VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Advanced Home Practice Test -3 | Paper -2 | JEE 2024

Date: 26/04/2024 **Maximum Marks: 186**

Duration : 3.0 Hours

General Instructions

1. The question paper consists of 3 Subjects (Subject I : Physics, Subject II : Chemistry, Subject III : Mathematics).
2. **Section 1** contains **8 Multiple Correct Answer Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE CHOICES** may be correct.
3. **Section 2** contains **6 Numerical Value Type Questions**. For each question, enter the correct numerical value (in decimal notation, rounded-off to the second decimal place; **e.g. 6.25, 7.00, –81.00, 30.27, 61.30, –7.00, –30.27, –0.33, –127.30).**
4. **Section 3** contains **2 List-Match sets.** Each List-Match set has **Two Multiple Choice Questions.** Each List-Match set has two lists: **List-I and List-II.** Four options are given in each Multiple Choice question based on List-I and List II and ONLY ONE of these four options satisfied the condition asked in the Multiple Choice Questions.
4. 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.
5. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
6. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the ID Card inside the examination hall/room.
7. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.
8. **No one will be permitted to leave the test room before the end of the test, i.e. 5.00 PM.**

Name of the Student :			
Roll Number :			
Invigilator's Signature		**Student's Signature**	

MARKING SCHEME

SECTION-1

- This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the 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, 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 Marks : 0 If unanswered;

  Negative Marks : –1 In all other cases.
- For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then

  choosing ONLY (A), (B) and (D) will get +4 marks; choosing ONLY (A) and (D) will get +2 marks;

  choosing ONLY (A) will get +1 mark;

  choosing no option(s) (i.e. the question is unanswered) will get 0 marks and

  choosing any other option(s) will get –1 marks.

SECTION-2

- This section contains **SIX (06) Numerical Value** questions. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08)
- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks: +3 If ONLY the correct Integer value is entered. There is **NO negative marking.**

  Zero Marks: 0 In all other cases.

SECTION-3

- This section contains **TWO (02)** List – Match sets
- Each List-Match set has **TWO (02)** Multiple Choice Questions.
- Each List-Match set has two lists : **List – I** and **List II**
- **List – I** has Four entries (I), (II), (III) and (V) 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** these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each 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 choose (i.e, the question is unanswered)
- Negative Marks : –1 In all other cases

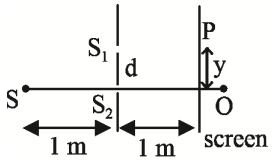
SUBJECT I : PHYSICS 62 MARKS

SECTION – 1

MULTIPLE CORRECT ANSWERS TYPE

This section contains 8 Multiple Choice Questions. Each Question has 4 choices A, B, C & D, out of which ONE or MORE Choices may be Correct:

1. In an arrangement shown in the figure, $d << D,$ where d is the distance of separation of the slits S_1 and S_2 and D is the distance between the slits and the screen. Source S is emitting monochromatic light of wavelength λ. Then choose the correct options.



(A) minimum value of d for the dark fringe at O is $\sqrt{\frac{\lambda}{2}}$

(B) minimum value of d for the dark fringe at O is $\sqrt{\frac{\lambda}{3}}$

(C) for this minimum value of d, the fringe width is $\sqrt{2\lambda}$

(D) for this minimum value of d, the fringe width is $\sqrt{\lambda/2}$.

2. A photon of energy 5.4852 eV moving along x-axis liberates an electron from the Li atom initially at rest at origin. The emitted electron moves along y-axis. Which of the options is/are correct? [Given Ionization potential of Li atom $= 5.3918V$. Atomic weight of $Li = 6.94g, N_A = 6.02\times10^{23}\, mol^{-1}$ and $m_e = 9.1\times10^{-31}\, kg$, use $hc = 12431eV$ Å]

(A) Speed of Li ion is 21.5 m/s

(B) Speed of Li ion is 14.2 m/s

(C) The Li ion moves making an angle of $\cos^{-1}(0.017)$ with x-axis

(D) The Li ion moves making an angle of $\cos^{-1}(0.52)$ with x-axis

3. An ideal gas at 75 cm mercury pressure is compressed isothermally until its volume is reduced to three quarters of its original volume. It is then allowed to expand adiabatically to a volume 20% greater than its original volume. If the initial temperature of the gas is 17°C, which of the following options is/are correct? [Use $\gamma = 1.5, \left(\frac{5}{8}\right)^{1.5} = 0.494, \left(\frac{5}{8}\right)^{1/2} = 0.79$]

(A) The final pressure of the complete process is 100 cm of mercury

(B) The final pressure of the complete process is 49.4 cm of mercury

(C) The final temperature of the complete process is 17°C

(D) The final temperature of the complete process is $-43.7°C$

4. A block of mass 3M connected to a massless rod of length L lies at rest on a fixed horizontal frictionless table. A second block of mass M impinges on the system with speed V_0 . It strikes the opposite end of the rod horizontally at a right angle and sticks to it. Which of the following statements is/are correct?

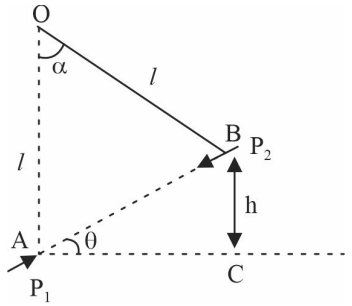
(A) The angular velocity of the new system about its C.O.M is $\frac{V_0}{L}$

(B) The angular velocity of the new system about its C.O.M is $\frac{V_0}{4L}$

(C) Linear velocity of 3 M after collision is $\frac{3V_0}{4}$

(D) Linear velocity of 3 M after collision is O

5. A small dipole of dipole moment $\vec{P}_2$ of mass m is suspended vertically by a string of length l. A small dipole of dipole moment $\vec{P}_1$ is now brought towards $\vec{P}_2$ from infinity so that the P_2 moves away and gravitational potential energy of dipole P_1 does not change. The final equilibrium position of the system including the direction of dipole, the angles and distance is shown in figure (where g is the acceleration due to gravity). Choose the correct statement(s).



(A) The work done in bringing the dipole to this position is $\frac{4mgh}{3}$

(B) The work done in bringing the dipole to this position is $\frac{5mgh}{3}$

(C) Change in electrostatic potential energy of dipole is $\frac{mgh}{3}$

(D) Change in electrostatic potential energy of dipole is $\frac{2mgh}{3}$

6. A container holds 10^{26} molecule$/m^3$, each of mass $3\times10^{-27}kg$. Assume that $\frac{1}{6}$ of the molecules move with velocity 2000 ms^{-1} directly towards one wall of the container while the remaining $\frac{5}{6}$ of the molecules move either away from the wall or in perpendicular direction, and all collisions of the molecules with the wall are elastic. Choose the correct options.

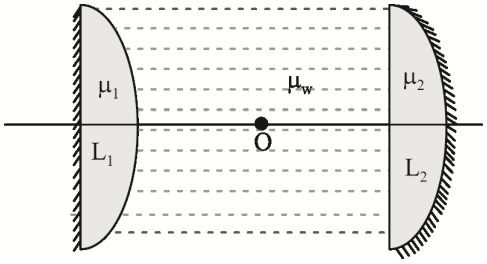
(A) Number of molecules hitting 1 m^2 of the wall every second is $\frac{1}{3}\times10^{29}$

(B) Number of molecules hitting $1m^2$ of the wall every second is 2×10^{29}

(C) Pressure exerted on the wall by molecule is $24\times10^5\ Nm^{-2}$

(D) Pressure exerted on the wall by molecules is $4\times10^5\ Nm^{-2}$

7. A cylindrical tube filled with water $\left(\mu_w = \frac{4}{3}\right)$ is closed at its both ends by two silvered thin plano-convex lenses as shown in the figure. Refractive index of lenses L_1 and L_2 are 2.0 and 1.5 while their radii of curvature are 5 cm and 9 cm respectively. A point object is placed some where at a point O on the axis of cylindrical tube. It is found that the object and image formed by both silvered lenses coincide. Which of the option(s) is/are correct?



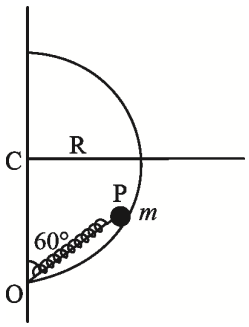
(A) The distance of object from lens L_1 is 10 cm

(B) The distance of object from lens L_2 is 10 cm

(C) The distance of object from lens L_1 is 8 cm

(D) The distance of object from lens L_2 is 8 cm.

8. A smooth semicircular wire track of radius R is fixed in a vertical plane as shown in figure. One end of a massless spring of natural length $\frac{3R}{4}$ is attached to the lower point O of the wire track. A small ring of mass $m = 1kg$, which can slide on the track, is attached to the other end of the spring. The ring is held stationary at point P such that the spring makes an angle of 60° with the vertical. The spring constant $K = \frac{mg}{R}$. Consider the ring to be smooth. The instant when ring is released. Which of the following option(s) is/are correct? (Take $g = 10\,m/s^2$.)



(A) The tangential acceleration of the ring is $\frac{5\sqrt{3}}{4} m/s^2$

(B) The tangential acceleration of the ring is $\frac{25\sqrt{3}}{4} m/s^2$

(C) Normal reaction acting on the ring is 3.75 N

(D) The radial acceleration of the ring is $5\sqrt{3}\,m/s^2$

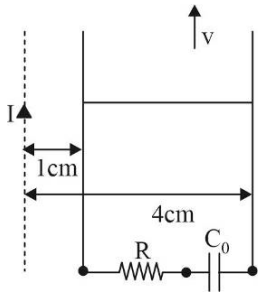
SPACE FOR ROUGH WORK

SECTION - 2

NUMERICAL VALUE TYPE

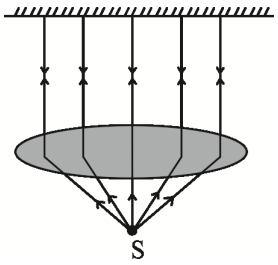
This section contains 6 Numerical Value Type Questions. For each question, enter the correct numerical value (in decimal notation, rounded-off to the second decimal place; e.g. 6.25, 7.00, –81.00, 30.27, 61.30, –7.00, –30.27, –0.33, –127.30).

9. A long straight wire carries a current, I = 2 ampere. A straight conducting rod is placed beside it on two conducting parallel rails of negligible resistance. Both the rails are parallel to the wire. The wire, the rod and the rails lie in the same horizontal plane, as shown in the figure. Two ends of the rod are at distances 1cm and 4cm from the wire. The rod is made to move on the rails with a constant speed v = 3.0 m/s (see in the figure). A resistor $R = 1.4\Omega$ and a capacitor $C_0 = 5.0\mu F$ are connected in series between the rails. At time $t = 0$, C_0 is uncharged. Maximum charge on the capacitor is _____$\times 10^{-12} C$. [$\mu_0 = 4\pi \times 10^{-7}$ SI units. Take ln 2 = 0.7]

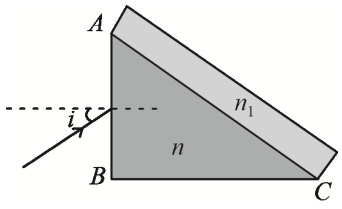


10. The decay of ^{210}PO nuclei (in the ground state) results in a daughter nuclei and an α particle. The α-particles emitted have two sets of kinetic energies which is 5.30 MeV and 4.50 MeV. Following the emission of these particles the daughter nuclei are found in the ground and excited states. The energy of gamma-quanta emitted by the excited nuclei in MeV is _____.

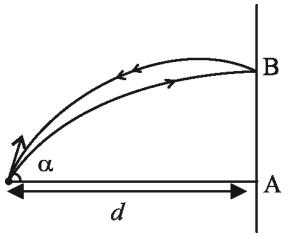
11. A totally reflecting, small plane mirror placed horizontally faces a parallel beam of light as shown in the figure. The mass of the mirror is 20 gm. Assume that there is no absorption in the lens and that 30% of the light emitted by the source goes through the lens. The power of the source needed to support the weight of the mirror in MW is _____. ($C = 3 \times 10^8\ m/\sec$)



12. A right angle prism (45°-90°-45°) of refractive index n has a plate of refractive index $n_1 (n_1 < n)$ cemented to its diagonal face. The assembly is in air. The ray is incident on face AB as shown in figure. The angle of incidence at AB for which the ray strikes the diagonal face at the critical angle is i. The value of $\sin i$ is_____.
[Given use $n = 2.4$ and $n_1 = 1.2$, $\sin 15° = 0.258$]



13. A ball is projected from a point which is at distance d from a smooth vertical wall. The ball is launched with initial velocity u making an angle α from horizontal and in a plane perpendicular to the wall. After rebounding from the wall, it returns to the point of projection. Hence, the maximum distance $d \le \dfrac{2eu^2}{g(x+2e)}$ for which the ball can return to the point of projection. The value of x is _____.
[where e is coefficient of restitution between wall and ball]



14. An optical bench has 2 m long scale having 5 equal divisions in each cm. While measuring the focal length of a convex lens, the lens is kept at 60 cm mark of the scale and the object pin is kept at 30 cm mark. The image of the object pin on the other side of the lens overlaps with image pin that is kept at 120 cm mark. In this experiment, the percentage error in the measurement of the focal length of the lens is_____

SPACE FOR ROUGH WORK

SECTION - 3

MATRIX MATCH TYPE

List-Match sets. Each List-Match set has Two Multiple Choice Questions. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice question based on List-I and List II and ONLY ONE of these four options satisfied the condition asked in the Multiple Choice Questions.

I. Match the following:

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

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

$$Q = W + \Delta U$$

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

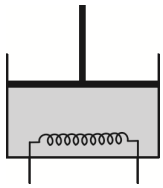
Work done by force $W = \int \vec{F}.\overrightarrow{ds}$, work done by gas $= \int P.dV$ and gravitational potential energy $= mgh.$

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

The List-I and List –II are given below.

List-I		List –II	
I.	Work done by gas	**(P)**	0
II	Increase in internal energy of gas	**(Q)**	500 J
III.	Heat supplied to the gas	**(R)**	1000 J
IV.	Increase in gravitational potential energy of piston	**(S)**	1500 J
		(T)	2000 J
		(U)	2500 J

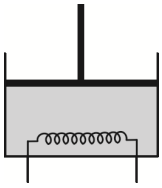
15. The piston of mass 1 kg and area of cross section 1 cm^2 is attached with a cylinder as shown. The piston and cylinder are thermally insulated and contain 2 mole of an ideal monoatomic gas. If piston is free to move and gas is heated gently to increase temperature by 60 K, choose the correct match. (Neglect atmospheric pressure)



(A) I $\rightarrow$ R; II $\rightarrow$ S; III $\rightarrow$ T; IV $\rightarrow$ Q **(B)** I $\rightarrow$ Q; II $\rightarrow$ R; III $\rightarrow$ S; IV $\rightarrow$ U

(C) I $\rightarrow$ R; II $\rightarrow$ S; III $\rightarrow$ U; IV $\rightarrow$ R **(D)** I $\rightarrow$ R; II $\rightarrow$ S; III $\rightarrow$ U; IV $\rightarrow$ T

16. The piston of mass 1 kg and area of cross section 1 cm^2 is attached with a cylinder as shown. The piston and cylinder are thermally insulated and contain 2 mole of an ideal monoatomic gas. If piston is fixed and gas is heated gently to increase temperature by 60 K, choose the correct match. (Neglect atmospheric pressure)

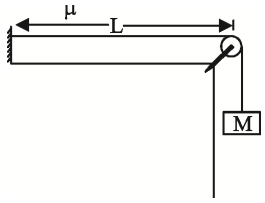


(A) I $\rightarrow$P; II $\rightarrow$P; III $\rightarrow$S; IV $\rightarrow$S **(B)** I $\rightarrow$P; II $\rightarrow$Q; III $\rightarrow$S; IV $\rightarrow$P

(C) I $\rightarrow$P; II $\rightarrow$S; III $\rightarrow$P; IV $\rightarrow$S **(D)** I $\rightarrow$P; II $\rightarrow$S; III $\rightarrow$S; IV $\rightarrow$P

II. Match the following:

A mass –pulley system is shown in figure.



When $M = m, L = l_0, \mu = \mu_0$, fundamental frequency is f_0, $f_0 = \frac{1}{2l_0}\sqrt{\frac{mg}{\mu_0}}$

List-I		List-II	
I.	$M = \frac{m}{2}, L = 2l_0, \mu = \frac{\mu_0}{4}$	**P.**	1
II.	$M = 2m, L = 2l_0, \mu = \frac{\mu_0}{2}$	**Q.**	$\frac{1}{\sqrt{2}}$
III.	$M = \frac{m}{4}, L = 3l_0, \mu = \frac{\mu_0}{4}$	**R.**	$\frac{1}{3}$
IV.	$M = \frac{m}{8}, L = 4l_0, \mu = \frac{\mu_0}{32}$	**S.**	$\frac{1}{2}$
		T.	2
		U.	3

Answer the following by appropriately matching the lists based on the information given in the above List I and List II.

17. The correct match for the fundamental frequencies in f_0 units will be :

(A) I $\rightarrow$P; II $\rightarrow$R ; III $\rightarrow$S; IV $\rightarrow$T **(B)** I $\rightarrow$Q ; II $\rightarrow$R; III $\rightarrow$P; IV $\rightarrow$S

(C) I $\rightarrow$Q; II $\rightarrow$P; III $\rightarrow$R; IV $\rightarrow$S **(D)** I $\rightarrow$Q; II $\rightarrow$P; III $\rightarrow$S; IV $\rightarrow$R

18. In List –I four different cases, they are vibrated at their 1st, 2nd, 3rd and 6th harmonics, respectively. The correct match for the four different cases in f_0 units will be :

(A) I $\rightarrow$Q; II $\rightarrow$T ; III $\rightarrow$P; IV $\rightarrow$R **(B)** I $\rightarrow$Q ; II $\rightarrow$T; III $\rightarrow$P; IV $\rightarrow$U

(C) I $\rightarrow$P; II $\rightarrow$Q; III $\rightarrow$R; IV $\rightarrow$T **(D)** I $\rightarrow$Q; II $\rightarrow$T; III $\rightarrow$R; IV $\rightarrow$P

SPACE FOR ROUGH WORK

SUBJECT II :CHEMISTRY 62 MARKS

SECTION – 1

MULTIPLE CORRECT ANSWERS TYPE

This section contains 8 Multiple Choice Questions. Each Question has 4 choices A, B, C & D, out of which ONE or MORE Choices may be Correct:

19. Select the correct statements(s).

(A) Sodium thiosulphate is prepared by boiling Na_2SO_3 solution with elemental sulphur in alkaline medium

(B) Sodium thiosulphate is prepared by boiling Na_2SO_3 solution with elemental sulphur in acidic medium

(C) Phosphate rock, $Ca_3(PO_4)_2$ on heating with sand and coke in electric furnace at 1400-1500°C yields dimeric phosphorus pentaoxide.

(D) Phosphinic acid reduces silver nitrate to mettalic silver

20. A chemist opened a cupboard and found four bottles containing water solutions, each of which had lost its label. Bottles 1,2,3 contained colourless solutions, while bottle 4 contained a blue solution. The labels from the bottles were lying scattered on the floor of the cupboard. They were:

Copper (II) sulphate,	Hydrochloric acid
Lead nitrate,	Sodium carbonate

By mixing samples of the contents of the bottles, in pairs, the chemist made the following observations:

Bottle 1 + Bottle 2	$\rightarrow$	White precipitate is formed.
Bottle 1 + Bottle 3	$\rightarrow$	White precipitate is formed
Bottle 1 + Bottle 4	$\rightarrow$	White precipitate is formed
Bottle 2 + Bottle 3	$\rightarrow$	Colourless and odourless gas is evolved
Bottle 2 + Bottle 4	$\rightarrow$	No visible reaction is observed.
Bottle 3 + Bottle 4	$\rightarrow$	Blue precipitate is formed.

With the help of the above observations , choose the correct statements.

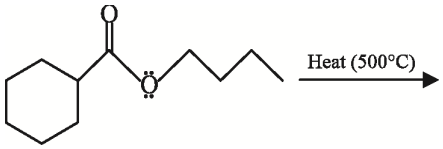
(A) Bottle 3 contains sodium carbonate

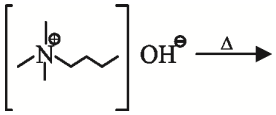
(B) Bottle 4 develops deep blue colour with aqueous ammonia

(C) Bottle 1 contains Copper (II) sulphate

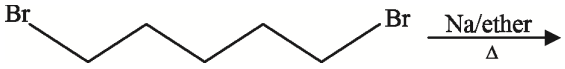
(D) Bottle 1 contains Lead nitrate

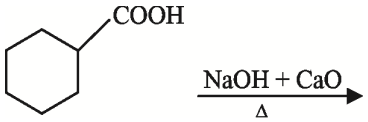
21.

I. 

II. 

III. $R-CH=CH_2 \xrightarrow{CH_2N_2,\Delta}$

IV. 

V. 

Select the correct statements from the following :

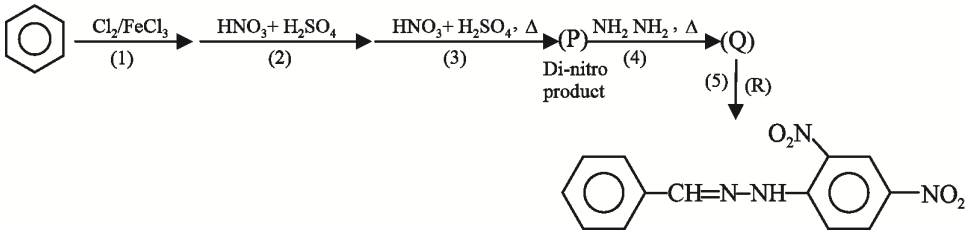
(A) Reaction II produces n-Butene as the major product.

(B) Reaction I, III, IV and V produce cyclo alkanes.

(C) Reaction II produces Saytzeff alkene as the major product

(D) Reaction V undergoes Decarboxylation to produce cyclohexane.

22. The correct statement/s about the following reaction sequence is/are



(A) 'R' gives an aldol condensation reaction on heating with NaOH solution

(B) The compound 'Q' gives a yellow precipitate in acetone

(C) Step '4' is an aromatic nucleophilic substitution reaction

(D) Step '1' is an aromatic electrophilic substitution reaction

23. $FeCr_2O_4 + NaOH + air \rightarrow (P) + Fe_2O_3$

$(P) + (Q) \longrightarrow Na_2Cr_2O_7$

$Na_2Cr_2O_7 + X \xrightarrow{\Delta} Cr_2O_3$

$Cr_2O_3 + Y \xrightarrow{\Delta} Cr$

Select the correct statements:

(A) P and Q are Na_2CrO_4, H_2SO_4

(B) P and Q are Na_2CrO_5, H_2SO_4

(C) X and Y are Carbon and Aluminium

(D) Na_2CrO_4 and Fe_2O_3 are separated by dissolving in H_2O

24. Choose the correct options

(A) According to wave mechanical model, the most probable distance of 1s electron of He^+ ion is $2a_0$. [a_0 is Bohr's radius]

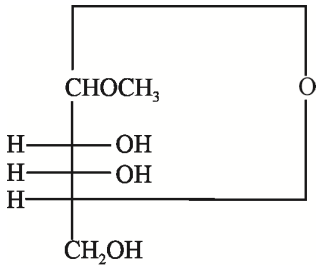
(B) According to wave mechanical model, the most probable distance of 1s electron of He^+ ion is $\frac{a_0}{2}$. [a_0 is Bohr's radius]

(C) According to wave mechanical model, there is a radial node in 2s orbital of H at $4a_0$

(D) 4p orbital has 2 spherical nodes

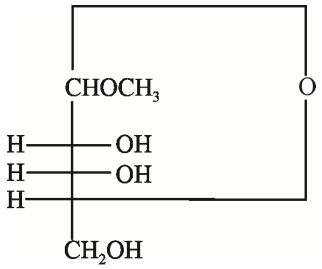
25. Select the correct options:

(A)



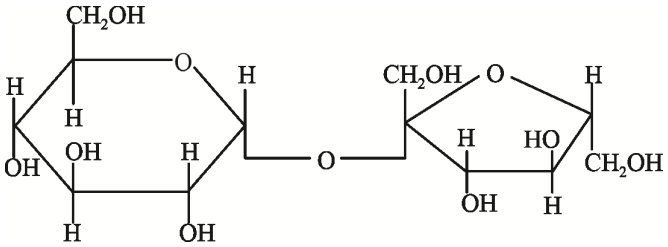
The number of moles of HIO_4 required to break down the above molecule is 2.

(B)



The number of moles of HIO_4 required to break down the above molecule is 1.

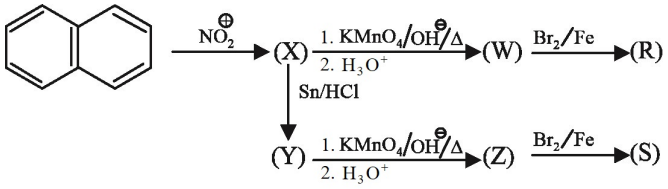
(C)



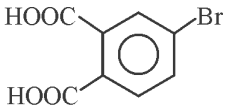
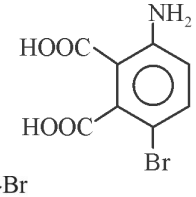
The above compound on hydrolysis will give a pair of epimers.

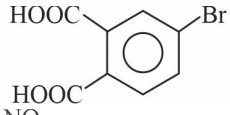
(D). Polyester is a condensation polymer.

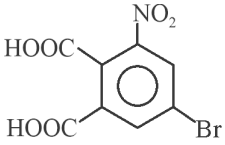
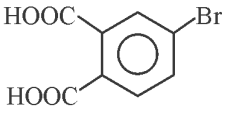
26. Change in diagram

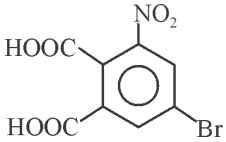
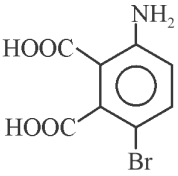


Which of the following are incorrect.?

(A) R:  , S: 

(B) R and S both are 

(C) R:  , S: 

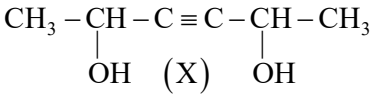
(D) R:  , S: 

SPACE FOR ROUGH WORK

SECTION - 2
NUMERICAL VALUE TYPE

This section contains 6 Numerical Value Type Questions. For each question, enter the correct numerical value (in decimal notation, rounded-off to the second decimal place; e.g. 6.25, 7.00, –81.00, 30.27, 61.30, –7.00, –30.27, –0.33, –127.30).

27.



A = Total no. of stereoisomers of the above compound (X).

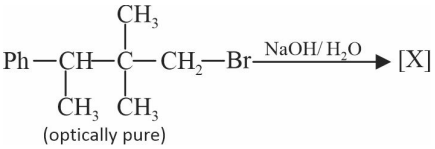
B = Total no. of optically active stereoisomers of the product when above compound (X) is reduced by Lindlar's catalyst.

C = Total no. of optically inactive stereoisomers of the product when (X) is reduced by Na/liq NH_3 (Birch's reduction)

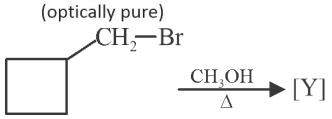
D = No. of products formed when optically inactive form formed in part (B) reacts with PhCOOOH followed by hydrolysis.

Find the value of A + B + C + D.

28. If [X] is the total number of substitution products formed in the reaction – I and [Y] is the total number of products (constitutional isomers containing five membered ring) formed in reaction-II, then find the value of sum of X and Y .

Reaction- I : 

(optically pure)

Reaction-II : 

29. The equivalent weight of H_2SO_4 in the following reaction is

$$H_2SO_4 + NaI \longrightarrow Na_2SO_4 + I_2 + H_2S + H_2O$$

30. $X =$ The coordination number of the metal ion in the red complex ion formed in a qualitative analysis test of iron (III).

$Y =$ The oxidation number of iron in brown ring complex

$Z =$ The number of following complex ions, in which the central metal ions use $(n-1)d$, ns and np orbitals for hybridization

$\left[Mn(CN)_6\right]^{4-}, \left[Ni(NH_3)_6\right]^{2+}, \left[Co(ox)_3\right]^{3-}, \left[Cu(NO_2)_6\right]^{4-}, \left[AgF_4\right]^{-}, \left[Ni(CN)_4\right]^{2-}$

$\left[PdCl_4\right]^{2-}, \left[Pd(CN)_4\right]^{2-}, \left[Co(SCN)_4\right]^{2-}$

Find the value of $X \times Y \times Z$

31. Decomposition of $A(g) \rightarrow \frac{2}{3}B(g) + \frac{2}{3}C(g)$ follows first order kinetics. Initially only A is present in the container. Pressure developed after 20 min, and infinite time are 3.5 and 4 atm respectively.

The value of $t_{50\%} + t_{75\%} + t_{87.5\%} = X \min$. The value of X is

32. **I.** An oxide of a metal contains 40% oxygen, by weight.

X = The equivalent weight of the metal

II. 29.2% (w/w) HCl stock solution has a density of 1.25 $g\,mL^{-1}$. The molecular weight of HCl is 36.5 $g\,mol^{-1}$. Y = The volume in mL of stock solution required to prepare a 500 mL solution of 0.4 M HCl. Find the value of $X + Y$

SPACE FOR ROUGH WORK

SECTION - 3
MATRIX MATCH TYPE

List-Match sets. Each List-Match set has Two Multiple Choice Questions. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice question based on List-I and List II and ONLY ONE of these four options satisfied the condition asked in the Multiple Choice Questions.

I. Match the following:

List-I		List -II	
I.	$n = 6 \rightarrow n = 3\,(In\,H-atom)$	**P.**	10 lines in the spectrum
II.	$n = 7 \rightarrow n = 3\,(In\,H-atom)$	**Q.**	Spectral lines in visible region
III.	$n = 5 \rightarrow n = 2\,(In\,H-atom)$	**R.**	6 lines in the spectrum
IV	$n = 5 \rightarrow n = 1\,(In\,H-atom)$	**S.**	Spectral lines in infrared region
		T.	Spectral lines in U.V. region

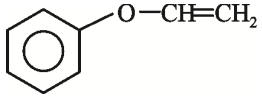
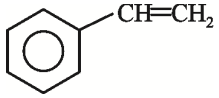
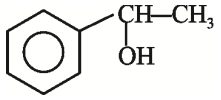
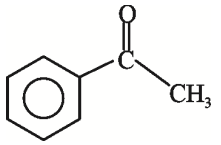
33. Which of the following is the only correct combination.

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

34. Which of the following is the only correct combination.

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

II. Match the following:

List-I		List -II	
I.		**P.**	Gives Benzoic acid with hot alkaline $KMnO_4$
II.		**Q.**	o/p directing and activating for $E^{\oplus}$
III.		**R.**	Gives fastest reaction with an electrophile
IV.		**S.**	Gives an ester on reductive ozonolysis
		T.	m-directing and deactivating for $E^{\oplus}$

35. Which of the following is the only correct combination.

(A) I-(Q,R,S), II-(P,Q) **(B)** I-(P, T), IV-(P, T)

(C) I-(R, S), II-(P, T) **(D)** I-(R, S), II-(R, Q)

36. Which of the following is the only correct combination.

(A) III-(R,S), II-(P,Q) **(B)** III-(P, Q), IV-(P, T)

(C) III-(P, Q), II-(P, T) **(D)** I-(R, S), II-(R, Q)

SPACE FOR ROUGH WORK

SUBJECT III : MATHEMATICS 62 MARKS

SECTION - 1

MULTIPLE CORRECT ANSWERS TYPE

This section contains 8 Multiple Choice Questions. Each Question has 4 choices A, B, C & D, out of which ONE or MORE Choices may be Correct:

37. Let $Y=\int_0^1 \frac{2x^2+3x+3}{(x+1)\left(x^2+2x+2\right)}dx$. Then which of the following option(s) are equal to Y?

(A) $\frac{\pi}{4}+2\ln 2-\arctan 2$ **(B)** $\frac{\pi}{4}+2\ln 2-\arctan\frac{1}{3}$

(C) $2\ln 2-\operatorname{arccot}3$ **(D)** $-\frac{\pi}{4}+2\ln 2+\operatorname{arccot}2$

38. Let $f:(1,\infty)\to R$ be a differential function such that

$$\int_2^{150}(x-1)\ln(x-1)\left(2f(x)-(x-1)\ln(x-1)\right)dx=\int_2^{150}f^2(x)dx$$

Then:

(A) area bounded by the curve and x-axis is equal to $\frac{1}{2}$

(B) $f(x)$ is strictly decreasing in $\left(1,1+\frac{1}{e}\right)$.

(C) number of solutions of the equation $f(x)=2$ is 2.

(D) $f(x)$ is monotonic in $\left(1+\frac{1}{e},\infty\right)$

39. For any ΔABC, if the length of the median through $\angle A$ is m_1, the median through $\angle B$ is m_2, the median through $\angle C$ is m_3 and $\begin{bmatrix}a^2\\b^2\\c^2\end{bmatrix}=M\begin{bmatrix}m_1^2\\m_2^2\\m_3^2\end{bmatrix}$ for a certain 3×3 matrix M. Then: (a, b, c are the set of the triangle)

(A) trace of matrix M is equal to $-\frac{4}{3}$

(B) M is symmetric matrix

(C) det. M is equal to $\frac{64}{81}$

(D) sum of all elements of matrix M is 4

40. Let $y=f(x)$ be a cubic polynomial such that $\lim_{x\to 0}(1+f(x))^{\frac{1}{x}}=e^{-1}; \lim_{x\to 0}\left(x^3 f\left(\frac{1}{x}\right)\right)^{\frac{1}{x}}=e^2$, then which of the following is/are correct?

(A) Sum of all real roots of $f(x)=0$ is -2

(B) Product of all real roots of $f(x)=0$ is 0

(C) $\lim_{x\to\infty}\left(\frac{f(x)}{x^3}\right)=2$

(D) $\lim_{x\to\infty}\left(\frac{f(x)}{x^3}\right)=1$

41. Let $f:(0,\infty)\to[-2,\infty), f(x)=ax^2-bx+c$ (where $a,b,c\in R$) be a surjective function such that $\lim_{x\to 0} f(x)=3$. If $g:[1,\infty)\to[-2,\infty), g(x)=f(x)$ is an invertible function, then identify which of the statement(s) is (are) correct?

(A) The value of 40. $g'(1)$ is equal to 0

(B) If domain of $g(g(x))$ is $\left[1+\sqrt{\frac{p}{q}},\infty\right)$, then $(q-p)$ equal to 2

(C) The number of solutions of the equation $g(x)=g^{-1}(x)$ is 2

(D) The value of $\frac{d}{dx}\left(90g^{-1}(x)\right)$ at $x=43$ is 3

42. Let $f(x)=\lim_{n\to\infty}(-n)\left(\left|2\tan^{-1}x-\frac{1}{n}\right|-2\left|\tan^{-1}x\right|\right), x\in R$. Identify the correct statement(s).

(A) The number of points where $f(x)$ is discontinuous is 1

(B) The number of points where $g(x)=|f(x)|$ is discontinuous is 1

(C) $f(1)+f(2)=2$

(D) The least positive integral value of λ for which the equation $f(x)=\left|x+\frac{5}{\lambda}\right|$ has a solution is 6.

43. Let $f(x)=\cot^{-1}\left(\frac{x^{2018}+5}{(x-5)(x-10)}\right)$, then:

(A) $\lim_{x\to 5^-} f(x)=0$ **(B)** $\lim_{x\to 5^+} f(x)=\pi$

(C) $\lim_{x\to 10^-} f(x)=\pi$ **(D)** $\lim_{x\to 10^+} f(x)=0$

44. Let $y=P(x)$ be a differentiable function $\forall x\in[0,\infty)$ such that

$\frac{d}{dx}(P(x))+(x-1)^3\geq P(x)+1\forall x\in[0,\infty)$. If $P(x)\leq x^3+3x+1\forall x\in[0,\infty)$ and $P(0)=1$, then which of the following is/are correct?

(A) $y=P(x)$ is a monotonic function

(B) Area bounded by $y=P(x)$; x-axis ; $x=0$ and $x=1$ is $\frac{11}{4}$

(C) $\int_{-1}^{1}P(x)dx=2$

(D) $y=P(x)$ is a bijective function.

SPACE FOR ROUGH WORK

SECTION - 2
NUMERICAL VALUE TYPE

This section contains 6 Numerical Value Type Questions. For each question, enter the correct numerical value (in decimal notation, rounded-off to the second decimal place; e.g. 6.25, 7.00, –81.00, 30.27, 61.30, –7.00, –30.27, –0.33, –127.30).

45. The value of $\sum_{\omega=1}^{\infty}\sin^{-1}\left[\frac{2\omega+1}{\omega(\omega+1)\left(\sqrt{\omega^2+2\omega}+\sqrt{\omega^2-1}\right)}\right]$ is equal to

46. If $I_1=\int_0^1\frac{x^{7/2}(1-x)^{9/2}}{30}dx$ and $I_2=\int_0^1\frac{x^{7/2}(1-x)^{9/2}}{(x+5)^{10}}dx$ and $\frac{I_1}{I_2}=5a^3\sqrt{a}$, where $a\in N$.

Then the value of a is _____

47. Let $\vec{a},\vec{b},\vec{c}$ be three vectors of magnitude 2, 3, 5 respectively, satisfying $\left|\left[\vec{a},\vec{b},\vec{c}\right]\right|=30$. If $\left(2\vec{a}+\vec{b}+\vec{c}\right).\left((\vec{a}\times\vec{c})\times(\vec{a}-\vec{c})+\vec{b}\right)=k$, then the value of $\left(\frac{k}{103}\right)$ is

48. Mr. A either walks to school or take bus to school everyday. The probability that he takes a bus to school is $\frac{1}{4}$. If he takes a bus, the probability that he will be late is $\frac{2}{3}$. If he walks to school, the probability that he will be late is $\frac{1}{3}$. The probability that *Mr.* A will be on time for at least one out of two consecutive days is $\frac{p}{q}$, where p and q are co-prime, find the value of $(q-p)$.

49. Let $A=\begin{bmatrix} a & x & p \\ y & q & b \\ r & c & z \end{bmatrix}$ and $B=\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$ where a,b,c,x,y,z,p,q,r are natural numbers. If tr. $\left(AB+AB^3+AB^5+....+AB^{19}\right)=210,$ then find number of ordered triples (*p, q, r*) .

[Note: tr. $\left(P\right)$ denotes the trace of matrix *P*.]

50. Let E_1,E_2,E_3 be three independent events associated with a random experiment such that $3P\left(E_1\cap\overline{E}_2\cap\overline{E}_3\right)=P\left(\overline{E}_1\cap E_2\cap\overline{E}_3\right)=9P\left(\overline{E}_1\cap\overline{E}_2\cap E_3\right)=3-3P\left(E_1\cup E_2\cup E_3\right)$, where $P\left(E_1\right),P\left(E_2\right),P\left(E_3\right)\neq 1$ and $P\left(A\right)$ denotes probability of event A.

If absolute value of $\begin{vmatrix} P\left(E_1\right) & P\left(E_2\right) & P\left(E_3\right) \\ P\left(E_2\right) & P\left(E_3\right) & P\left(E_1\right) \\ P\left(E_3\right) & P\left(E_1\right) & P\left(E_2\right) \end{vmatrix}=\frac{a}{b},$ where $a,b\in N$, then find the least value of $\left(a+b\right)$.

SECTION - 3
MATRIX MATCH TYPE

Each List-Match set has Two Multiple Choice Questions. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice question based on List-I and List II and ONLY ONE of these four options satisfied the condition asked in the Multiple Choice Questions.

I. Match the following:

Let *C* be a circle of radius *r* with centre at *O*, let *P* be a point outside *C* and *D* be a point on *C*. A line through *P* intersects *C* at *Q* and *R*, *S* is the midpoint of *QR*.

List-I		List -II	
I.	For different choice of lines through *P*, what is the curve on which *S* lies:	P	$\left(PS\right)^2$
II.	Let *P* is situated at a distance 'd' from centre O, then which of the following does not equal the product $\left(PQ\right)\left(PR\right)$	Q	An arc of circle with OP diameter
III.	Let *ABC* be an equilateral triangle inscribed in *C*. If α,β,γ denote the distances of D from vertices *A, B, C* respectively , what is the value of product $\left(\beta+\gamma-\alpha\right)\left(\gamma+\alpha-\beta\right)\left(\alpha+\beta-\gamma\right)$:	R	0
		S	d^2-r^2
		T	Straight Line
		U	1
		V	$\left(PS\right)^2-\left(SQ\right)\left(SR\right)$

51. Which of the following is the only correct combination.

(A) I- (T) **(B)** II- (S) **(C)** I-(Q) **(D)** None of these

52. Which of the following is the only correct combination.

(A) II - (P), III-(U) **(B)** II- (V), III-(R) **(C)** II-(P), I- (T) **(D)** I-(T), II-(Q), III-(U)

II. Match the Column :

Column –I represents a quadratic equation with some given conditions. Column –II represents number of non-positive integral values of '*k*' and Column-III represents number of prime values of 'k'. Then match the following.

List-I		List -II		List -3	
I.	Let α and β are real roots of $x^2-8x+k^2-6k=0$ such that $\frac{\alpha}{\beta}+\frac{\beta}{\alpha}=2$.	**(i)**	0	**(P)**	0
II.	If one root of the equation $(k-2)x^2-(8-2k)x+(3k+8)=0$ is negative and other is positive.	**(ii)**	1	**(Q)**	1
III.	If difference between the real roots of equation $4x^2-2kx+1=0$ is less than $\sqrt{3}$.	**(iii)**	2	**(R)**	2
IV.	If quadratic expression $2kx^2-(4k-5)x-10$ is negative for exactly three distinct integral values of x.	**(iv)**	3	**(S)**	3

53. Which of the following options is the only correct combination?

(A) (I) (iii) (S) **(B)** (II) (ii) (R) **(C)** (III) (i) (P) **(D)** (IV) (i) (Q)

54. Which of the following options is the only correct combination?

(A) (I) (iv) (Q) **(B)** (II) (iv) (P) **(C)** (III) (ii) (S) **(D)** (IV) (iii) (R)

SPACE FOR ROUGH WORK