VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Advanced Home Practice Test -2 | Paper -1 | JEE 2024

Date: 23/04/2024 **Maximum Marks: 180**

Duration : 3.0 Hours

General Instructions

1. The question paper consists of 3 Subject (Subject I: **Physics**, Subject II: **Chemistry**, Subject III: **Mathematics**). Each Part has **three** sections (Section 1, Section 2 & Section 3).

2. **Section 1** contains **8 Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.

   Section 2 contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

   Section 3 contains **FOUR (04)** Matching List sets. Each set has **TWO** lists: **List I** and **List II**.
   Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

3. For answering a question, an ANSWER SHEET (OMR SHEET) is provided separately. Please fill your **Test Code, Roll No.** and **Group** properly in the space given in the ANSWER SHEET.

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

Candidate's Signature : _____ **Invigilator's Signature** _____

MARKING SCHEME

SECTION – 1 | (Maximum Marks: 24)

- This section contains **Eight (08) Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks: +3 **ONLY** if the correct numerical value is entered.

Zero Mark: 0 In all other cases.

SECTION – 2 | (Maximum Marks: 24)

- This section consists of **Six (06)** Questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- 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 and both of which are correct

Partial Marks: +1 If two or more options are correct but ONLY one option is chosen, and it is a correct option

Zero Mark: 0 if none of the options is chosen (i.e. the question is unanswered)

Negative Marks: –2 In all other cases.

SECTION – 3 | (Maximum Marks: 12)

- This section contains **Four (04**) Matching List sets. Each set has **TWO** lists: **List I** and **List II**.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme.

Full Marks : +3 If ONLY the correct option 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.

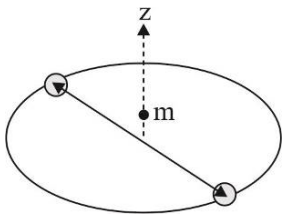
SUBJECT I : PHYSICS 60 MARKS

SECTION 1

NUMERICAL VALUE TYPE

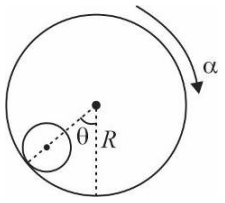
This section contains **8 Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.

1. Two stars, each of mass M and separated by some distance, orbit about their centre of mass. A planetoid of mass $m(m << M)$ moves along the axis of this system perpendicular to the orbital plane. Let T_P be the period of simple harmonic motion for the planetoid for small displacement from the center of mass along the z-axis and let T_s be the period of motion for the two stars. The ratio $\left(\frac{T_s}{T_p}\right)^2$ is ____.

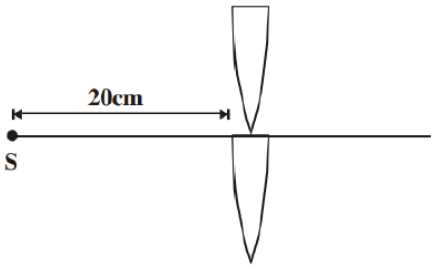


2. Peak emission from a black body at a certain temperature occurs at a wavelength of 4000Å. On increasing its temperature, the total radiation emitted is increased to 256 times. These radiations are allowed to fall on a metal surface. The photoelectrons emitted by peak emission wavelength at higher temperature can be brought to rest by applying a potential which is equivalent to the excitation potential corresponding to the transition from level $n = 2$ to level $n = 4$ in a singly ionized Helium atom (obeys Bohr's Model). The work function of the metal (in eV) is _____.
[Given $hc = 1240\ eV \cdot nm$, ionization energy of hydrogen atom = 13.6 eV]

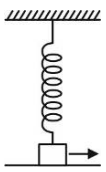
3. A uniform sphere of mass $m = 2$ kg rolls without slipping on the inside of a cylinder of radius $R = 2$ m. The cylinder spins around its axis (which points horizontally) with angular acceleration α. What should α (in rad/s^2) be if it is desired that the centre of the sphere to remain motionless at an angle $\theta = 30°$ from the vertical. (Take $g = 10\text{m/s}^2$)



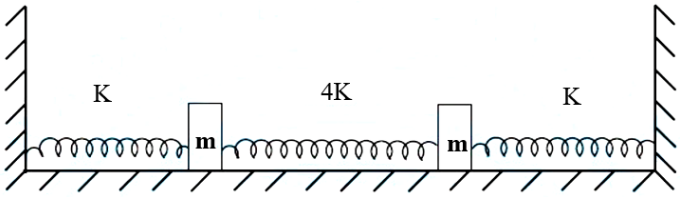
4. A convex lens of focal length 12 cm and 4 mm aperture diameter is cut into two equal halves and are placed as shown in the figure. A point source S is placed on the principal axis of the lens at a distance 20 cm from the lens as shown in the figure. Find the separation (in mm) between the images formed.



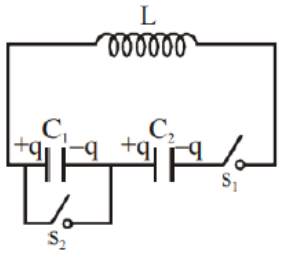
5. A spring is attached with a small block of mass m and a fixed ceiling. The block is lying on a smooth horizontal table and initially the spring is vertical and unstretched. Natural length of the spring is $3l_0$. A constant horizontal force F is applied on the block so that it moves in the direction of force. When length of the spring becomes $5l_0$, block is about to leave contact with the table, and its velocity at that instant is zero. Then ratio $\frac{mg}{F}$ is _____.



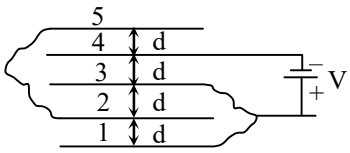
6. In the figure shown, two identical blocks each of mass m are connected to three massless springs of same natural length 'l_0' each. If both the blocks are displaced slowly by x_0 each from their mean position and released, then the time period of oscillation of each block is $T_1 = 2\pi\sqrt{\frac{m}{aK}}$, when they are oscillating in opposite phase and $T_2 = 2\pi\sqrt{\frac{m}{bK}}$ when they are oscillating in same phase, then $a \times b =$ _____.



7. Two capacitors C_1 and C_2 of capacitance $\frac{1}{\pi^2} \times 10^{-2} F$ each and an inductor L of inductance $2 \times 10^{-2} H$ are connected in series as shown in the figure. Initially charge on each capacitor is $4\sqrt{3}\mu C$. At $t = 0$ switch S_1 is closed and at $t = \frac{1}{400}$ sec, switch S_2 is also closed. The maximum charge on capacitor C_2 during LC oscillation is $n\sqrt{2}\mu C$. The value of n is _____.



8. Five identical large conducting plates each of area A are placed parallel to each other at separation d. Plates 1 and 3 are connected by thin conducting wire and plate 2 and 5 are connected by another thin conducting wire. The junction of plate 1 and 3 and plate 4 are connected by a battery of emf V as shown.



The system is in steady state. Now, plate 4 is moved upward slowly so that it comes in contact with plate 5. The amount of work done by battery during motion of plate 4 is x mJ. (Here $\frac{\in_0 A}{d} = 30\mu F, V = 10$ volts). Find the value of x.

SPACE FOR ROUGH WORK

SECTION 2

MULTIPLE CORRECT ANSWERS TYPE

This Section contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

9. Potential energy of a particle of mass m moving along x-axis under the action of a single conservative force varies with x as $u = u_0 \sin ax$, where u_0 and a are positve constants. Initially particle is projected with speed v_0 from the position $x = x_0$. Which of the following statement(s) is(are) correct?

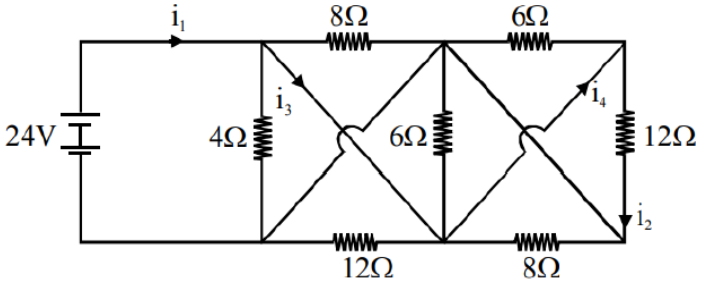
(A) If $x_0 = 0$ and $v_0 = 0$, particle will remain at rest

(B) If $x_0 = 0$ and $v_0 = 0$, particle will perform oscillatory motion between $x = 0$ and $x = -\frac{\pi}{a}$

(C) If $x_0 = 0$ and $v_0 = 2\sqrt{\frac{u_0}{m}}$, particle will continue to travel for a long time

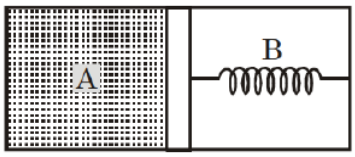
(D) If $x_0 = +\frac{\pi}{2a}$, particle's motion will be SHM for small displacements

10. For the circuit shown in the figure, which of the following option(s) is(are) correct?



(A) $i_1 = 24A$ **(B)** $i_2 = 2A$ **(C)** $i_3 = 15A$ **(D)** $i_4 = 6A$

11. A thermally insulated chamber of volume $2V_0$ is divided by a frictionless and insulated piston of cross section area S into two equal parts A and B. Part A has an ideal diatomic gas at pressure P_0 and temperature T_0 and in part B is vacuum. A massless spring of force constant K is connected with the piston and the wall of the container as shown. Initially the spring is unstretched. The ideal gas in chamber A is allowed to expand slowly with the help of an external agent. After achieving equilibrium state, external agent is removed. Let in equilibrium the spring be compressed by a length x_0, then which of the following statement(s) is(are) correct?



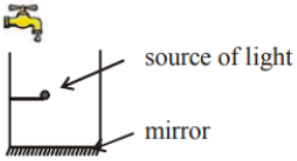
(A) Final pressure of the gas is $\frac{Kx_0}{S}$

(B) Work done by the gas is $\frac{5\left[P_0V_0 - kx_0^2 - \frac{kx_0V_0}{S}\right]}{2}$

(C) Magnitude of change in internal energy of the gas is $\frac{1}{2}kx_0^2$

(D) Work done by the external agent is $\frac{5V_0\left[\frac{kx_0}{S} - P_0\right]}{2} + 3kx_0^2$

12. A small source of light is mounted inside a cylindrical container of height h. The bottom of the container is covered with a mirror. Initially, the container is empty. Then a clear liquid with the index of refraction n is slowly poured into the container. The level of liquid H rises steadily, reaching the top of the container in time T. Let h_1 be the distance of source of the light from the bottom of the container. Consider paraxial ray approximation.



Consider two cases in which the observer is in the air observing the image of the source in the mirror.

(1) $H \le h_1$ (2) $h_1 \le H \le h$

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

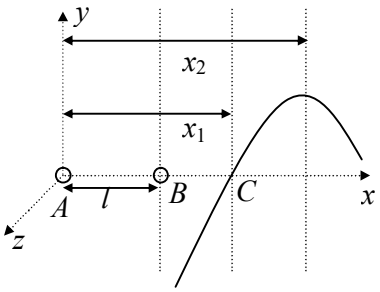
(A) The speed of the image of the source in case (1) during this process is $\frac{2h}{T}\left(1-\frac{1}{n}\right)$

(B) The speed of the image of the source in case (2) during this process is $\frac{h}{T}\left(1-\frac{1}{n}\right)$

(C) The speed of the image of the source in case (1) during this process is $\frac{h}{2T}\left(1-\frac{1}{n}\right)$

(D) The speed of the image of the source in case (2) during this process is $\frac{h}{2T}\left(1-\frac{1}{n}\right)$

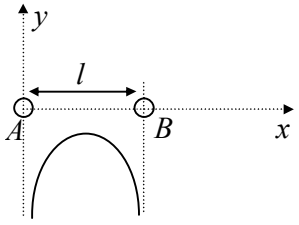
13. Two infinite long wires A and B carrying currents $2I$ and I are placed parallel to each other at $x=0$ and $x=l$ respectively. The magnetic field to the right of the wire B on the line that passes through the two wires varies as shown in figure (here magnetic field is plotted on y-axis). Which of the following statement(s) is(are) correct?



(A) current in A is along positive z-axis and current in B is along negative z-axis

(B) except point C and infinity, the magnetic field intensity is not zero at any point on the line joining A and B

(C) magnetic field intensity between A and B on the line joining A and B varies as



(D) value of x_1 and x_2 are $2l$ and $l(\sqrt{2}+2)$ respectively

14. A cylindrical tube of length L and radius of cross-section R carries a steadily flowing liquid of density ρ and viscosity η. The profile of the velocity of flow is given by $v = v_0\left(1-\frac{r^2}{R^2}\right)$, where *r* is the radial distance of the flowing liquid from the axis. Then, Which of the following statement(s) is (are) correct?

(A) Kinetic energy of the fluid within the volume of the tube is $\frac{\pi}{6}\rho L v_0^2 R^2$

(B) Frictional force exerted on the tube by the fluid is $6\pi\eta R v_0$

(C) Pressure difference between the ends of the tube is proportional to ηv_0

(D) Rate of flow of liquid is directly proportional to kinetic energy of the fluid

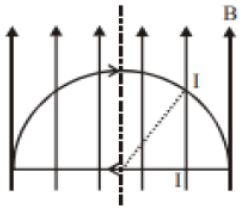
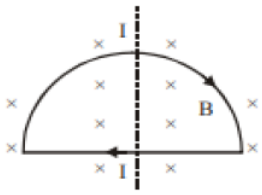
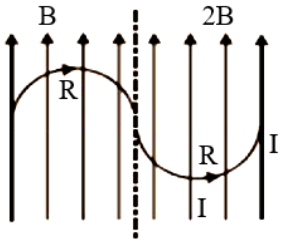
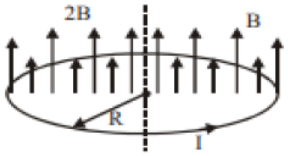
SPACE FOR ROUGH WORK

SECTION - 3

MATCHING LIST TYPE

This section contains **4** Matching List sets. Each set has **TWO** lists: **List I** and **List II**. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

15. In Column-I, certain arrangement of current carrying wires are kept in a uniform magnetic field. In column-II, force F acting on the wire and its torque τ about the dotted axis, is mentioned. Choose the correct match.

Column I		**Column II**	
I.		**P.**	$F \neq 0,\ \tau \neq 0$
II.		**Q.**	$F = 0,\ \tau \neq 0$
III.	 Magnetic field in left half region is B and in the right half is 2B (both uniform)	**R.**	$F = 0,\ \tau = 0$
IV.	 Magnetic field in left half region is B and in the right half is 2B (both uniform)	**S.**	$F \neq 0,\ \tau = 0$

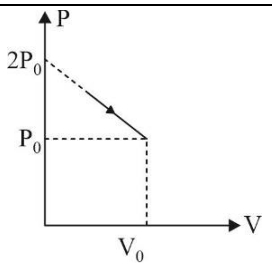
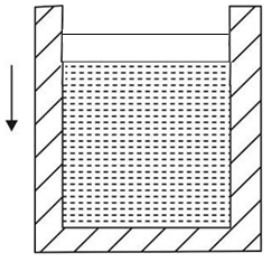
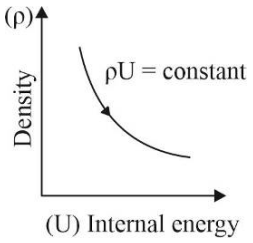
(A) I – Q ; II – S ; III – P ; IV – R
(B) I – R ; II – Q ; III – P ; IV – S
(C) I – Q ; II – R ; III – P ; IV – S
(D) I – R ; II – S ; III – P ; IV – R

16. An eagle is flying horizontally at $30\,ms^{-1}$, $100\,m$ above the ground. It was carrying a mouse in its grasp, which is released at a certain instant. The eagle continues on its path at the same speed for 2 s before attempting to retrieve its prey. To catch the mouse it dives in a straight line at constant speed and recaptures the mouse 20 m above the ground. Choose the correct match $(g = 10\,ms^{-2})$

Column I		Column II	
I.	The diving speed of the eagle (in ms^{-1})	**P.**	4
II.	Diving distance of the eagle (in m)	**Q.**	100
III.	Mouse's free fall time (in second)	**R.**	37
IV.	Angle made by eagle with vertical during descent (in degrees)	**S.**	50
		T.	53

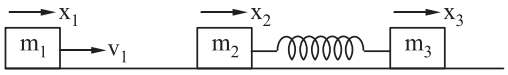
(A) I – Q ; II – S ; III – P ; IV – R **(B)** I – S ; II – Q ; III – P ; IV – R
(C) I – Q ; II – S ; III – P ; IV – T **(D)** I – S ; II – Q ; III – P ; IV – T

17. Match the following Column I and II.

Column I		Column II	
I.	A monatomic gas expands according to the process $P/T^{5/2} = \text{constant}$	**P.**	Temperature of the gas increase
II.		**Q.**	Temperature of the gas decreases
III.	 Piston and all walls are thermally insulated and the piston is slowly moving downward	**R.**	No heat exchange with the gas
IV.		**S.**	Heat is absorbed by the gas

(A) I – Q,R ; II – P,S ; III – P,R ; IV – P,S **(B)** I – Q,R ; II – P,R ; III – P,S ; IV – P,S
(C) I – P,R ; II – Q,R ; III – P,R ; IV – P,S **(D)** I – P,R ; II – P,S ; III – Q,R ; IV – P,S

18. Figure shows a system of three blocks of equal masses on a smooth horizontal surface. Mass m_1 hits m_2 with perfectly inelastic impact, with initial velocity $v_1 = v$. Initially masses m_2 and m_3 are at rest and the spring is relaxed. After impact, the displacements of m_2 and m_3 are x_2 and x_3 respectively and their velocities are v_2 and v_3. v_{cm} is the velocity of centre of the mass of the system. Now match the entries in column I with those relevant entries in column II.



Column-I		Column-II	
(I)	When $v_3 = 0$	**(A)**	$v_{cm} = \frac{v}{3}$
(II)	When $x_2 = x_3$	**(B)**	Potential energy is minimum
(III)	When $v_2 = \frac{v}{6}$	**(C)**	Total kinetic energy is maximum
(IV)	When $v_2 = v_3 = \frac{v}{3}$	**(D)**	$v_3 = \frac{2v}{3}$
		(E)	Potential energy is maximum

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

SPACE FOR ROUGH WORK

SUBJECT II : CHEMISTRY — 60 MARKS

SECTION 1

NUMERICAL VALUE TYPE

This section contains **8 Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.

1. Magnitude of $\Delta_{Lattice}H°$ for $Ca_3N_2(kJ/mol)$ is _____.

Given :

$\Delta_{sub}H°$ for calcium = 100 kJ/mol

$\Delta_fH°$ for $Ca_3N_2 = 500$ kJ/mol

1st ionization energy of calcium = 50 kJ/mol

2nd ionization energy of calcium = 70 kJ/mol

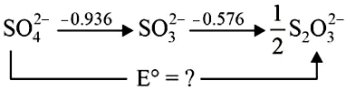
1st electron gain enthalpy of nitrogen = 50 kJ/mol

2nd electron gain enthalpy of nitrogen = 70 kJ/mol

3rd electron gain enthalpy of nitrogen = 100 kJ/mol

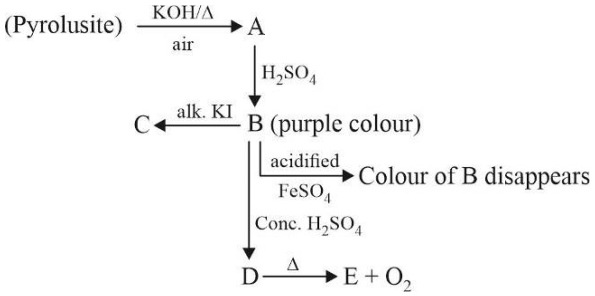
Bond dissociation energy of $N_2 = 25$ kJ/mol

2. Consider the standard reduction potentials (in volts) as shown in figure. If $x = -1000\,E°$. Find x?



3. A weak base BOH was titrated against HCl. The pH at 1/4th equivalence point was 9.24. Strong base was now added (6m.eq) to completely convert the salt. The total volume of solution was 50 mL. Calculate pH at this point.

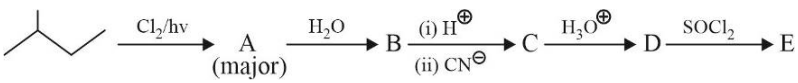
4.



Find the oxidation state of metal in compound 'E'.

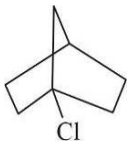
5. 2.48 g of white phosphorus is reacted with thionyl chloride to give an oxide of sulphur 'A'. This compound 'A' isolated and titrated with $KMnO_4$ in acidic medium. Find number of milli moles of $KMnO_4$ required to completely consume compound 'A'.

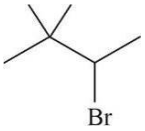
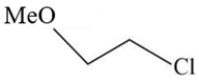
6.



On estimation of chlorine in 2.69 gm of E using Carius method, the amount of AgCl formed (in gm) is _____. [Given : Atomic mass of C = 12, H = 1, Cl = 35.5, O = 16, Ag = 108]

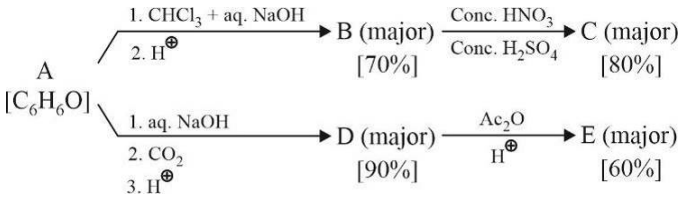
7. Number of compounds which can follow 1st order kinetic when treated with aqueous NaOH is _____.

(i) t-pentyl chloride (ii)  (iii) p-nitrochlorobenzene

(iv)  (v)  (vi) Fluoromethane

(vii) Monomer of PVC (viii) allyl iodide

8.



Given that A gives positive neutral $FeCl_3$ test, if each of the given reaction sequence is carried out with 10 moles of A, the sum of total amount of oxygen (in gm) present in C and E is _____. The yields of B, C, D & E are given in parentheses. [Given : Atomic mass of O = 16]

SPACE FOR ROUGH WORK

SECTION-2

MULTIPLE CORRECT ANSWERS TYPE

This Section contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

9. Incorrect order among following is/are :

(A) $OCl_2 < OF_2$: Bond angle

(B) $HF > H_2O > NH_3$: Boiling point order

(C) $O(CH_3)_2 = O(SiH_3)_2$: % S character in hybrid orbital of oxygen

(D) $CHF_3 < CHCl_3$: Acidic character

10. Identify the statement which is correct w.r.t surface phenomenon

(A) If on adding electrolyte in an emulsion, the conductivity increases then it will be oil in water type emulsion

(B) Macromolecular colloids are generally lyophobic in nature

(C) Gases which can react with absorbents are generally chemisorbed

(D) Chemisorption is favoured by very high temperature and large surface area

11. Which of the following are correct statement?

(A) The hydrometallurgy process of extraction of silver metal is based on complex formation

(B) Cinnabar ore is concentrated by froth flotation

(C) The process of converting hydrated alumina into alumina is calcination

(D) In alumino-thermite, Al is used as a reducing agent

12. Which of the following statement is/are correct?

(A) Nickel salts give rose red ppt with dimethyl glyoxime in excess of NH_4OH

(B) Fe(III) salt produce red colour with potassium thiocynate

(C) In nitroprusside, the iron and NO exist as Fe(III) and NO

(D) When ammonium dichromate is heated green colour chromium oxide is formed and colourless gas is released

13. Diphenyl acetylene $\xrightarrow[2.\ Zn]{1.\ O_3}$ P $\xrightarrow[2.\ H^+]{1.\ Conc.\ KOH}$ Q $\xrightarrow{H_3O^+}$ R

The correct statement(s) is/are :

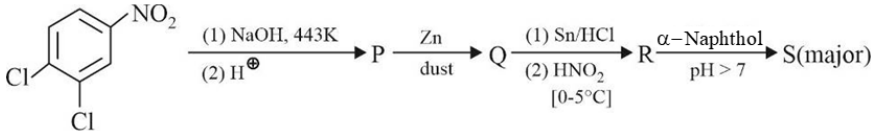
(A) Number of rings in R is 5

(B) Formation of Q from P is similar to aldol condensation

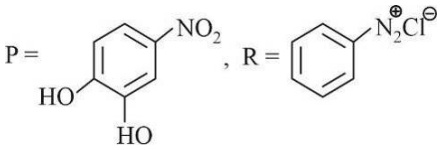
(C) Number of ester linkages in R is 2

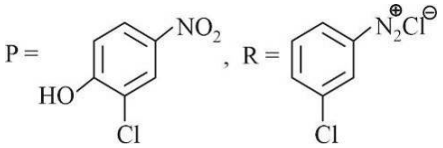
(D) Formation of R from Q is completely intramolecular esterification reaction

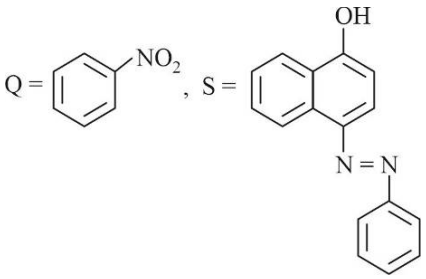
14.

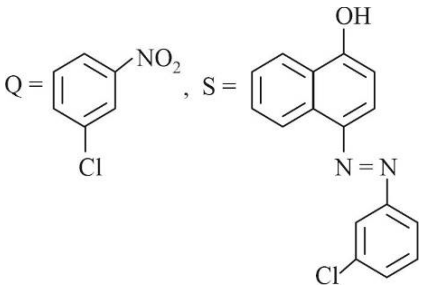


The correct option(s) is/are :

(A) 

(B) 

(C) 

(D) 

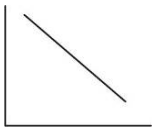
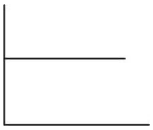
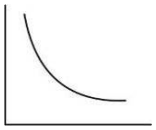
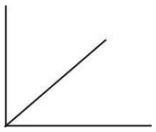
SPACE FOR ROUGH WORK

SECTION - 3

MATCHING LIST TYPE

This section contains **4** Matching List sets. Each set has **TWO** lists: **List I** and **List II**. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

15. Match the following columns:

Column I (Graphs for reaction : A → Products)		**Column II (Co-ordinates, y-axis vs x-axis)**	
I.		**P.**	ln[A] vs t (order = 1)
II.		**Q.**	$t_{1/2}$ vs $[A_0]$ (order =1)
III.		**R.**	r vs t (order = 0)
IV.		**S.**	$t_{1/2}$ vs $[A_0]$ (order > 1)
		T.	r vs [A] (order = 1)

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

16. Match the following columns

Column I		**Column II**	
I.	Metal sulphate $\xrightarrow{\Delta}$ Metal oxide + $SO_2 + O_2$	**P.**	Ba
II.	Metal cation $+K_2CrO_4 \longrightarrow$ Yellow ppt	**Q.**	Sr
III.	Metal $+ NH_3 \xrightarrow{\text{Liquid}}$ Blue solution	**R.**	Na
IV.	$MCl_2 +$ Conc. $H_2SO_4 \longrightarrow$ White ppt	**S.**	Mg

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

17. Match the complexes in column I with Column II

Column I		Column II	
I.	$[CoCl_3(NH_3)_3]$	**P.**	Show facial form
II.	$[Cr(OX)_3]^{3-}$	**Q.**	Compound can be optically active
III.	$[CrCl_2(OX)_2]$	**R.**	Trans-form is optically inactive
IV.	$[RhCl_3(Py)_3]$	**S.**	Show meridional form
		T.	Do not show geometrical isomerism

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

18. Match the compound in Column I with the observation in Column II and choose the correct option :

Column I		Column II	
I.	o-Nitrophenol	**P.**	Neutral $FeCl_3$ test
II.	p-Aminobenzaldehyde	**Q.**	Silver mirror test
III.	Methyl orange	**R.**	Sodium fusion extract of the compound on boiling with $FeSO_4$ followed by acidification with conc. H_2SO_4 gives Prussian blue colour
IV.	$CO + NaOH \xrightarrow[(ii)\ H^+]{(i)\ 473\,K,10\,atm} X$ 'X' gives	**S.**	Sodium fusion extract of the compound on treatment with Fe^{3+} ions give blood red colour
		T.	Sodium fusion extract of the compound gives violet colour on treatment with $Na_2[Fe(CN)_5NO]$

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

SPACE FOR ROUGH WORK

SUBJECT III : MATHEMATICS 60 MARKS

SECTION 1

NUMERICAL VALUE TYPE

This section contains **8 Numerical Value Type Questions**. For each question, enter the correct numerical value of the answer. If the numerical value has more than two decimal places, **truncate/roundoff** the value to **TWO** decimal places.

1. Consider the curve $y = \tan^{-1} x$ and a point $A\left(1, \frac{\pi}{4}\right)$ on it. If the variable point $P_i(x_i, y_i)$ moves on the curve for $i = 1,2,3,....n(n \in N)$ such that $y_r = \sum_{m=1}^{r} \tan^{-1}\left(\frac{1}{2m^2}\right)$ & $B(x, y)$ be the limiting position of variable point P_n as $n \to \infty$, the value of reciprocal of the slope of AB will be _____.

2. If $\lim_{x \to 0} \frac{\log_e \cot\left(\frac{\pi}{4} - K_1 x\right)}{\tan K_2 x} = 1$, then $\frac{K_2}{K_1}$ is _____.

3. The altitude through A of ΔABC meets BC at D and the circumscribed circle at E. If $D \equiv (2,3)$, $E \equiv (5,5)$, the ordinate of the orthocenter being a natural number. If the probability that the orthocenter lies on the lines $y = 1$; $y = 2$; $y = 3,....., y = 10$ is $\frac{m}{n}$, where m and n are relative primes, the value of $m + n$ is _____.

4. If $z_1, z_2 \in C$, $z_1^2 + z_2^2 \in R$, $z_1(z_1^2 - 3z_2^2) = 2$ and $z_2(3z_1^2 - z_2^2) = 11$, the value of $z_1^2 + z_2^2$ is _____.

5. The number of solutions of the equations $|z - (4 + 8i)| = \sqrt{10}$ & $|z - (3 + 5i)| + |z - (5 + 11i)| = 4\sqrt{5}$, where $i = \sqrt{-1}$ is _____.

6. A sequence of positive terms $A_1, A_2, A_3, ..., A_n$ satisfies the relation $A_{n+1} = \frac{3(1 + A_n)}{(3 + A_n)}$. Least integral value of A_1 for which the sequence is decreasing can be _____.

7. If λ be the number of 3-digit numbers are of the form xyz with $x < y$, $z < y$ & $x \neq 0$, then the value of $\frac{\lambda}{30}$ is _____.

8. A circle with centre in the first quadrant is tangent to $y = x + 10$, $y = x - 6$ and Y-axis. Let (p, q) be the centre of the circle. If the value of $(p + q) = a + b\sqrt{a}$, when $a, b \in Q$, then the value of $|a - b|$ is _____.

SECTION 2

MULTIPLE CORRECT ANSWERS TYPE

This Section contains **6 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

9. Let, $A_1 = \int_n^{n+1} (\min\{|x-n|, |x-(n+1)|\})\,dx$

$A_2 = \int_{n+1}^{n+2} (|x-n| - |x-(n+1)|)\,dx$

$A_3 = \int_{n+2}^{n+3} (|x-(n+4)| - |x-(n+3)|)\,dx$

$g(x) = A_1 + A_2 + A_3$, then

(A) $A_1 + A_2 + A_3 = 9$ **(B)** $A_1 + A_2 + A_3 = \frac{9}{4}$

(C) $\sum_{n=1}^{100} g(x) = \frac{900}{4}$ **(D)** $\sum_{n=1}^{100} g(x) = 900$

10. If the equation $\sin^2 x - a\sin x + b = 0$ has only one solution in $(0, \pi)$ then which of the following statement(s) is/are correct.

(A) $a \in (-\infty, 1] \cup [2, \infty)$ **(B)** $b \in (-\infty, 0] \cup [1, \infty)$

(C) $a = 1 + b$ **(D)** $b = 1 + a$

11. Consider the equation of line AB is $\frac{x}{2} = \frac{y}{-3} = \frac{z}{6}$. Through a point $P(1,2,5)$ line PN is drawn perpendicular to AB and line PQ is drawn parallel to the plane $3x + 4y + 5z = 0$ to meet AB at Q. Then

(A) Coordinate of N are $\left(\frac{52}{49}, -\frac{78}{49}, \frac{156}{49}\right)$

(B) The coordinates of Q are $\left(3, -\frac{9}{2}, 9\right)$

(C) The equation of PN is $\frac{x-1}{3} = \frac{y-2}{-176} = \frac{z-5}{-89}$

(D) Coordinates of N are $\left(\frac{156}{49}, \frac{52}{49}, -\frac{78}{49}\right)$

12. The plane passing through the point $(-2, -2, 2)$ and containing the line joining the points (1,1,1) and $(1, -1, 2)$ makes intercepts of lengths a, b, c respectively on the axes of x, y and z respectively, then

(A) $a = 3b$ **(B)** $b = 2c$

(C) $a + b + c = 12$ **(D)** $a + 2b + 2c = 0$

13. A tangent to the ellipse $4x^2+9y^2=36$ is cut by the tangent at the extremities of the major axis at T and T'. The circle TT' as diameter passes through the point.

(A) $\left(-\sqrt{5},0\right)$ **(B)** $\left(\sqrt{5},0\right)$ **(C)** $\left(\sqrt{3},0\right)$ **(D)** $\left(-\sqrt{3},0\right)$

14. The determinant $\begin{vmatrix} a^2 & a^2-(b-c)^2 & bc \\ b^2 & b^2-(c-a)^2 & ca \\ c^2 & c^2-(a-b)^2 & ab \end{vmatrix}$ is divisible by

(A) $a+b+c$ **(B)** $(a+b)(b+c)(c+a)$

(C) $a^2+b^2+c^2$ **(D)** $(a-b)(b-c)(c-a)$

SPACE FOR ROUGH WORK

SECTION - 3

MATCHING LIST TYPE

This section contains **4** Matching List sets. Each set has **TWO** lists: **List I** and **List II**. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

15. Match the statement of Colum I with the value of Column II

Column I		**Column II**	
I.	The number of solutions of the equation $\lvert \tan 2x \rvert = \sin x \; ; \; x \in (0, \pi)$	**P.**	1
II.	The value of $4\tan\frac{\pi}{16} - 4\tan^3\frac{\pi}{16} + 6\tan^2\frac{\pi}{16} - \tan^4\frac{\pi}{16} + 1$	**Q.**	4
III.	If the equation $\tan(p\cot x) = \cot p(\tan x)$ has a solution in $(0, \pi) - \left\{\frac{\pi}{2}\right\}$, then $\frac{4}{\pi}P_{\max}$ is	**R.**	3
IV.	The value of $\frac{2x}{\pi}$ in $[0, 2\pi]$, if $5^{\cos^2 2x + 2\sin^2 x} + 5^{2\cos^2 x + \sin^2 2x} = 126$ has a solution	**S.**	2

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

SPACE FOR ROUGH WORK

16. If A and B are two independent events, such that $P(A)=\frac{1}{3}\ \&\ P(B)=\frac{1}{4}$.

Column I		Column II	
I.	If $P\left(\frac{A}{B}\right)=\lambda_1$, then $12\lambda_1$ is	**P.**	A prime number
II.	If $P\left(\frac{A}{A\cup B}\right)=\lambda_2$, then $9\lambda_2$ is	**Q.**	A composite number
III.	If $P[(A\cap\overline{B})\cup(\overline{A}\cap B)]=\lambda_3$ then $12\lambda_3$ is	**R.**	A natural number
IV.	If $P(\overline{A}\cup B)=\lambda_4$, then $12\lambda_4$ is	**S.**	A perfect number

(A) I – Q,R ; II – Q,R,S ; III – P,R ; IV – Q,R

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

(C) I – Q,R,S ; II – R,Q ; III – P,R ; IV – R,S

(D) I – P,R ; II – Q,R ; III – P,R ; IV – Q,S,R

17. Let $f(x)$ denotes the determinant $f(x)=\begin{vmatrix} x^2 & 2x & 1+x^2 \\ x^2+1 & x+1 & 1 \\ x & -1 & x-1 \end{vmatrix}$. On expansion $f(x)$ is seen to be a 4^{th} degree polynomial given by $f(x)=a_0x^4+a_1x^3+a_2x^2+a_3x+a_4$. Using differentiation of determinant or otherwise match the entries in Column I with one or more entries of the elements of Column II

Column I		Column II	
I.	$a_0^2+a_1$ is divisible by	**P.**	2
II.	$a_2^2+a_4$ is divisible by	**Q.**	3
III.	$a_0^2+a_2$ is divisible by	**R.**	4
IV.	$a_4^2+a_3^2+a_1^2$ is divisible by	**S.**	5

(A) I – P ; II – Q ; III – Q,P ; IV – S

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

(C) I – P,S ; II – P,R ; III – P,Q ; IV – Q

(D) I – P,S ; II – Q,P ; III – R,P ; IV – Q

18. Match the following Colum I and Column II

Column I		Column II	
I.	Let $f(x)=\begin{cases} a^x, x<2 \\ 8, x=2 \\ \dfrac{b(x^2-b^2)}{(x-2)}, x>2 \end{cases}$ If f is continuous at $x=2$ then the locus of the pair of perpendicular tangents to the ellipse $\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}=1$ is $x^2+y^2=r^2$, then r^2 is divisible by	**P.**	3
II.	If the ellipse $\dfrac{(x-h)^2}{M}+\dfrac{(y-k)^2}{N}=1$ has major axis on the line $y=2$, minor-axis on the line $x=-1$ major axis has length 10 and minor axis has length 4. The $h+k+M+N$ is divisible by	**Q.**	4
III.	If PQ is a focal chord of ellipse $\dfrac{x^2}{25}+\dfrac{y^2}{16}=1$ which passes through $S(3,0)$ and $PS=2$, then length of PQ is divisible by	**R.**	5
IV.	A tangent to the ellipse $\dfrac{x^2}{27}+\dfrac{y^2}{48}=1$ having slope $\left(-\dfrac{4}{3}\right)$ cuts the x and y-axis at the points A and B respectively. If O is the origin, then area of ΔOAB is divisible by	**S.**	6

(A) I – P,R,S ; II – P,Q,S ; III – R ; IV – P,Q,S

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

(C) I – S,Q,P ; II – Q ; III – P,Q,S ; IV – P,R,S

(D) I – P,Q,S ; II – P,R,S ; III – R ; IV – P,Q,S

SPACE FOR ROUGH WORK