VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

Mock JEE Main-3 (CBT) | JEE-2024

Date: 12/01/2024 **Maximum Marks: 300**

Timing: 3:30 PM to 6:30 PM **Duration : 3.0 Hours**

General Instructions

1. The test is of **3 hours** duration and the maximum marks is **300.**
2. The question paper consists of **3 Parts** (Part I: **Physics**, Part II: **Chemistry**, Part III: **Mathematics**). Each Part has **two** sections (Section 1 & Section 2).
3. **Section 1** contains **20 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.
4. **Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. You will NOT be allowed to attempt the sixth question. If you wish to attempt any other question apart from the five already attempted, then you will have to delete any one response from the five previously answered and then proceed to answer the new one.**
   The answer to each question should be **rounded off to the nearest integer**.
5. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
6. 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**.

Marking Scheme

1. **Section – 1:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. **Section – 2:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

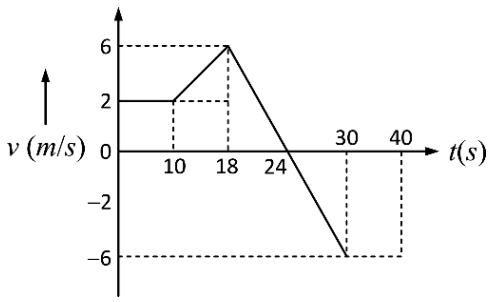
Candidate's Signature : _____ **Invigilator's Signature** _____

PART I : PHYSICS	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. A particle moves in a straight line with the velocity as shown in figure. At $t = 0,\ x = -16\,m.$



(A) The maximum value of the position coordinate of the particle is 70 *m*

(B) The maximum value of the position coordinate of the particle is 36 *m*

(C) The particle is at the position of 36 *m* at *t* = 18 *s*

(D) The particle is at the position of 40 *m* at *t* = 30 *s*

2. Equation of travelling wave on a stretched string of linear density 5 *g*/*m* is $y = 0.03\sin(450t - 9x)$ where distance and time are measured in SI unit. The tension in the string is:

(A) 12.5 *N* **(B)** 7.5 *N* **(C)** 10 *N* **(D)** 5 *N*

SPACE FOR ROUGH WORK

3. Given below are two statements:

Statement-I : Heat supplied to a gas in a process is 100 *J* and work done by the gas in the same process is 120 *J*, then pressure of the gas in the process should increase.

Statement-II : Work done by the gas is greater than the heat supplied to the gas. Hence, internal energy of the gas should decrease.

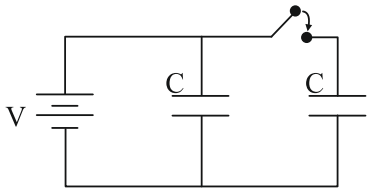
(A) Statement I is true but Statement II is false

(B) Both Statement I and Statement II are false

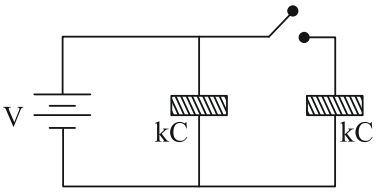
(C) Statement I is false but Statement II is true

(D) Both Statement I and Statement II is true

4. Figure given below shows two identical parallel plate capacitors connected to a battery with switch *S* closed. The switch is now opened and the free space between the plates of capacitors is filled with a dielectric of dielectric constant 3. What will be the ratio of total electrostatic energy stored in both capacitors before and after the introduction of the dielectric.



(a) when switch is closed



(a) After opening switch, dielectric is introduced

(A) 3 : 5 **(B)** 2 : 5 **(C)** 5 : 3 **(D)** 5 : 2

SPACE FOR ROUGH WORK

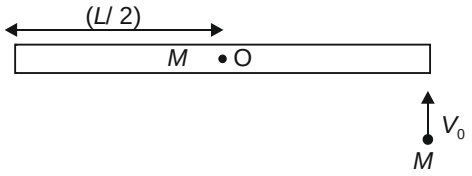
5. The potential energy of a particle of mass *m* is given by:

$$V(x) = \begin{cases} E_0 & , \quad 0 \le x \le 1 \\ 0 & , \quad x > 1 \end{cases}$$

λ_1 and λ_2 are the de-Broglie wavelengths of the particle, when $0 \le x \le 1$ and $x > 1$ respectively. If the total energy of particle is $2E_0$, then $\frac{\lambda_1}{\lambda_2}$ is:

(A) 2 **(B)** $\sqrt{2}$ **(C)** 1 **(D)** 4

6. A uniform rod of mass *M* and length *L*, which is free to rotate about a fixed vertical axis through *O*, is lying on a frictionless horizontal table. *A* particle of equal mass strikes the rod with a velocity V_0 and sticks to it. The angular velocity of the combination immediately after the collision is:



(A) $\frac{3V_0}{4L}$ **(B)** $\frac{3V_0}{8L}$ **(C)** $\frac{3V_0}{2L}$ **(D)** $\frac{2V_0}{L}$

SPACE FOR ROUGH WORK

7. Match List I with List II

List I		List II	
(A)	Specific heat	**(P)**	$[MLT^{-3}K^{-1}]$
(B)	Coefficient of thermal conductivity	**(Q)**	$[MT^{-3}K^{-4}]$
(C)	Boltzmann constant	**(R)**	$[L^2T^{-2}K^{-1}]$
(D)	Stefan's constant	**(S)**	$[ML^2T^{-2}K^{-1}]$

(A) A $\rightarrow$ R, B $\rightarrow$ S, C $\rightarrow$ P, D $\rightarrow$ Q **(B)** A $\rightarrow$ Q, B $\rightarrow$ P, C $\rightarrow$ S, D $\rightarrow$ R

(C) A $\rightarrow$ R, B $\rightarrow$ P, C $\rightarrow$ S, D $\rightarrow$ Q **(D)** A $\rightarrow$ P, B $\rightarrow$ R, C $\rightarrow$ S, D $\rightarrow$ Q

8. **Statement-I :** The ferromagnetic property depends on temperature. At high temperature, ferromagnet becomes paramagnet.

Statement-II : At high temperature, the domain wall area of a ferromagnetic substance increases.

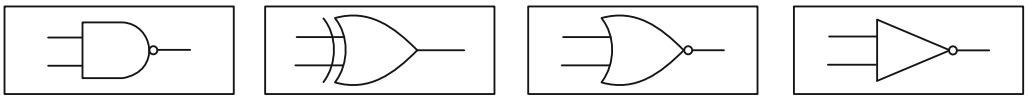
(A) Both Statement-I and Statement-II are true

(B) Both Statement-I and Statement-II are false

(C) Statement-I is true but Statement-II is false

(D) Statement-I is false but Statement-II is true

9. Given below are symbols for some logic gates.



1 2 3 4

The *XOR* gate and *NOR* gate respectively are:

(A) 1 and 2 **(B)** 2 and 3 **(C)** 3 and 4 **(D)** 1 and 4

SPACE FOR ROUGH WORK

10. In a cathode ray tube, a potential difference of 3000 *V* is maintained between the deflector plates whose separation is 2 *cm*. A magnetic field of $2.5\times10^{-3}\,Wbm^{-2}$ at right angles to the electric field gives no deflection of the electron beam, which receives an initial acceleration by a potential difference of 10,000 *V*. The e/m of an electron will be:

(A) $3.2\times10^{11}\,C\,kg^{-1}$ **(B)** $1.8\times10^{11}\,C\,kg^{-1}$

(C) $1.8\times10^{10}\,C\,kg^{-1}$ **(D)** $2.9\times10^{11}\,C\,kg^{-1}$

11. There is a small hole at the bottom of open tank filled with water. If total pressure at the bottom, just above the hole is 3 atm $(1\text{atm} = 10^5\,Nm^{-2})$ then velocity of water flowing from hole is:

(A) $\sqrt{400}\,ms^{-1}$ **(B)** $\sqrt{600}\,ms^{-1}$ **(C)** $\sqrt{60}\,ms^{-1}$ **(D)** None of these

12. A bob of mass of 10 *kg* is attached to a wire 0.3 *m* long. Its breaking stress is $4.8\times10^7\,N/m^2$. The area of cross-section of the wire $10^{-6}\,m^2$. Then the maximum angular velocity with which it can be rotated in a horizontal circle is:

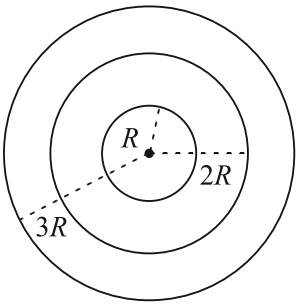
(A) 8 *rad/s* **(B)** 4 *rad/s* **(C)** 2 *rad/s* **(D)** 1 *rad/s*

13. The energy spectrum of a black body exhibits a maximum around a wavelength λ_0. The temperature of the black body is now changed such that the energy is maximum around a wavelength $\frac{3\lambda_0}{4}$. The power radiated by the black body will now increase by a factor of

(A) $\frac{256}{81}$ **(B)** $\frac{64}{27}$ **(C)** $\frac{16}{9}$ **(D)** $\frac{4}{3}$

SPACE FOR ROUGH WORK

14. Three concentric metallic spherical shells of radii R, $2R$, $3R$ are given charges Q_1, Q_2, Q_3 respectively. It is found that the charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells $Q_1 : Q_2 : Q_3$ is:



(A) 1 : 2 : 3 **(B)** 1 : 3 : 5

(C) 1 : 4 : 9 **(D)** 1 : 8 : 18

15. A ball is projected from ground with a velocity v at an angle θ to the vertical. On its path it makes an elastic collision with a vertical wall and returns to ground. The total time of flight of the ball is:

(A) $\frac{2v\sin\theta}{g}$ **(B)** $\frac{2v\cos\theta}{g}$ **(C)** $\frac{v\sin\theta}{g}$ **(D)** $\frac{v\cos\theta}{g}$

16. Given Below are two statements:

Statement-I : For a prism of refracting angle 60° and refractive index $\sqrt{2}$, minimum deviation is 30°.

Statement-II : At minimum deviation, $r_1 = r_2 = \frac{A}{2} = 30°$.

(A) Statement I is true but Statement II is false

(B) Both Statement I and Statement II are false

(C) Statement I is false but Statement II is true

(D) Both Statement I and Statement II is true

SPACE FOR ROUGH WORK

17. Time period of a simple pendulum of length L is T_1 and time period of a uniform rod of the same length L pivoted about one end and oscillating in a vertical plane is T_2. Amplitude of oscillations in both the cases is small. Then $\frac{T_1}{T_2}$ is:

(A) $\sqrt{\frac{4}{3}}$ **(B)** 1 **(C)** $\sqrt{\frac{3}{2}}$ **(D)** $\sqrt{\frac{1}{3}}$

18. An electron moves in a circular orbit at a distance from a proton with kinetic energy E. To escape to infinity, the energy which must be supplied to the electron is:

(A) E **(B)** $2E$ **(C)** $0.5E$ **(D)** $\sqrt{2}E$

19. RMS speed of a monoatomic gas is increased by 2 times. If the process is done adiabatically then the ratio of initial volume to final volume will be:

(A) 4 **(B)** $(4)^{2/3}$ **(C)** $2^{3/2}$ **(D)** 8

20. A wire has a mass (0.3 ± 0.003) *g*, radius (0.5 ± 0.005) *mm* and length (6 ± 0.06) *cm*. The maximum percentage error in the measurement of its density is:

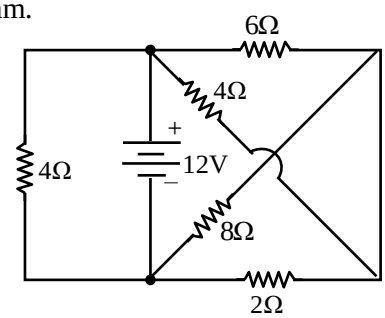
(A) 1 **(B)** 2 **(C)** 3 **(D)** 4

SPACE FOR ROUGH WORK

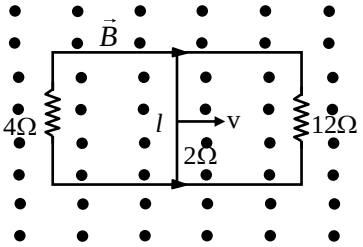
SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

1. Compute the value of battery current (in Ampere) for the circuit shown in figure. All the resistances are in ohm.

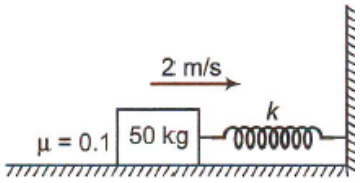


2. In the figure shown, a uniform magnetic field $|\vec{B}| = 0.5T$ is perpendicular to the plane of circuit. The sliding rod of length $l = 0.25m$ moves uniformly with constant speed, $v = 4ms^{-1}$. If the resistance of the sliding rod is $2\Omega,$, then the current flowing through the sliding rod is $\eta \times 10^{-1} A$. Find the value of η.



SPACE FOR ROUGH WORK

3. A block of mass 50 *kg* is projected horizontally on a rough horizontal floor. The coefficient of friction between the block and the floor is 0.1. The block strikes a light spring of stiffness $k = 100$ *N*/*m* with a velocity 2 *m*/*s*, the maximum compression (in meters) of the spring is _____.



4. A spherical soap bubble of radius 3 *cm* is formed inside another spherical soap bubble of radius 6 *cm*. If the internal pressure of the smaller bubble of radius 3 cm in the above system is equal to the internal pressure of the another single soap bubble of radius *r cm*. The value of *r* is _____.

5. M grams of steam at 100°C is mixed with 200 *g* of ice at its melting point in a thermally insulated container. If it produces liquid water at 40°C, the value of *M* is _____. [Heat of vaporization of water is 540 *cal*/*g* and heat of fusion of ice is 80 *cal*/*g*, specific heat of water = 1 *cal*/*g* °C]

6. The average translational kinetic energy of N_2 gas molecules at $x\times10^2\,°C$ becomes equal to the kinetic energy of an electron accelerated from rest through a potential difference of 0.1 volt. The nearest integer value of *x* is _____. [Given : $k_B = 1.38\times10^{-23}\ J/K$]

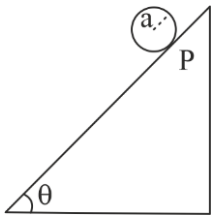
SPACE FOR ROUGH WORK

7. When a moving coil galvanometer is shunted with 5Ω resistor, it shows a full scale deflection for a current of 250 *mA*. However when 1050Ω resistance is connected with it in series (while shunt is removed), it gives full scale deflection for 25 volt. The resistance of galvanometer is _____ Ω.

8. A plane electromagnetic wave with frequency of 30 *MHz* travels in free space. At particular point in space and time, electric field is 6 *V*/*m*. The magnetic field at this point will be $x\times10^{-8}T$. The value of *x* is _____.

9. What is the power output (in *MW*) of a ${}_{92}U^{235}$ reactor if it takes 16 days to use up 864 *gms* of fuel and if each fission produces 235 *MeV* of usable energy? [Avogadro number $= 6\times10^{23}/mol$]

10. A solid disc of radius '*a*' and mass '*m*' rolls down without slipping on an inclined plane making an angle θ with the horizontal. The acceleration of the disc will be $\frac{2}{b}g\sin\theta$, where *b* is _____.



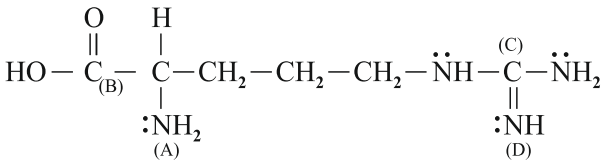
SPACE FOR ROUGH WORK

PART II : CHEMISTRY	MARKS: 100

SECTION 1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. Given below is the structure of Arginine.



The correct hybridization of labelled atoms is:

	(A)	(B)	(C)	(D)		(A)	(B)	(C)	(D)
(A)	sp^3	sp	sp^2	sp^2	**(B)**	sp^3	sp^2	sp	sp
(C)	sp^3	sp^2	sp^2	sp^2	**(D)**	sp^2	sp^2	sp^2	sp^2

2. Which of the following statements are correct regarding $[Cr(NH_3)_6]^{3+}$?

I. It is an inner orbital complex.

II. It is an outer orbital complex

III. It is paramagnetic and octahedral in shape.

IV. It is diamagnetic and octahedral in shape.

(A) I and III **(B)** I and IV **(C)** II and III **(D)** II and IV

SPACE FOR ROUGH WORK

3. Given below are two statements:

Statement-I : When $KMnO_4$ solution is added to oxalic acid solution, the decolorization is slow in the beginning but becomes instantaneous after sometime.

Statement II : During the reaction between $KMnO_4$ and oxalic acid, MnO_4^- catalyzes the reaction.

In the light of above statements, choose the correct answer from the options given below:

(A) Both statements I and II are false

(B) Both statements I and II are true

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

4. Match List I with List II.

List I (Reaction)		**List I (Color of product)**	
(A)	I_2 + starch $\rightarrow$ Product	**(I)**	White
(B)	$NO_2^- + CH_3COOH \longrightarrow X$ (X $\downarrow$ Sulphanilic acid and 1 – naphthyl amine) Product	**(II)**	Purple
(C)	$S^{2-} + Na_2[Fe(CN)_5NO] \rightarrow$ Product	**(III)**	Red
(D)	$SO_4^{2-} + (CH_3COO)_2\ Pb \rightarrow$ Product	**(IV)**	Blue

(A) A $\rightarrow$ IV, B $\rightarrow$ II, C $\rightarrow$ I, D $\rightarrow$ III **(B)** A $\rightarrow$ II, B $\rightarrow$ III, C $\rightarrow$ I, D $\rightarrow$ IV

(C) A $\rightarrow$ IV, B $\rightarrow$ III, C $\rightarrow$ II, D $\rightarrow$ I **(D)** A $\rightarrow$ III, B $\rightarrow$ IV, C $\rightarrow$ II, D $\rightarrow$ I

5. During the preparation of Mohr's salt, dilute H_2SO_4 is used instead of conc. H_2SO_4 in order to:

(A) prevent oxidation **(B)** prevent hydrolysis

(C) prevent reduction **(D)** prevent precipitation

SPACE FOR ROUGH WORK

6. Which of the following statements are correct?

(1) In group 6, Mo(VI) and W (VI) are less stable than Cr(VI).

(2) The order of oxidizing power is $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$.

(3) Fe^{2+} is stronger reducing agent than Cr^{2+} in aq. Medium.

(4) The ability of oxygen to stabilize high oxidation states in 3-d series exceeds that of fluorine.

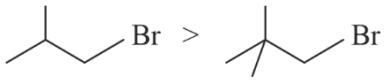
Choose the correct answer from the options below:

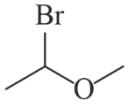
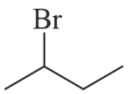
(A) 1, 2, 4 only **(B)** 2, 4 only **(C)** 3, 4 only **(D)** 1, 2, 3 only

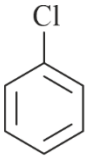
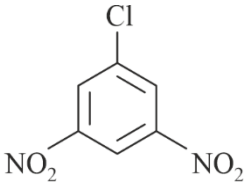
7. Which of the following polymer is stored in the liver of animals?

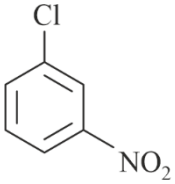
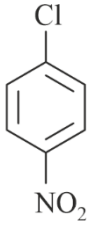
(A) Amylose **(B)** Cellulose **(C)** Amylopectin **(D)** Glycogen

8. Identify the correct order of reactivity for the following pairs towards the respective mechanism.

(1) S_N2  >

(2) S_N1  > 

(3) Electrophilic substitution  > 

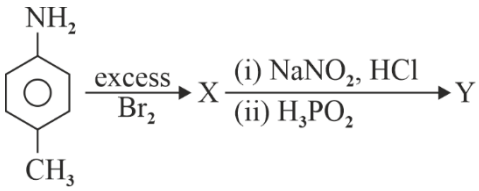
(4) Nucleophilic substitution  > 

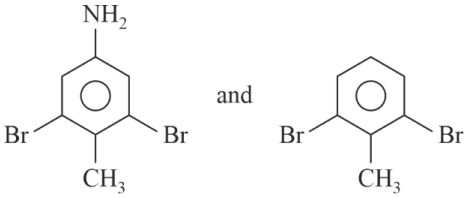
Choose the correct answer from the options given below:

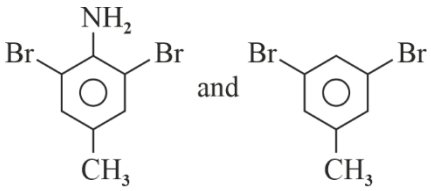
(A) 1, 2, 3 only **(B)** 1, 3 only **(C)** 1, 2, 3 and 4 **(D)** 2, 3, 4 only

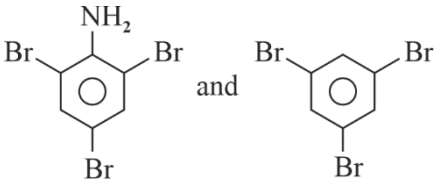
SPACE FOR ROUGH WORK

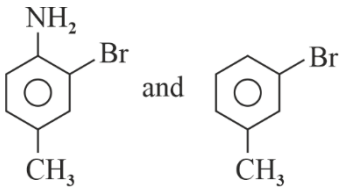
9. What is the product X and Y in following reaction?



(A) 

(B) 

(C) 

(D) 

10. Which of the following orders is/are correct with respect to the mentioned property?

I. $HF > HI > HBr > HCl$ (Boiling point)

II. $NH_3 > SbH_3 > AsH_3 > PH_3$ (Melting point)

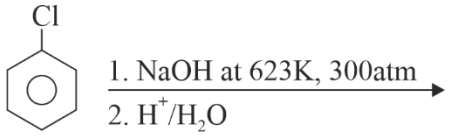
III. $O > S > Se > Te > Po$ (Electron affinity)

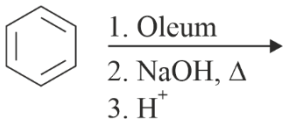
IV $Cl_2 > Br_2 > F_2 > I_2$ (Bond Dissociation Enthalpy)

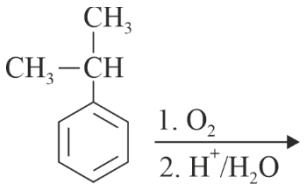
(A) I, II and III **(B)** I, II and IV **(C)** I, II, III and IV **(D)** II and IV

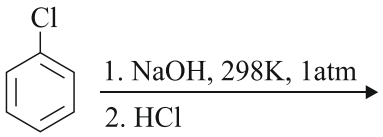
SPACE FOR ROUGH WORK

11. Which of the following reactions will yield phenol?

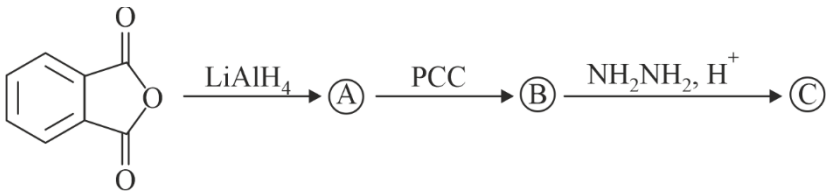
I. 

II. 

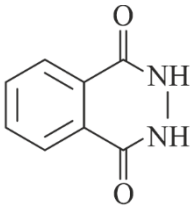
III. 

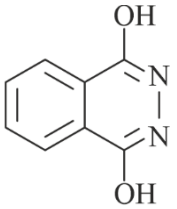
IV. 

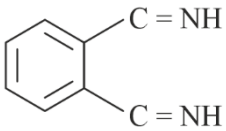
(A) Only I and II **(B)** I, II and III **(C)** I, II, III and IV **(D)** II and III

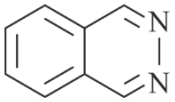
12. 

Product C is:

(A) 

(B) 

(C) 

(D) 

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13. The value of $\Delta_f H^\circ$ for PCl_5 is:

Given : $P_4(s) + 6Cl_2(g) \rightarrow 4PCl_3(\ell); \Delta H = -1270\,kJ/mol$

$PCl_3(\ell) + Cl_2(g) \rightarrow PCl_5(s); \Delta H = -137\,kJ/mol$

(A) 772 kJ/mol **(B)** –498 kJ/mol **(C)** –454.5 kJ/mol **(D)** –772 kJ/mol

14. 120 g of an organic compound that contains only carbon and hydrogen gives 330 g of CO_2 and 270 g of water on complete combustion. The percentage of carbon and hydrogen, respectively are:

(A) 25 and 75 **(B)** 40 and 60 **(C)** 60 and 40 **(D)** 75 and 25

15. $NiCl_2$ + NH_4OH + dimethyl glyoxime $\rightarrow$ complex

X $\rightarrow$ Number of cyclic rings in the complex

Y $\rightarrow$ Number of hydrogen bonds in the complex

X and Y are:

(A) X = 4, Y = 2 **(B)** X = 4, Y = 4 **(C)** X = 2, Y = 2 **(D)** X = 2, Y = 4

16. Match List I & List II.

List I (Organic Compounds)		**List II (Test)**	
(A)	Polysaccharides	**(P)**	Biuret test
(B)	Triglycerides	**(Q)**	Iodine test
(C)	Monosaccharides	**(R)**	Acrolein test
(D)	Proteins	**(S)**	Barfoed's test

(A) A $\rightarrow$ S, B $\rightarrow$ P, C $\rightarrow$ Q, D $\rightarrow$ R **(B)** A $\rightarrow$ Q, B $\rightarrow$ R, C $\rightarrow$ S, D $\rightarrow$ P

(C) A $\rightarrow$ Q, B $\rightarrow$ P, C $\rightarrow$ S, D $\rightarrow$ R **(D)** A $\rightarrow$ S, B $\rightarrow$ P, C $\rightarrow$ R, D $\rightarrow$ Q

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17. Which of the following statements are correct.

I. The pH of 10^{-8} M aq. Solution of HCl is 6.96 at 25°C. ($K_w = 10^{-14}$)

II. The molar solubility of $Zr_3(PO_4)_4$ is given by the expression $S = \left(\frac{K_{sp}}{6912}\right)^{1/7}$

III. Phosphoric acid is a dibasic acid whereas ammonium hydroxide is a monoacidic base.

IV. The conjugate base of H_2O is H_3O^+ ion.

(A) I and III **(B)** I and II **(C)** II and III **(D)** III and IV

18. **Statement-I :** In paper chromatography, the characteristic rate of movement of each substance on the chromatoprophic paper is represented by retardation factor or R_f value

Statement-II : R_f value of a substance is generally greater than one.

(A) Both statements-I and statement-II are true and statement-II is the correct explanation of statement-I

(B) Both statements-I and statement-II are true but statement-II is not the correct explanation of statement-I

(C) Statement-I is true and statement-II is false

(D) Statement-I is false and statement-II is true

19. Samarium belongs to 4f series. Its electronic configuration is.

(A) [Xe] $4f^7\ 6s^1$ **(B)** [Xe] $4f^6\ 6s^2$

(C) [Xe] $4f^7\ 5d^1\ 6s^2$ **(D)** [Xe] $4f^{10}\ 6s^2$

20. The decreasing order of the atomic radii of N, O, F, Cl, and Br is:

(A) Br > Cl > O > N > F **(B)** Br > Cl > N > O > F

(C) Br > Cl > F > N > O **(D)** Br > N > Cl > O > F

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SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

1. The number of possible geometrical isomer for the complex $[Pt(en)_2Cl_2]^{2+}$ is _____.

2. Sum of bond orders in N_2, N_2^+, N_2^-, N_2^{2-}, He_2 and Li_2 is _____.

3. X = Sum of number of bonding electrons around the underlined atoms in $\underline{P}F_5$, $\underline{S}F_6$, $H_2\underline{S}O_4$.
Y = Total number of lone pairs in PCl_5, SF_6, H_2SO_4.
Find the value of X + Y.

4. Substance A reacts according to first order kinetics with $k = 5.25 \times 10^{-5}$ sec^{-1}. The rate of reaction after 3.66 hour if reaction started with 1.0 M of A is $x \times 10^{-5}$ mol L^{-1} sec^{-1}. The value of x is _____. (Nearest Integer)

5. If $E^\circ_{Fe^{2+}/Fe} = -0.44\,V$ and $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77\,V$. Calculate $E^\circ_{Fe/Fe^{3+}}$ in mV.

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6. Copper under goes first ionisation and forms Cu^+ ion. The value of azimuthal quantum number of outermost electron of Cu^+ is 'x' and principal quantum number is 'y' then value of x × y is _____.
[Atomic number of Cu = 29]

7. In the given below oxides Cl_2O_7, Na_2O, Al_2O_3, N_2O, CaO, SO_2, BaO, P_4O_{10}, NO is:
X = Number of amphoteric oxides.
Y = Number of acidic oxides.
Then X × Y = _____.

8. The freezing point of a dilute glucose solution having osmotic pressure of 30 atm at 25°C is –x°C. What is value of x? (Nearest Integer) $[(K_f)_{H_2O} = 1.86\ K\,kg/mol$ and molality is equal to molarity]

9. In how many of the following processes, ΔS is positive?

(1) $O_2(g, 10\,atm) \rightarrow O_2(g, 2\,atm)$ **(2)** $O_2(g, 273\,K) \rightarrow O_2(g, 300\,K)$

(3) $Cl_2(g) \rightarrow 2\,Cl(g)$ **(4)** $C(diamond) \rightarrow C(graphite)$

(5) $N_2(g, 2\,atm) \rightarrow N_2(g, 4\,atm)$ **(6)** $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

10. For the equilibrium reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ the value of equilibrium constant, $K_c = 10$ at 400 K. The value of equilibrium constant, K_p is _____ × 10^{-3}.
(Nearest integer) [Given: R = 0.08 L atm mol^{-1} K^{-1}]

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PART III : MATHEMATICS	MARKS: 100

SECTION 1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. Two sets A and B as under:

$A = \{(a, b) \in R \times R : |a - 5| < 1 \text{ and } |b - 5| < 1\}$; $B = \{(a, b) \in R \times R : 4(a - 6)^2 + 9(b - 5)^2 \le 36\}$. Then:

(A) Neither $A \subset B$ nor $B \subset A$ **(B)** $B \subset A$

(C) $A \subset B$ **(D)** $A \cap B = \phi$ (an empty set)

2. A real valued function $f(x)$ satisfies the functional equation $f(x - y) = f(x) f(y) - f(a - x) f(a + y)$ where a is a given constant and $f(0) = 1$, then $f(2a - x)$ is equal to:

(A) $f(x)$ **(B)** $-f(x)$ **(C)** $f(-x)$ **(D)** $f(a) + f(a - x)$

3. If the direction ratios of a line are $1+\lambda, 1-\lambda, 2,$ and it makes an angle of 60° with the positive y-axis then λ is:

(A) $1+\sqrt{3}$ **(B)** $2-\sqrt{5}$ **(C)** $1-\sqrt{3}$ **(D)** $3+\sqrt{5}$

4. If p, q, r be the roots of $x^3 - ax^2 + bx - c = 0,$ then the area of the triangle whose sides are p, q, r is:

(A) $\frac{1}{4}\left[a(4ab-a)\right]^{1/2}$ **(B)** $\frac{1}{2}\left[b(4ab-a+c)\right]^{1/2}$

(C) $\frac{1}{4}\left[a(4ab-a^3-8c)\right]^{1/2}$ **(D)** $\frac{1}{4}\left[b(4ab-a^3-8c)\right]^{1/2}$

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5. The value of $({}^{21}C_1 - {}^{10}C_1) + ({}^{21}C_2 - {}^{10}C_2) + ({}^{21}C_3 - {}^{10}C_3) + ({}^{21}C_4 - {}^{10}C_4) + ... + ({}^{21}C_{10} - {}^{10}C_{10})$ is:

(A) $2^{21} - 2^{10}$ **(B)** $2^{20} - 2^9$ **(C)** $2^{20} - 2^{10}$ **(D)** $2^{21} - 2^{11}$

6. The set of all $\alpha \in R$, for which $\omega = \frac{1+(1-8\alpha)z}{1-z}$ is a purely imaginary number, for all $z \in C$ satisfying $|z| = 1$ and Re $(z) \neq 1$, is:

(A) An empty set **(B)** Equal to R **(C)** $\{0\}$ **(D)** $\left\{0, \frac{1}{4}, -\frac{1}{4}\right\}$

7. Let $z \in C$ be such that $|z| < 1$. If $\omega = \frac{5+3z}{5(1-z)}$, then:

(A) $5\,\text{Re}(\omega) > 4$ **(B)** $5\,\text{Im}(\omega) < 1$ **(C)** $5\,\text{Re}(\omega) > 1$ **(D)** $4\,\text{Im}(\omega) > 5$

8. Let α and β be the roots of the quadratic equation $x^2 \sin\theta - x(\sin\theta\cos\theta + 1) + \cos\theta = 0$ $(0 < \theta < 45°)$ and $\alpha < \beta$. Then $\sum_{n=0}^{\infty}\left(\alpha^n + \frac{(-1)^n}{\beta^n}\right)$ is equal to:

(A) $\frac{1}{1-\cos\theta} + \frac{1}{1+\sin\theta}$ **(B)** $\frac{1}{1+\cos\theta} - \frac{1}{1-\sin\theta}$

(C) $\frac{1}{1+\cos\theta} + \frac{1}{1-\sin\theta}$ **(D)** $\frac{1}{1-\cos\theta} - \frac{1}{1+\sin\theta}$

SPACE FOR ROUGH WORK

9. If the four-letter words (need not be meaningful) are to be formed using the letters from the word "MEDITERRANEAN" such that the first letter is *R* and the fourth letter is *E*, then the total number of all such words is:

(A) 110 **(B)** 59 **(C)** $\frac{11!}{(2!)^3}$ **(D)** 56

10. Let α be a fixed angle where $\alpha \in \left(0, \frac{\pi}{2}\right)$. If $P = (\cos\theta, \sin\theta)$ and $Q = (\cos(\alpha - \theta), \sin(\alpha - \theta))$ then Q is obtained from P by:

(A) Clockwise rotation around origin through an angle α

(B) Anticlockwise rotation around origin through an angle α

(C) Reflection in the line through origin with slope $\tan\alpha$

(D) Reflection in the line through origin with slope $\tan\frac{\alpha}{2}$

11. If $\lim\limits_{x\to 0}\frac{f(x)}{x^2} = a$ and $\lim\limits_{x\to 0}\frac{f(1-\cos x)}{g(x)\sin^2 x} = b$ (where, $b \neq 0$), then $\lim\limits_{x\to 0}\frac{g(1-\cos 2x)}{x^4}$, is:

(A) $\frac{4a}{b}$ **(B)** $\frac{a}{4b}$ **(C)** $\frac{a}{b}$ **(D)** None of these

SPACE FOR ROUGH WORK

12. A helicopter flying along the curve given by $y - x^{3/2} = 7$, $(x \geq 0)$. A soldier positioned at the point $\left(\frac{1}{2}, 7\right)$ wants to shoot down the helicopter when it is nearest to him. Then this nearest distance is:

(A) $\frac{\sqrt{5}}{6}$ **(B)** $\frac{1}{6}\sqrt{\frac{7}{3}}$ **(C)** $\frac{1}{2}$ **(D)** $\frac{1}{3}\sqrt{\frac{7}{3}}$

13. Let $\sqrt{3}\hat{i} + j$, $\hat{i} + \sqrt{3}j$ and $\beta\hat{i} + (1-\beta)j$ respectively be the position vectors of the points *A*, *B* and *C* with respect to the origin *O*. If the distance of point *C* from the bisector of the acute angle between *OA* and *OB* is $\frac{3}{\sqrt{2}}$, then the sum of all possible values of β is:

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

14. Let $A = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$ and $B = \begin{bmatrix} 9^2 & -10^2 & 11^2 \\ 12^2 & 13^2 & -14^2 \\ -15^2 & 16^2 & 17^2 \end{bmatrix}$, then the value of $\det(A'BA)$ is:

(A) 1224 **(B)** 1042 **(C)** 540 **(D)** 539

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15. If the area of the bounded region $R = \left\{(x, y) : \max\{0, \log_e x\} \le y \le 2^x, \frac{1}{2} \le x \le 2\right\}$ is, $\alpha(\log_e 2)^{-1} + \beta(\log_e 2) + \gamma$, then the value of $(\alpha + \beta - 2\gamma)^2$ is equal to:

(A) 2 **(B)** 8 **(C)** 4 **(D)** 1

16. If $y = y(x)$ and $\left(\frac{2+\sin x}{y+1}\right)\left(\frac{dy}{dx}\right) = -\cos x,\ y(0) = 1,$ then $y\left(\frac{\pi}{2}\right)$ equals:

(A) $\frac{1}{3}$ **(B)** $\frac{2}{3}$ **(C)** $-\frac{1}{3}$ **(D)** 1

17. The maximum and minimum value of the $f(x)$ if $f(x) = \sin x + \int_{-\pi/2}^{\pi/2} (\sin x + t\cos x)\, f(t)dt$ is:

(A) $\frac{\sqrt{5}}{3}, -\frac{\sqrt{5}}{3}$ **(B)** $\sqrt{5}, -\sqrt{5}$ **(C)** $\sqrt{3}, -\sqrt{3}$ **(D)** None of these

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18. Let $f: R \to R$ be a differentiable function satisfying $f'(3) + f'(2) = 0$.

Then $\lim\limits_{x\to 0}\left(\dfrac{1+f(3+x)-f(3)}{1+f(2-x)-f(2)}\right)^{1/x}$ is equal to:

(A) 1 **(B)** e^{-1} **(C)** e **(D)** e^2

19. If e_1 and e_2 are the eccentricities of the ellipse, $\dfrac{x^2}{18}+\dfrac{y^2}{4}=1$ and the hyperbola, $\dfrac{x^2}{9}-\dfrac{y^2}{4}=1$ respectively and (e_1, e_2) is a point on the ellipse, $15x^2 + 3y^2 = k$, then k is equal to:

(A) 14 **(B)** 15 **(C)** 17 **(D)** 16

20. If α and β are the roots of the quadratic equation, $x^2 + x\sin\theta - 2\sin\theta = 0$, $\theta \in \left(0, \dfrac{\pi}{2}\right)$, then $\dfrac{\alpha^{12}+\beta^{12}}{(\alpha^{-12}+\beta^{-12})(\alpha-\beta)^{24}}$ is equal to:

(A) $\dfrac{2^6}{(\sin\theta+8)^{12}}$ **(B)** $\dfrac{2^{12}}{(\sin\theta-8)^6}$ **(C)** $\dfrac{2^{12}}{(\sin\theta+8)^{12}}$ **(D)** $\dfrac{2^{12}}{(\sin\theta-4)^{12}}$

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SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

1. The total number of numbers lying between 100 and 1000 that can be formed with the digits 1, 2, 3, 4, 5, if the repetition of digits is not allowed and numbers are divisible by either 3 or 5, is _____.

2. Let $a_1, a_2, a_3, ..., a_n$ be an arithmetic progression with $a_1 = 3$ and $S_P = \sum_{i=1}^{p} a_i, 1 \le p \le 100.$

For any integer n with $1 \le n \le 20.$ Let $m = 5n$. If $\frac{S_m}{S_n}$ does not depend on n, then sum of all possible values of a_2.

3. Let $a_1, a_2, ..., a_{10}$ be an AP with common difference –3 and $b_1, b_2, ..., b_{10}$ be a GP with common ratio 2. Let $c_k = a_k + b_k, k = 1, 2, ..., 10.$ If $c_2 = 12$ and $c_3 = 13,$ then $\sum_{k=1}^{10} c_k$ is equal to _____.

4. In a bombing attack, there is 50% chance that a bomb will hit the target. At least two independent hits are required to destroy the target completely. Then the minimum number of bombs, that must be dropped to ensure that there is at least 99% chance of completely destroying the target, is _____.

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5. The value of $\lim\limits_{x\to\pi/4}\dfrac{(\cos x+\sin x)^3-2\sqrt{2}}{1-\sin 2x}$ is $\dfrac{-P\sqrt{2}}{Q}$ then $P + Q$ is _____, where P & Q are co-prime integer.

6. If the curves, $x^2-6x+y^2+8=0$ and $x^2-8y+y^2+16-k=0,\ (k>0)$ touch each other at a point, then maximum value of k is _____.

7. Let $f : (0, 2) \to R$ be defined as $f(x)=\log_2\left(1+\tan\left(\dfrac{\pi x}{4}\right)\right)$ and $g : R \to R$ be defined as $g(x) = x-1$ and $\lim\limits_{x\to1}\dfrac{f(x)-1}{g(x)}$ is equal to $\dfrac{\pi}{a^2}\cdot\log_2 e,$ then absolute value of a is _____.

8. The value of $\int\limits_0^1\dfrac{dx}{1+\sqrt{x}+\sqrt{1+x}}$ is $\dfrac{a}{b}-\dfrac{1}{\sqrt{b}}-\dfrac{\log(1+\sqrt{b})}{b}$, then $a-b$ is _____.

9. For the natural numbers m, n, if $(1-y)^m(1+y)^n=1+a_1y+a_2y^2+....+a_{m+n}y^{m+n}$ and $a_1=a_2=10,$ then the value of $(m + n)$ is equal to _____.

10. A line parallel to the straight line $2x-y=0$ is tangent to the hyperbola $\dfrac{x^2}{4}-\dfrac{y^2}{2}=1$ at the point (x_1, y_1). Then $x_1^2+5y_1^2$ is equal to _____.

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End of 2024-Mock JEE Main - 3 (CBT)