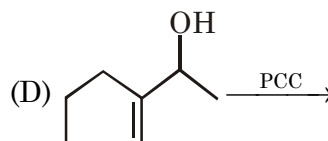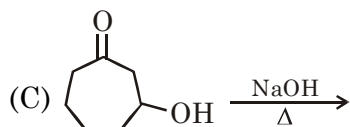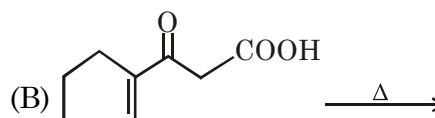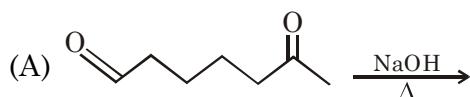# PART-2 : CHEMISTRY

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

● This section contains **EIGHT** questions.
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  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. Which is the correct statement about face centre cubic unit cell of edge length 200 pm ?

(A) Packing fraction of unit cell is 0.74

(B) The radius of largest sphere that can be fitted into voids is 51.75 pm

(C) The distance of nearest neighbours is 141.44 pm

(D) The distance of next neighbours is 200 pm

2. Which of the following information (s) is/are correct ?

(A) q_p is path independent quantity

(B) q_v is path independent quantity

(C) PV # nRT is not applicable in ideal gas undergoing reversible adiabatic expansion

(D) For any pure substance, in any physical state, $C_{p, m}$ is always greater than $C_{v, m}$

Space for Rough Work

3. Which of the following plot is **correct** ?

(A) Radial distribution function vs Radius — curves labeled 3p, 3s

(B) Radial distribution function vs Radius — curve labeled 1s

(C) Radial wave function vs Radius — curve labeled 2p

(D) Radial wave function vs Radius — curves labeled 2p, 3p, 3d

4. Which of the following reaction(s) can produce [cyclopentene with acetyl group] as one of the product ?

(A) [dialdehyde/diketone] $\xrightarrow[\Delta]{\text{NaOH}}$

(B) [cyclopentene with β-keto acid, COOH] $\xrightarrow{\Delta}$

(C) [cycloheptanone with OH] $\xrightarrow[\Delta]{\text{NaOH}}$

(D) [cyclopentene with CH(OH)CH$_3$, OH] $\xrightarrow{\text{PCC}}$

Space for Rough Work

5. Which of the following(s) will give a product with one carbon less than the reactant ?

(A) $MeCOOH \xrightarrow[\text{(iii) Ag}_2\text{O , (iv) H}_2\text{O}]{\text{(i) SOCl}_2\text{ , (ii) CH}_2\text{N}_2}$

(B) $Me–\overset{\overset{\displaystyle O}{\|}}{C}–Cl \xrightarrow[\text{(ii) Aq. KOH ,}\Delta]{\text{(i) NaN}_3}$

(C) $Ph–\overset{\overset{\displaystyle O}{\|}}{C}–NH_2 \xrightarrow[\Delta]{KOH + Br_2}$

(D) $CH_3 – CN \xrightarrow{H^+/H_2O}$
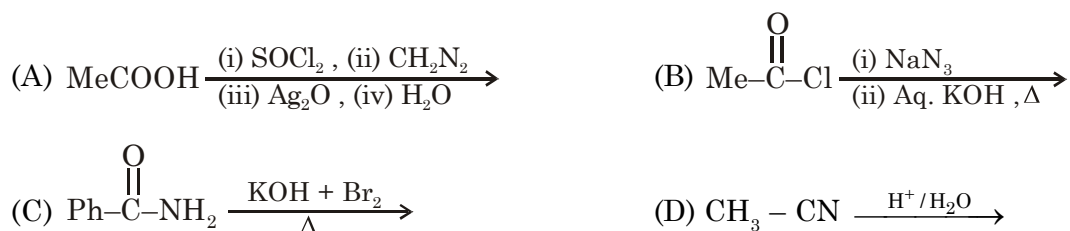
6. Choose correct option(s) for following conversion :
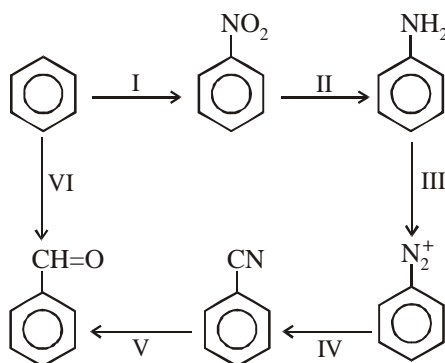
(A) Reagent used for conversion I is HNO_3 / H_2SO_4 and reagent used for conversion II is Sn / HCl

(B) Reagent used for conversion III is $NaNO_2$ + HCl (0–5ºC) and reagent used for conversion IV is CuCN + KCN, Δ

(C) Reagent used for conversion V is $SnCl_2$, HCl, $H_3O^\oplus$

(D) Reagent used for conversion VI is CO, HCl / $AlCl_3$, CuCl

7. Select **CORRECT** statement for H_2O_2 and O_3 both
(A) Both are polar and diamagnetic
(B) Both can oxidise PbS to $PbSO_4$
(C) Both are permanent bleaching agent
(D) When both react to each other O_2 and H_2O produced

8. $R – Cl \xrightarrow[\text{silicon}]{\text{Cu powder}} 'X' \xrightarrow[\text{–HCl}]{\text{+H}_2\text{O}} 'Y' \xrightarrow{\text{Condensation}} 'Z'$
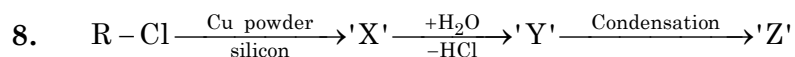
Which of the following option is/are correct for above reaction?
(A) 'X' is called chain stopping unit in the formation of linear silicones.
(B) 'X' can produce cyclic silicones on hydrolysis
(C) After the condensation of 'Y' cross linked silicone is formed.
(D) 'Z' is an organosilicon polymer.

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. **List-I**   **List-II**
   (Oxides of nitrogen)   **(Preparation reaction of oxide of nitrogen and characteristics)**

   (I) N_2O_5 (P) $HNO_3 + P_4O_{10}$

   (II) N_2O_3 (Q) $NO + N_2O_4$ (at −30°C)

   (III) NO   (R) Heating of NH_4NO_3

   (IV) N_2O (S) Blue liquid

                                                    (T) Colourless solid

                                                    (U) Neutral

   Which of the following option has the **CORRECT** combination considering list-I and list-II?

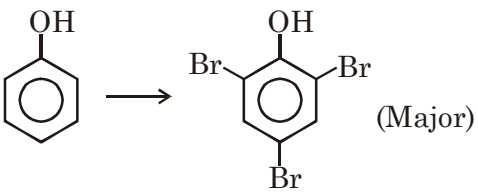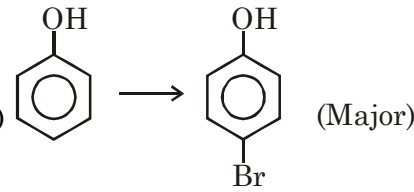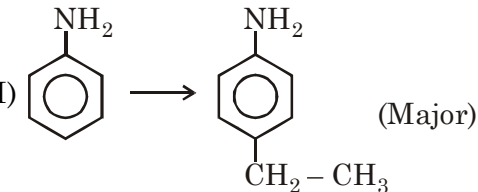   (A) (II), (P)   (B) (III), (R)   (C) (IV), (P)   (D) (II), (Q)
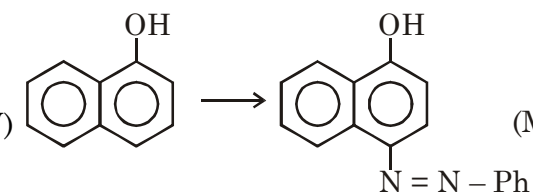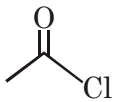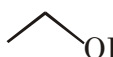
10. **List-I**   **List-II**
    (Oxides of nitrogen)   **(Preparation reaction of oxide of nitrogen and characteristics)**

    (I) N_2O_5 (P) $HNO_3 + P_4O_{10}$

    (II) N_2O_3 (Q) $NO + N_2O_4$ (at −30°C)

    (III) NO   (R) Heating of NH_4NO_3

    (IV) N_2O (S) Blue liquid

                                                    (T) Colourless solid

                                                    (U) Neutral

    Which of the following option has the **INCORRECT** combination considering list-I and list-II ?

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

Space for Rough Work

11. Considering the following reactions in **List-I** and reagents which can be used to covert to get the given conversion are given in **List-II**

List-I	**List-II**

(I) Phenol → 2,4,6-tribromophenol (Major)

(P) Br_2 / CS_2

(II) Phenol → p-bromophenol (Major)

(Q) Br_2 / aq.

(III) Aniline → 4-ethylaniline (CH_2-CH_3) (Major)

(R) $\diagup\!\!\diagdown_{Cl}$, $AlCl_3$

(IV) 1-Naphthol → 4-(phenylazo)-1-naphthol (Major), $N=N-Ph$

(S) $Ph-N_2^+Cl^-$, slightly basic medium

(T) CH_3COCl ($\overset{O}{\underset{Cl}{\|}}$), $AlCl_3$ followed by reduction

(U) $\diagup\!\!\diagdown_{OH}$, H^+

Which of the following has the **CORRECT** combination considering list-I and list-II

(A) (I), (Q)   (B) (II), (Q)   (C) (III), (R)   (D) (III), (T)

Space for Rough Work

12. Considering the following reactions in **list-I** and reagents which can be used to covert to get the given conversion are given in **list-II**

List-I   **List-II**

(I) (Major)   (P) Br_2 / CS_2

(II) (Major)   (Q) Br_2 / aq.

(III) (Major)   (R) Cl, $AlCl_3$

(IV) (Major) (S) $Ph-N_2^+Cl^-$, slightly basic medium

(T) Cl, $AlCl_3$ followed by reduction
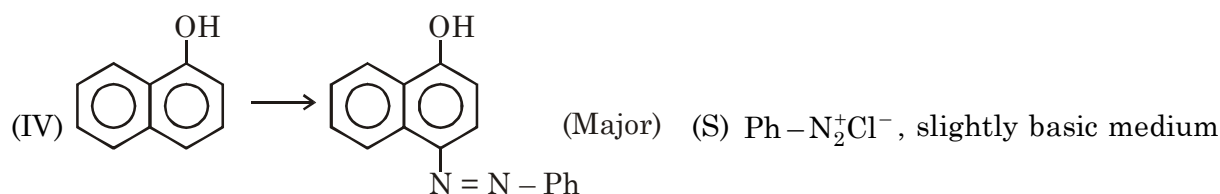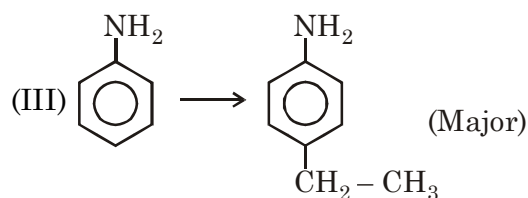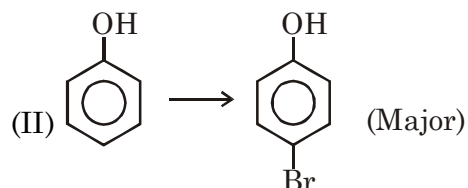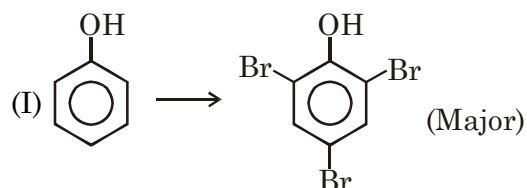
(U) OH, H^+
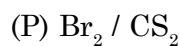
Which of the following has the **INCORRECT** combination considering list-I and list-II

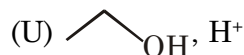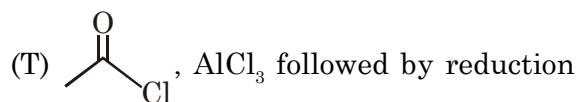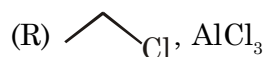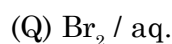(A) (I), (P)   (B) (I), (Q)   (C) (II), (P)   (D) (IV), (S)

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 darken 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 : +3 If ONLY the correct numerical value is entered as answer.
  Zero Marks : 0 In all other cases.

1.

$$A \text{ (molecular formula } C_8H_{10}O \text{ rotates PPL)}$$

Red P + HI → C (Optically inactive)

KMnO$_4$ /Δ → B ($C_7H_6O_2$ molecular formula)
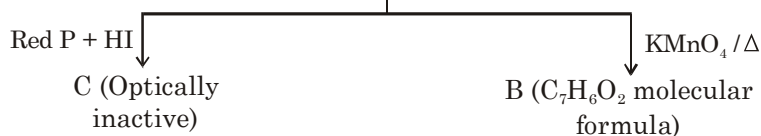
A reacts with I_2 + NaOH to produce Yellow ppt.

$$(A) \xrightarrow{\text{TsCl}} (D) \xrightarrow[\text{KOH /}\Delta]{\text{alcoholic}} (E)$$
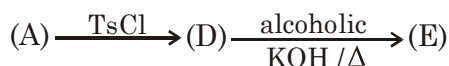
How many statements are correct regarding A ?

(a) (A) gives red color with CAN reagent

(b) (A) reacts with Na metal to give colourless odourless gas

(c) (A) reacts with Lucas reagent to give turbidity after 5-10 mins.

(d) (B) is [benzene ring with CO_2H group]
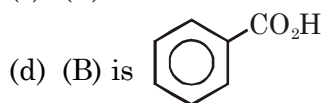
(e) (C) does not react with NBS

(f) (A) gives violet color with neutral $FeCl_3$

(g) (E) decolourise Br_2 / solution

(h) (C) reacts with SeO_2 to convert into (A)

Space for Rough Work

2. At 7°C, the ionic product of heavy water is 1.0×10^{-16}. pD value of heavy water at 7°C is.

3. Given :

$X(g) \longrightarrow 3Y(g)$
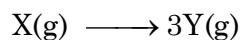
P_t = 400 mmHg : Total pressure after time 70 min

P_{∞} = 600 mmHg : Total pressure after completion

$t_{0.75} = 2 \times t_{0.5}$

Calculate rate constant of appearance of Y in minute^{-1}

given ln2 = 0.7

4. A sample of iron oxide has FeO and Fe_2O_3 in the mole ratio of 2:1. It is partially oxidised to change this ratio to 1:2. Number of moles of FeO oxidised per mole of initial mixture is:

Space for Rough Work

ALLEN

5. Consider the following reactions :

$NH_3 + H_2O + CO_2 \longrightarrow$ 'P'

'P' $+ H_2O + CO_2 \longrightarrow$ 'Q'

'Q' $+ NaCl \longrightarrow$ 'R' + 'S'$_{(Solid)}$

'R' + lime water $\longrightarrow$ 'T'$_{(g)}$ + other products in balance reaction
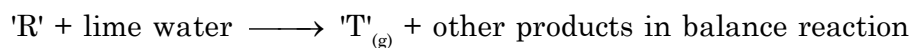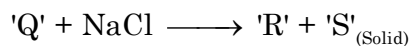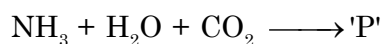
Find the sum of the molecular weight of compound 'S' + 'T' + other products.
Given atomic weight of H = 1, Cl = 35.5, N = 14, Na = 23, O = 16, Ca = 40, C = 12

6. How much percentage loss is incurred when $KMnO_4$ is prepared by dilution of K_2MnO_4 solution if 100% conversion takes place.

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. Let $P(n) = \sum_{r=0}^{n} \frac{(-1)^r r}{r+1} {}^nC_r$. Now which of the following holds good -

(A) $|P_{10}|$ is harmonic mean of $|P_9|$ & $|P_{11}|$

(B) $\sum_{r=5}^{10} P(r)P(r-1) = -\frac{6}{55}$

(C) $|P_{10}|$ is arithmetic mean of $|P_9|$ & $|P_{11}|$

(D) $\sum_{r=5}^{10} P(r)P(r-1) = \frac{6}{55}$

2. Let z be a complex number such that $|2z + 3i| = |z^2|$.

Identify the correct statement(s)

(A) $|z|_{maximum}$ is equal to 3.

(B) $|z|_{minimum}$ is equal to 1.

(C) If $|z|$ is maximum when $z = \alpha + i\beta$ ($\alpha, \beta \in R$ and $i = \sqrt{-1}$) then $(\alpha^3 + \beta^3)$ is equal to 27.

(D) If $|z|$ is minimum when $z = x + iy$ (x, y $\in$ R and $i = \sqrt{-1}$) then $(x^2 + 2y^2)$ is equal to 2.

Space for Rough Work

ALLEN

3. Let P be a 2 × 2 matrix such that $P\begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$ and $P^2\begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$. The value(s) of p for which

det(P – pI) = 0, where I is an identity matrix of order 2, is/are

[**Note :** det(M) denotes determinant of square matrix M]

(A) 0   (B) –1   (C) 1   (D) 2

4. Let A be a fourth order diagonal matrix whose entries are complex numbers such that $A^4 = I_4$.
If trace of A is zero then (here I_4 is fourth order unit matrix)

(A) There exist 24 such matrices A

(B) There exist 36 such matrices A

(C) Determinant value of all such matrices is 1

(D) Determinant value of all such matrices is –1

5. A, B & C be three points in space such that A ≡ (3, 4, 2), B ≡ (3, 0, 2) & C ≡ (5, 0, 0), then :-

(A) distance of orthocentre of ΔABC from origin is $\sqrt{13}$

(B) the position vector of circumcentre of ΔABC is $4\hat{i} + 2\hat{j} + \hat{k}$

(C) if point D forms parallelogram with remaining three points, then D ≡ (5, 4, 0)

(D) If point D forms parallelogram with remaining three points then D ≡ (5, – 4, 0)

Space for Rough Work

6. Tangents are drawn from any point on straight line $y = x + 8$ to the auxiliary circle of $x^2 + 16y^2 = 16$. If A and B are the points of contact of these tangent and P, Q are corresponding points of A and B on the ellipse respectively. The locus of mid point of PQ is

(A) a pair of lines   (B) a parabola   (C) an ellipse   (D) a hyperbola

7. Equation of a minor axis of an ellipse is $x + 2y = 3$ and length of minor axis is $\sqrt{5}$, foot of directrix is $(2, 3)$, then

(A) equation of ellipse is $4(2x - y - 1)^2 + 2(x + 2y - 3)^2 = 25$

(B) eccentricity of ellipse is $\dfrac{1}{\sqrt{2}}$

(C) major axis is $\sqrt{10}$

(D) length of LR is $\dfrac{\sqrt{5}}{\sqrt{2}}$

8. If the complex numbers z_1, z_2, z_3 and z_4, in order, are vertices of a quadrilateral such that $5z_1 - 6z_2 + 3z_3 - 2z_4 = 0$ and $5|z_1 - z_4|^2 = 9|z_2 - z_3|^2$ then which of the following is/are correct.

(A) z_1, z_2, z_3 and z_4 are vertices of a rectangle.

(B) The line segment joining z_1 and z_3 divides the line segment joining z_2 and z_4 in the ratio $1 : 3$.

(C) The line segment joining z_2 and z_4 divides the line segment joining z_1 and z_3 in the ratio $3 : 5$.

(D) z_1, z_2, z_3 and z_4 are concyclic.

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 variable tangent to the circle $(x - 1)^2 + (y - 1)^2 = 1$ meets x-axis & y-axis at points A and B respectively. If locus of centroid of ΔOAB (O being origin) is a conic S, then

	List-I		**List-II**
(I)	Center of S is at	(P)	$(0,0)$
(II)	Eccentricity of S is	(Q)	$\left(\dfrac{2}{3},\dfrac{2}{3}\right)$
(III)	Focus of S can lie at	(R)	$\left(\dfrac{4}{3},\dfrac{4}{3}\right)$
(IV)	Ordinate of vertex of S can be	(S)	$\dfrac{2}{3}\left(1+\dfrac{1}{\sqrt{2}}\right)$
		(T)	$\dfrac{2}{3}\left(1-\dfrac{1}{\sqrt{2}}\right)$
		(U)	$\sqrt{2}$

Which of the following is the only CORRECT combination ?

(A) (I), (P) (B) (I), (Q) (C) (II), (S) (D) (II), (T)

Space for Rough Work

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

Let a variable tangent to the circle $(x - 1)^2 + (y - 1)^2 = 1$ meets x-axis & y-axis at points A and B respectively. If locus of centroid of ΔOAB (O being origin) is a conic S, then

	List-I		**List-II**
(I)	Center of S is at	(P)	$(0,0)$
(II)	Eccentricity of S is	(Q)	$\left(\dfrac{2}{3},\dfrac{2}{3}\right)$
(III)	Focus of S can lie at	(R)	$\left(\dfrac{4}{3},\dfrac{4}{3}\right)$
(IV)	Ordinate of vertex of S can be	(S)	$\dfrac{2}{3}\left(1+\dfrac{1}{\sqrt{2}}\right)$
		(T)	$\dfrac{2}{3}\left(1-\dfrac{1}{\sqrt{2}}\right)$
		(U)	$\sqrt{2}$

Which of the following is the only **INCORRECT** combination ?

(A) (III), (P)   (B) (III), (R)   (C) (IV), (T)   (D) (IV), (U)

Space for Rough Work

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

Let C : $(x - h)^2 + (y - k)^2 = r^2$ is a circle which touches hyperbola $H:\dfrac{x^2}{2}-y^2=1$ either at one or two points (r > 0).

List-I and List-II provides the centre and radius respectively of circle C.

	List-I		**List-II**
(I)	(–1,0)	(P)	$\sqrt{2}-1$
(II)	$\left(\sqrt{3},0\right)$	(Q)	$\dfrac{2}{\sqrt{3}}$
(III)	$\left(\sqrt{7},0\right)$	(R)	$\sqrt{3}-\sqrt{2}$
(IV)	(0,3)	(S)	$2\sqrt{2}$
		(T)	$\sqrt{2}+1$
		(U)	$\sqrt{3}+\sqrt{2}$

Which of the following is the only **INCORRECT** combination ?

(A) (I), (P) (B) (I), (T) (C) (II), (R) (D) (II), (S)

Space for Rough Work

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

Let $C : (x - h)^2 + (y - k)^2 = r^2$ is a circle which touches hyperbola $H : \dfrac{x^2}{2} - y^2 = 1$ either at one or two points (r > 0).

List-I and List-II provides the centre and radius respectively of circle C.

List-I		**List-II**	
(I)	(–1,0)	(P)	$\sqrt{2} - 1$
(II)	$\left(\sqrt{3}, 0\right)$	(Q)	$\dfrac{2}{\sqrt{3}}$
(III)	$\left(\sqrt{7}, 0\right)$	(R)	$\sqrt{3} - \sqrt{2}$
(IV)	(0,3)	(S)	$2\sqrt{2}$
		(T)	$\sqrt{2} + 1$
		(U)	$\sqrt{3} + \sqrt{2}$

Which of the following is the only **CORRECT** combination ?

(A) (III), (S) (B) (III), (Q) (C) (IV), (T) (D) (IV), (U)

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 darken 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   : +3 If ONLY the correct numerical value is entered as answer.
  Zero Marks   : 0 In all other cases.

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1. Given $\theta \in \left(0, \dfrac{\pi}{2}\right)$ such that $\cos\theta = \dfrac{1}{3}$, then the value of $\left[\displaystyle\lim_{n\to\infty}\sum_{k=0}^{n}\dfrac{\cos k\theta}{5^k}\right]$ is equal to

(where [.] denotes greatest integer function)

2. If $\hat{p}\times 2\hat{q} + 2\hat{r} = 2\hat{q} + \hat{p}\times 2\hat{r}$, then $\left|3\hat{p} + 2\hat{q} - 2\hat{r}\right|$ is equal to (where $\hat{p}, \hat{q}, \hat{r}$ are unit vectors)

3. Volume of parallelopiped formed by planes $2x + 2y + z = 4$, $2x + 2y + z = 1$, $2x - y + z = 3$, $2x - y + z = 6$, $3x + 4y + 12z = -1$, $3x + 4y + 12z = 12$ is

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Space for Rough Work

4. Let $F(z) = \dfrac{z+i}{z-i}$ for all complex numbers $z \neq i$ and consider $z_n = F(z_{n-1})$ for all positive integers n. Given that $z_0 = 2 + i$, So $|z_{2020}|$ is equal to

5. Let A,B and C are three points on ellipse $\dfrac{x^2}{25} + \dfrac{y^2}{16} = 1$ where line joining A & C is parallel to the x-axis and B is end point of minor axis whose ordinate is positive then maximum area of ΔABC, is-(take $\sqrt{3} = 1.73$)

6. PABC is a tetrahedron such that $\angle APB = \angle BPC = \angle CPA = 90^\circ$. If the sum of its six edges is constant S and let maximum volume of the tetrahedron be $\dfrac{5\sqrt{2}-7}{k}S^3$, then k is equal to

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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)	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.	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 Candidate	_____ Signature of the Invigilator