Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Main Home Practice Test - 2 | JEE - 2024

Date: 04/01/2024 **Maximum Marks: 300**

Timing: 10:00 AM to 1:00 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.

Syllabus

Physics: Full Syllabus
Chemistry: Full Syllabus
Mathematics: Full Syllabus

Name of the Candidate (In CAPITALS) : ________________

Roll Number : ________________

OMR Bar Code Number : ________________

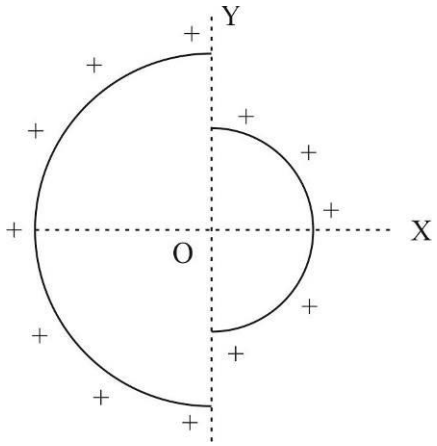
Candidate's Signature : ________________ Invigilator's Signature ________________

PART - I : PHYSICS 100 MARKS

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 semicircular wires of radius $20cm$ and $10cm$ have a common-centre at the origin O as shown in the figure. Assume that both the wires are uniformly charged and have an equal charge of $0.70nC$ each. The magnitude of electric field at the common centre of curvature O of the system is:



(A) 100 V/m **(B)** 301 V/m **(C)** 401 V/m **(D)** 501 V/m

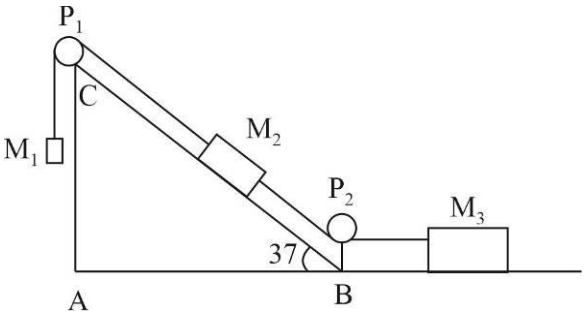
2. A pendulum suspended from the roof of an elevator at rest has a time period T_1, when the elevator moves up with an acceleration a its time period becomes T_2, when the elevator moves down with an acceleration a, its time period becomes T_3, then:

(A) $T_1 = \sqrt{(T_2 T_3)}$ **(B)** $T_1 = \sqrt{(T_2^2 + T_3^2)}$

(C) $T_1 = \dfrac{T_2 T_3 \sqrt{2}}{\sqrt{T_2^2 + T_3^2}}$ **(D)** $T_1 = \dfrac{T_2 T_3}{\sqrt{T_2^2 + T_3^2}}$

SPACE FOR ROUGH WORK

3. Two identical bodies M_2 and M_3 each of 4kg are tied to a massless inextensible string which is made to pass around pulleys P_1 and P_2 as shown in figure. Angle *ABC* = 37°. The coefficient of kinetic friction between the bodies and the surface on which they slide is 0.25. If the body M_1 moves down with uniform speed, find the value of mass M_1.



(A) 36.8 kg **(B)** 9.8 kg **(C)** 4.2 kg **(D)** 2.1 kg

4. A vertical cylinder closed from both ends is equipped with an easily moving piston dividing volume into two parts, each containing one mole of air. In equilibrium at $T_0 = 300K$ the volume of the upper part is $\eta = 4.0$ times greater than that of the lower part. At what temperature will be ratio of these volumes be equal to $\eta' = 3.0$?

(A) 329.1K **(B)** 403.2K **(C)** 239.1K **(D)** 421.9K

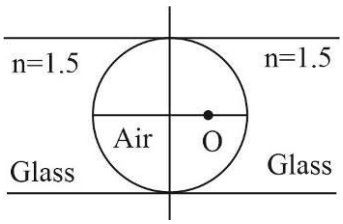
5. A particle of mass *m* moves in a circular orbit in a central potential field $U(r) = \frac{1}{2}kr^2$. If Bohr's quantization conditions are applied, radii of possible orbitals and energy levels vary with quantum number *n* as:

(A) $r_n \propto \sqrt{n},\ E_n \propto n$ **(B)** $r_n \propto n^2,\ E_n \propto \frac{1}{n^2}$

(C) $r_n \propto n,\ E_n \propto n$ **(D)** $r_n \propto \sqrt{n},\ E_n \propto \frac{1}{n}$

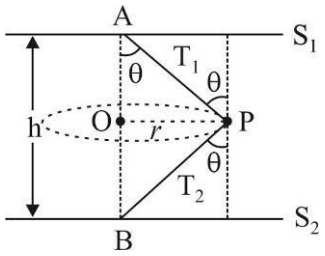
SPACE FOR ROUGH WORK

6. Two concave refracting surfaces of equal radii of curvature R face each other in air as shown in figure. A point object O is placed midway between the centre and one of the poles. Then, the separation between the images of O formed by each refracting surfaces is:



(A) 11.4 R **(B)** 1.14 R **(C)** 0.12 R **(D)** 0.0114 R

7. Two identical strings with fixed ends separated by height h have their other ends tied to body P of mass m as shown in figure. When the body rotates with uniform angular speed $2\sqrt{2g/h}$ in a horizontal plane about the vertical axis, the ratio of tensions (T_1/T_2) in the string is:



(A) $\frac{3}{5}$ **(B)** $\frac{5}{3}$ **(C)** $\frac{2}{5}$ **(D)** $\frac{5}{2}$

8. If the Broglie wavelength of an electron is equal to 10^{-3} times the wavelength of a photon of frequency $6\times10^{14}Hz,$ then the speed of electron is equal to :

(Speed of light $=3\times10^{8}m/s$ Planck's constant $=6.63\times10^{-34}J.s$ Mass of electron $=9.1\times10^{-31}kg$)

(A) $1.8\times10^{6}m/s$ **(B)** $1.1\times10^{6}m/s$ **(C)** $1.45\times10^{6}m/s$ **(D)** $1.7\times10^{6}m/s$

SPACE FOR ROUGH WORK

9. The temperature at which average de-Broglie wavelength of helium atom becomes 0.5 *nm* is:

(A) 6.6 *K* **(B)** 7.1 *K* **(C)** 279.6 *K* **(D)** 280.1 *K*

10. An electron orbiting around a nucleus has angular momentum *L*. The magnetic field produced by the electron at the centre of the orbit can be expressed as:

(A) $B=\left(\mu_0 e/8\pi mr^3\right)L$ **(B)** $B=\left(\mu_0 e/4\pi mr^3\right)L$

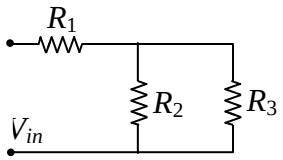
(C) $B=\left(\mu_0 e/6\pi mr^3\right)L$ **(D)** $B=\left(e/4\pi\varepsilon_0 mr^3\right)L$

11. Two bodies of mass M_1 and M_2 are kept separated by a distance d. The potential at the point where the gravitational field produced by them is zero, is:

(A) $-\frac{G}{d}\left(M_1+M_2+2\sqrt{M_1M_2}\right)$ **(B)** $-\frac{G}{d}\left(M_1M_2+2\sqrt{M_1+M_2}\right)$

(C) $-\frac{G}{d}\left(M_1-M_2+2\sqrt{M_1M_2}\right)$ **(D)** $-\frac{G}{d}\left(M_1M_2-2\sqrt{M_1+M_2}\right)$

12. For ensuring dissipation of same energy in all three resistors (R_1, R_2, R_3) connected as shown in figure, their values must be related as:



(A) $R_1 = R_2 = R_3$ **(B)** $R_2 = R_3$ and $R_1 = 4R_2$

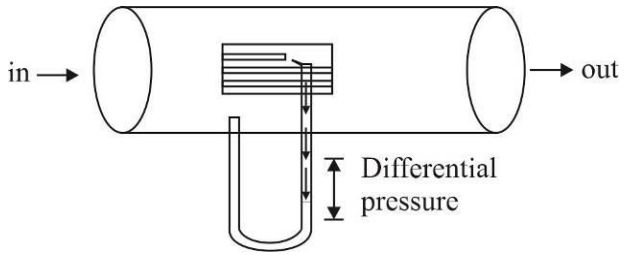
(C) $R_2 = R_3$ and $R_1 = \frac{1}{4}R_2$ **(D)** $R_1 = R_2 + R_3$

13. A thin ring has a radius *R*, density ρ and Young's modulus *Y*. The ring is rotated in its own plane about an axis passing through its centre with angular velocity ω. Then, the small increase in its radius is:

(A) $dR=\frac{\rho\omega^2R^3}{Y}$ **(B)** $dR=\frac{3\rho\omega^2R^3}{Y}$ **(C)** $dR=\frac{6\rho\omega^2R^3}{Y}$ **(D)** $dR=\frac{\rho\omega^2R^3}{2Y}$

SPACE FOR ROUGH WORK

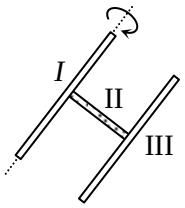
14. The Pitot tube shown in the figure is used to measure fluid flow velocity in a pipe of cross-sectional area S. It was invented by a French engineer Henri Pitot in the early 18th century. The volume of the gas flowing across the section of the pipe per unit time is:
(The difference in the liquid columns is Δh, ρ_0 and ρ are the densities of liquid and the gas respectively)



(A) $Q = 2S\sqrt{\frac{\Delta h \rho_0 g}{\rho}}$ **(B)** $Q = S\sqrt{\frac{2\Delta h \rho_0 g}{\rho}}$

(C) $Q = S\sqrt{\frac{\Delta h g \rho_0}{\rho}}$ **(D)** $Q = S\sqrt{\frac{2\Delta h g \rho}{\rho_0}}$

15. A structure in the shape of letter *H* is formed with the help of three identical rods each of length *l*. The system can rotate along axis *I*. The angular speed of the system when plane of *H* becomes vertical from its original position of rest along the horizontal is:



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

SPACE FOR ROUGH WORK

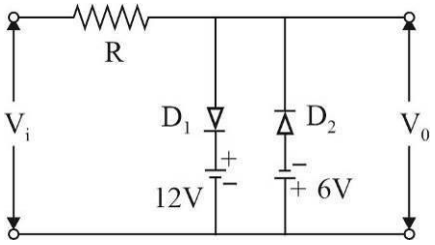
16. The impedance of the *R-L* circuit given in the adjacent figure is expressed by the relation $Z^2 = A^2 + B^2$. Then, the dimensions of *AB* are:

(A) $\left[M^1L^2I^{-2}T^{-3}\right]$ **(B)** $\left[M^2L^4I^{-4}T^{-6}\right]$ **(C)** $\left[M^1L^{-1}I^{-2}T^{-3}\right]$ **(D)** $\left[M^{-1}L^{-2}I^2T^{-4}\right]$

17. A LASER source of heat of power $1.2W$ is placed very close to one end of a rod of cross-section area $3cm^2$ and thermal conductivity $400W/mK$. The length of the rod (L) required to maintain a temperature difference of 10°C across its ends is: (Assume that all power emitted by the source falls on the rod)

(A) 1.5 *m* **(B)** 2.2 *m* **(C)** 1.8 *m* **(D)** 1 *m*

18. A sinusoidal voltage of amplitude 15V is connected the input terminals of the circuit shown in the figure. Assume that the diodes are ideal. In the output waveform:



(A) Positive peaks of the input will be clipped to +12V and negative peaks will be clipped to –6V

(B) Positive peaks of the input will be clipped to +6V and negative peaks will be clipped to –12V

(C) Positive peaks of the input will be clipped to +12V and negative peaks will be clipped to –12V

(D) Positive peaks of the input will be clipped to +6V and negative peaks be clipped to –6V

19. Two different coils have self-inductances $I_1 = 8mH, I_2 = 2mH$. The current in both the coils is increased at the same constant rate. At a certain instant of time, the current, the induced voltage and energy stored in the first coil are i_1, V_1 and W_1 respectively. Corresponding values for the second coil at the same instant are i_2, V_2 and W_2 respectively. Then:

(A) $i_1/i_2 = \frac{1}{8}$ **(B)** $i_1/i_2 = 8$ **(C)** $W_2/W_1 = 4$ **(D)** $V_2/V_1 = 4$

20. Two forces of equal magnitude act at a point making an angle θ with each other. If the direction of one of the forces is reversed, the direction of the resultant will turn through:

(A) 30° **(B)** 45° **(C)** 60° **(D)** 90°

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. A body starts from rest and travels with uniform acceleration such that it covers 8 m during the 2nd second. During the 5th second it would travel a distance _____ (in m).

2. A particle is moving along a circular path with a constant speed of $10ms^{-1}$. What is the magnitude of the change in velocity (*m*/*s*) of the particle, when it moves through an angle of $60°$ around the centre of the circle?

3. The electric potential (in volt) in a region along the *x*-axis varies with *x* according to the relation $V(x)=5+4x^2$, where *x* is in *m*. Therefore, force experienced by a charge of $1C$ placed at $x = -1m$ is _____*N*.

4. A $420m$ long rope of mass $5kg$ joins two rock climbers. One climber strikes the rope and the second one feels the effect $1.4s$ later. The tension in the rope is $\frac{n}{14}$ kilo newton. Find value of *n* _____.

5. A certain quantity of oxygen $\left(\gamma=\frac{7}{5}\right)$ is compressed isothermally until its pressure is doubled (p_2). The gas is then allowed to expand adiabatically until its original volume is restored. Then, the final pressure (p_3) in terms of initial pressure (p_1) is $p_3=\frac{p_1}{4^{1/n}}$. The value of *n* is _____.

SPACE FOR ROUGH WORK

6. A particle of mass 0.2 *kg* moves along a path given by the relation $\vec{r} = 2\cos\omega\hat{i} + 3\sin\omega t\,\hat{j}$ in meter. Then, the torque on the particle about the origin is $(n-3)$ in *Nm*. Find value of *n* _____.

7. A sinusoidal voltage of peak value 283*V* and angular frequency 320 *rad/s* is applied to a series *LCR* circuit. Given that $R = 5\Omega, L = \frac{1}{40}H$ and $C = 1000\,\mu F$. The phase difference between the voltage across the source and the current is nearly $\frac{\pi}{n}$ radian, where *n* is _____.

8. Ice at $-20°C$ is added to 50 g of water at $40°C$. When the temperature of the mixture reaches $0°C$, it is found that $20g$ of ice is still unmelted. The amount of ice added to the water was close to _____ g.

(Specific heat of water $= 4.2J/g/°C$ Specific heat of Ice $= 2.1J/g/°C$

Heat of fusion of water at $0°C = 334J/g$)

9. A ball dropped on ground from a height of 1*m* rises to a height of 75*cm* on rebounce. When thrown down from the same height with a velocity of 2*m/s*, it would rise to a height _____*cm*.

(Assume $g = 10m/s^2$)

10. A myopic adult has a far point at 0.1*m*. His power of accommodation is 4 dioptres. What is his near point with glass in cm? (Take the image distance from the lens of the eye to the retina to be 2*cm*.)

SPACE FOR ROUGH WORK

PART - II : CHEMISTRY 100 MARKS

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. The maximum number of possible oxidation states of actinoides are shown by:

(A) neptunium (Np) and plutonium (Pu) **(B)** actinium (Ac) and thorium (Th)

(C) nobelium (No) and lawrencium (Lr) **(D)** berkelium (Bk) and californium (Cf)

2. The pH of $0.02\,M\,NH_4Cl$ solution will be [given $K_b\left(NH_4OH\right)=10^{-5}$ and log 2 = 0.301]

(A) 4.65 **(B)** 5.35 **(C)** 2.65 **(D)** 4.35

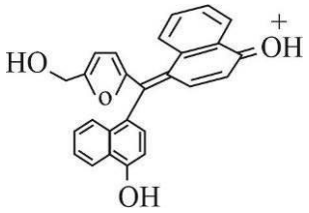
3. The set in which compounds have different nature is:

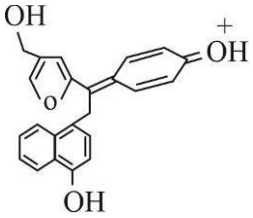
(A) B_2O_3 and N_2O_3 **(B)** NO and CO

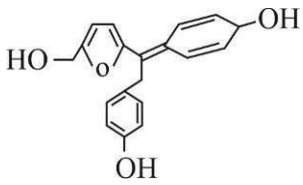
(C) Cr_2O_3 and Sc_2O_3 **(D)** CrO_3 and Mn_2O_7

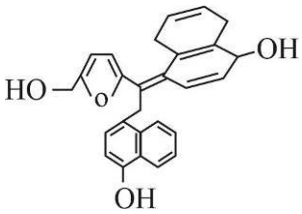
SPACE FOR ROUGH WORK

4. The correct structure of redish-purple coloured complex formed in reaction of molisch's test for carbohydrates is:

(A) 

(B) 

(C) 

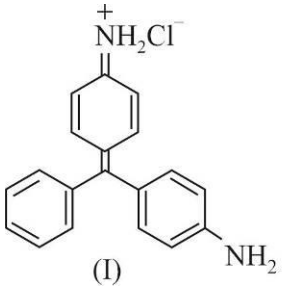
(D) 

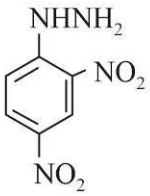
5. For the reaction of H_2 with I_2, the equilibrium constant is $2.5\times10^{-4}\,dm^3\,mol^{-1}s^{-1}$ at 327 °C and $1.0\,dm^3\,mol^{-1}s^{-1}$ at $527\,°C$. The activation energy for the reaction, in $kJ\,mol^{-1}$ is:

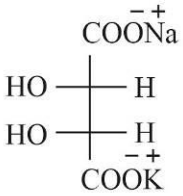
$(R = 8.314 J\,K^{-1}\,mol^{-1})$

(A) 150 **(B)** 72 **(C)** 166 **(D)** 59

6.


(I)


(II)

Alkaline $CuSO_4$ + 
(III)

$NH_4OH + AgNO_3$
(IV)

Which among the above compounds can be used to distinguish between Benzaldehyde and acetophenone?

(A) Only (II) **(B)** Only (IV)

(C) (III) and (IV) only **(D)** (I), (III) and (IV) only

SPACE FOR ROUGH WORK

7. The crystal field stabilization energy (CFSE) of $\left[Fe(H_2O)_6\right]Cl_2$ and $K_2\left[NiCl_4\right]$ respectively, are:

(A) $-0.4\Delta_0$ and $-1.2\Delta_t$ **(B)** $-0.4\Delta_0$ and $-0.8\Delta_t$

(C) $-2.4\Delta_0$ and $-1.2\Delta_t$ **(D)** $-0.6\Delta_0$ and $-0.8\Delta_t$

8. For the reaction,

$2SO_2(g)+O_2(g)\rightleftharpoons 2SO_3(g)$,

$\Delta H=-57.2 kJ\,mol^{-1}$ and $K_c=1.7\times10^{16}$.

Which of the following statement is INCORRECT?

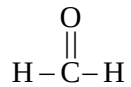
(A) The equilibrium constant decreases as the temperature increases

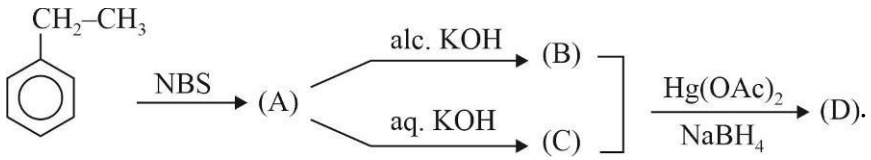
(B) The addition of inert gas at constant volume will not affect the equilibrium constant

(C) The equilibrium constant is large suggestive of reaction going to completion and so no catalyst is required.

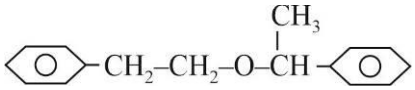
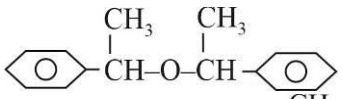
(D) The equilibrium will shift in forward direction as the pressure increases.

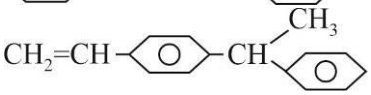
9. The species given below that does NOT show disproportionation reaction is:

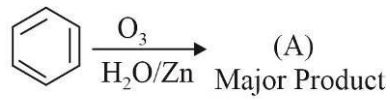
(A)  **(B)** HNO_2 **(C)** $H_2PO_2^-$ **(D)** SO_4^{2-}

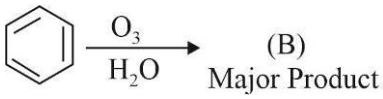
10. In the given reaction 

Product (D) is:

(A)  **(B)** 

(C)  **(D)** 

11. 



For above chemical reactions, identify the correct statement from the following.

(A) Compound 'A' is Glyoxal and compound 'B' is oxalic acid

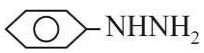
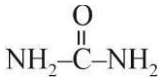
(B) Both compound 'A' and compound 'B' are oxalic acid

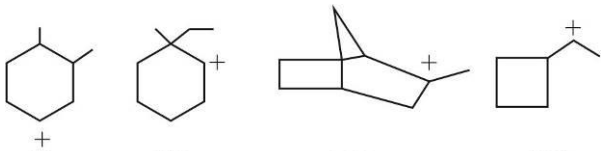
(C) Compound 'A' is oxalic acid and compound 'B' is Glyoxal

(D) Both compound 'A' and compound 'B' are Glyoxal

SPACE FOR ROUGH WORK

12. Which of the following will not give test for nitrogen in lassaigne's test?

(A)  **(B)**  **(C)** NH_2NH_2 **(D)** 

13. 

(I) (II) (III) (IV)

Among the given carbocations rearrangement is favourable.

(A) (I), (II) and (III) only **(B)** (II) and (IV) only

(C) (II) only **(D)** (I) and (II) only

14. The correct order of the wavelength of absorption for the given complex.

(A) $\left[CrCl_6\right]^{3-} > \left[Cr\left(H_2O\right)_6\right]^{3+} > \left[Cr\left(NH_3\right)_6\right]^{3+}$

(B) $\left[Cr(H_2O)_6\right]^{3+} > \left[CrCl_6\right]^{3-} > \left[Cr\left(NH_3\right)_6\right]^{3+}$

(C) $\left[Cr(NH_3)_6\right]^{3+} > \left[Cr\left(H_2O\right)_6\right]^{3+} > \left[CrCl_6\right]^{3-}$

(D) $\left[CrCl_6\right]^{3-} > \left[Cr\left(NH_3\right)_6\right]^{3+} > \left[Cr(H_2O)_6\right]^{3+}$

15. According to the Crystal Field Theory, which one of the following compounds is an inner orbital complex?

(A) $\left[NiCl_2\left(PPh_3\right)_2\right]$ **(B)** $\left[Ni\left(CN\right)_2\left(PPh_3\right)_2\right]$

(C) $\left[Co\left(H_2O\right)_3F_3\right]$ **(D)** $\left[NiF_6\right]^{4-}$

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16. Identify the incorrect statement from the following:

(A) β-1, 4 glycosidic linkage makes cellulose polymer

(B) α-amylose contains unbranched chain

(C) All polysaccharides are reducing sugars

(D) In DNA, cytosine and guanine base pairs are bonded with three hydrogen bonding

17. Thermal decomposition of a Mn compound (X) at 513 K results in compound Y, MnO_2 and a gaseous product. MnO_2 reacts with NaCl and concentrated H_2SO_4 to give a pungent gas Z. X, Y and Z respectively, are :

(A) $K_2MnO_4, KMnO_4 \text{ and } Cl_2$ **(B)** $KMnO_4, K_2MnO_4 \text{ and } Cl_2$

(C) $K_2MnO_4, KMnO_4 \text{ and } SO_2$ **(D)** $K_3MNO_4, K_2MnO_4 \text{ and } Cl_2$

18. The molar solubility of $Cd(OH)_2$ is $1.84\times10^{-5}M$ in water. The expected solubility of $Cd(OH)_2$ in a buffer solution of pH = 12 is :

(A) $\frac{2.49}{1.84}\times10^{-9}M$ **(B)** $2.49\times10^{-10}M$ **(C)** $6.23\times10^{-11}M$ **(D)** $1.84\times10^{-9}M$

19. A pale green crystalline metal salt of M dissolves freely in water. On standing it gives a brown ppt. on addition of aqueous NaOH. The metal salt solution also gives a black ppt. on bubbling H_2S in basic medium. An aqueous solution of the metal salt decolourises the pink colour of the permanganate solution. The metal in the metal salt solution is:

(A) Pb **(B)** Co **(C)** Fe **(D)** Hg

20. The INCORRECT match in the following is :

(A) $\Delta G^\circ > 0, K < 1$ **(B)** $\Delta G^\circ < 0, K < 1$

(C) $\Delta G^\circ = 0, K = 1$ **(D)** $\Delta G^\circ < 0, K > 1$

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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. To synthesise 1.0 mole of product from ethyl-3-oxobutanoate_____ equivalents of CH_3MgBr reagent will be required. (Integer value)

2. 250mL of 0.5 M NaOH was added to 500 mL of 1 M HCl. The number of NaCl molecules in the solution after complete reaction is _____$\times 10^{20}$. (Nearest integer) $(N_A = 6 \times 10^{23})$

3. An average person if needs 100 kJ of muscular work to walk one kilometer then what is maximum distance (in *km*) that a person will able to walk after eating 160 gm of glucose _____.
(Nearest integer) $(\text{Use}: \Delta_C H(\text{glucose}) = -2800 \text{kJ mol}^{-1})$ [Molar mass of glucose $= 180 \text{ g mol}^{-1}$]

4. The number of nitrogen atoms in a molecule produced when benzaldehyde is reacted with 2, 4-DNP.

5. A viral preparation was inactivated in a chemical bath. The inactivation process was found to be of first order in virus concentration, and at the beginning of the experiment 25% of the virus was found to be inactivated per minute. The rate constant for viral inactivation is _____$\times 10^{-4} \text{sec}^{-1}$.
(Nearest integer) [Use: $\log 4 = 0.6; \log 3 = 0.48$]

6. At 25°C, the vapour pressure of CCl_4 is 115 mm Hg and that of $SiCl_4$ is 230 mm Hg. The mole fraction of CCl_4 in the vapour phase at 25°C if solution is made by mixing equal masses of CCl_4 and $SiCl_4$ is _____$\times 10^{-3}$. (Nearest integer) (Mass number of $Si = 28, Cl = 35.5, C = 12$)

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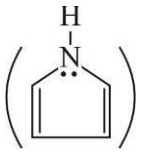
7. The number of delocalisable π electrons in pyrrole  molecule is _____.

8. The total number of unpaired electrons in t_{2g} orbitals of central atom in $[CoF_6]^{3-}$ ion is _____.

[Atomic number of Co is 27]

9. At 1400 K, for the reaction in equilibrium:

(i) $3H_{2(g)} + SO_{2(g)} \longrightarrow H_2S_{(g)} + 2H_2O_{(g)}$, $K_{p_1} = 1.8 \times 10^8$

(ii) $H_{2(g)} + \frac{1}{2}S_{2(g)} \longrightarrow H_2S_{(g)}$, $K_{p_2} = 8 \times 10^{-2}$

Thus for the equilibrium

(iii) $4H_{2(g)} + 2SO_{2(g)} \longrightarrow S_{2(g)} + 4H_2O_{(g)}$, $K_p = 5 \times 10^x$. Value of x is _____.

10. Number of electrons with $(\ell + m_\ell) = 0$ for the calcium element is _____.

(Atomic number of $Ca = 20$)

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PART - III : MATHEMATICS 100 MARKS

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. $P(x_1, y_1)$ and $Q(x_2, y_2), y_1 < 0, y_2 < 0$ be the end points of the latus rectum of the ellipse $x^2 + 4y^2 = 4$. The equations of the parabolas with latus rectum PQ are:

(A) $x^2 + 2\sqrt{3}y = 3 + \sqrt{3}$ **(B)** $x^2 - 2\sqrt{3}y = 3 + \sqrt{3}$

(C) $x^2 + 2\sqrt{3}y = 3 - \sqrt{3}$ **(D)** Both B and C

2. Let $g(x)$ be a continuous and differentiable function such that $\int_0^2 \left\{ \int_{\sqrt{2}}^{\sqrt{5/2}} \left[2x^2 - 3 \right] dx \right\} \cdot g(x)dx = 0,$ then $g(x) = 0$ when $x \in (0, 2)$ has: (Where [.] denote greatest integer function)

(A) Exactly one real root **(B)** Atleast one real root

(C) No real root **(D)** Two real roots

3. The mean and variance of seven observations are 8 and 16 respectively. If five of these are 2, 4, 10, 12, 14 then absolute differences of remaining observations will be:

(A) 2 **(B)** 14 **(C)** 8 **(D)** 6

4. Let $f(x)$ is a continuous function for all real values of x and satisfies $\int_0^x f(t)dt = \int_x^1 t^2 . f(t)dt + \frac{x^{16}}{8} + \frac{x^6}{3} + a$ then value of 'a' is equal to:

(A) $-\frac{1}{24}$ **(B)** $\frac{17}{168}$ **(C)** $\frac{1}{7}$ **(D)** None of these

5. If 3 lies between the roots of the equation $2x^2 - (a-1)x + 8 = 0,$ then the least integral value of a is:

(A) 8 **(B)** 9 **(C)** 10 **(D)** 11

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6. Let $f(x)=\begin{vmatrix} \sec x & \cos x & \sec^2 x+\cot x \operatorname{cosec} x \\ \cos^2 x & \cos^2 x & \operatorname{cosec}^2 x \\ 1 & \cos^2 x & \cos^2 x \end{vmatrix}$, then $\int_0^{\pi/2} f(x)\,dx$ is:

(A) $-\left(\frac{\pi}{4}+\frac{8}{15}\right)$ **(B)** $+\left(\frac{\pi}{4}-\frac{8}{15}\right)$ **(C)** $-\left(\frac{\pi}{8}+\frac{4}{15}\right)$ **(D)** $+\left(\frac{\pi}{8}-\frac{4}{15}\right)$

7. The complex number $z=1+i$ is rotated through an angle $\frac{3\pi}{2}$ in anticlockwise direction about the origin and stretched by additional $\sqrt{2}$ unit, then the new complex number is:

(A) $-\sqrt{2}-\sqrt{2}i$ **(B)** $\sqrt{2}-\sqrt{2}i$ **(C)** $2-\sqrt{2}i$ **(D)** None of these

8. In a ΔAEX, T is the mid-point of XE, and P is the mid-point of ET. If the ΔAPE is equilateral of side length equal to unity then which of the following alternative is not correct?

(A) $AX=\sqrt{13}$ **(B)** $\angle EAT=90°$

(C) $\cos\angle XAE=\frac{-1}{\sqrt{13}}$ **(D)** $AT=\frac{1}{\sqrt{3}}$

9. If the mapping $f(x)=ax+b,\ a<0$ maps [–1, 1] onto [0, 2], then for all values of 'θ', $A=\cos^2\theta+\sin^4\theta$ is such that:

(A) $f(0)\le A\le f(-2)$ **(B)** $f\left(\frac{1}{4}\right)\le A\le f(0)$

(C) $f\left(\frac{1}{3}\right)\le A\le f(0)$ **(D)** $f(-1)\le A\le f(-2)$

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

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

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11. The coefficient of x^n in the expansion of $\frac{1}{(1-x)(3-x)}$ is:

(A) $\frac{3^{n+1}-1}{2.3^{n+1}}$ **(B)** $\frac{3^{n+1}-1}{3^{n+1}}$ **(C)** $2\left(\frac{3^{n+1}-1}{3^{n+1}}\right)$ **(D)** None of these

12. Let α_1, α_2 and β_1, β_2 be the roots of $ax^2+bx+c=0$ and $px^2+qx+r=0$ respectively. If the system of equations $\alpha_1 y+\alpha_2 z=0, \beta_1 y+\beta_2 z=0$ has a non-trivial solution, then $\frac{b^2}{q^2}=$

(A) $\frac{ac}{pr}$ **(B)** $\frac{ar}{pc}$ **(C)** $\frac{ap}{cr}$ **(D)** None of these

13. Let F_1 and F_2 be the foci of the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ and point B (0, b) be an end point of the minor axis. If triangle BF_1F_2 is equilateral, e is the eccentricity of the ellipse and Δ is the area of the triangle BF_1F_2, then:

(A) $e=\frac{1}{4}$ **(B)** $e=\frac{1}{3}$ **(C)** $\Delta=\frac{\sqrt{3}}{4}a^2$ **(D)** $\Delta=\sqrt{3}a^2$

14. Minimum value of $n \in N$ such that $\cot^{-1}\left(\frac{n^2-10n+19}{\sqrt{3}}\right)>\frac{\pi}{6}$ is:

(A) 4 **(B)** 3 **(C)** 5 **(D)** 6

15. A particle starts at origin and moves along the x-axis in such a way that its velocity at point (x, 0) is given by $\frac{dx}{dt}=\cos^2 \pi x$. Then particle never reaches point, on:

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

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16. The function *f*, defined by $f(x)=\frac{x^2}{2}+\ln|x|-2\cos x$ increases for $x\in$

(A) R^- **(B)** R^+ **(C)** $R-\{0\}$ **(D)** $[1,\infty)$

17. If $f(x)$ is a continuous function $\forall\, x\in R$ and the range of $f(x)=(2,\sqrt{26})$ and $g(x)=\left[\frac{f(x)}{a}\right]$ is continuous $\forall x\in R$ ([.] denotes the greatest integer function), then the least positive integral value of a is:

(A) 2 **(B)** 3 **(C)** 6 **(D)** 5

18. Total number of 3 letters words that can be formed from the letters of the word 'SAHARANPUR', is equal to:

(A) 210 **(B)** 237 **(C)** 247 **(D)** 227

19. A five-digit number (having all different digits) is formed using the digits 1, 2, 3, 4, 5, 6, 7, 8 and 9. The probability that the formed number either begins or ends with an odd digit, is equal to:

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

20. The point $(-2m, m+1)$ is an interior point of the smaller region bounded by circle $x^2+y^2=4$ and the parabola $y^2=4x$ then:

(A) $-1<m<-5+2\sqrt{6}$ **(B)** $-1<m<\frac{3}{5}$

(C) $0<m<4$ **(D)** $-5-2\sqrt{6}<m<1$

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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. Let $\vec{a}=\hat{i}+2\hat{j}+3\hat{k},\ \vec{b}=2\hat{i}+3\hat{j}+4\hat{k},\ \vec{c}=4\hat{i}+\hat{j},\ \vec{d}=5\hat{i}+2\hat{j}+\hat{k}$. Consider the sequence of vectors $\vec{x}_1=\vec{a},\ \vec{x}_2=\vec{c}+\left(\frac{(\vec{x}_1-\vec{c})\cdot\vec{d}}{|\vec{d}|^2}\right)\vec{d},\ \vec{x}_3=\vec{a}+\left(\frac{(\vec{x}_2-\vec{a})\cdot\vec{b}}{|\vec{b}|^2}\right)\vec{b},\ \vec{x}_4=\vec{c}+\left(\frac{(\vec{x}_3-\vec{c})\cdot\vec{d}}{|\vec{d}|^2}\right)\vec{d},$ $\vec{x}_5=\vec{a}+\left(\frac{(\vec{x}_4-\vec{a})\vec{b}}{|\vec{b}|^2}\right)\vec{b},\ \vec{x}_6=\vec{c}+\left(\frac{(\vec{x}_5-\vec{c})\cdot\vec{d}}{|\vec{d}|^2}\right)\vec{d}$ and so on $\lim\limits_{n\to\infty}|\vec{x}_{2n}-\vec{x}_{2n+1}|=$

2. If the matrix $\begin{bmatrix}0 & 2y & z\\ x & y & -z\\ x & -y & z\end{bmatrix}$ is orthogonal, then the value of $\frac{1}{x^2}+\frac{1}{y^2}+\frac{1}{z^2}$ is equal to _____.

3. Non-zero vectors $\vec{a},\vec{b},\vec{c}$ satisfy $\vec{a}\cdot\vec{b}=0,\ (\vec{b}-\vec{a})\cdot(\vec{b}+\vec{c})=0$ and $2|\vec{b}+\vec{c}|=|\vec{b}-\vec{a}|$. If $\vec{a}=\mu\vec{b}+4\vec{c}$ then the value of μ is _____.

4. If the binomial expansion of $(a+bx)^{-2}$ is $\frac{1}{4}-3x+.....,$ where $a>0$, then $a+b$ is _____.

5. Let $\vec{a},\vec{b}$ and $\vec{c}$ be three vectors such that $|\vec{a}|=2|\vec{b}|=4|\vec{c}|$ and $2\vec{a}-3\vec{b}+6\vec{c}=\vec{0}$. If θ is the angle between $\vec{a}$ and $\vec{b}$, then $3\cos\theta$ is equal to_____.

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6. The ellipse $E_1 : \frac{x^2}{9} + \frac{y^2}{4} = 1$ is inscribed in a rectangle *R* whose sides are parallel to the coordinate axes. Another ellipse E_2 passing through the point (0, 4) circumscribes the rectangle *R*. If eccentricity of the ellipse E_2 is e then 6e is equal to_____.

7. Let $\alpha, \beta(\alpha < \beta)$ be the solutions of $\sum_{n=1}^{6} \frac{1}{\sin\left(\theta + (n-1)\frac{\pi}{4}\right)\sin\left(\theta + \frac{n\pi}{4}\right)} = 4\sqrt{2}$ and determinant value of *A* where $A = \begin{pmatrix} \sin\beta & \sin\alpha \\ \sin\alpha & \sin\beta \end{pmatrix}$ is *k* then $8k^2 =$

8. The total number of three-digit numbers, the sum of whose digits is even, is equal to _____.

9. The perpendicular distance of the point whose position vector is (1, 3, 5) from the line $\vec{r} = \hat{i} + 2\hat{j} + 3\hat{k} + \lambda\left(\hat{i} + 2\hat{j} + 2\hat{k}\right)$ is equal to:

10. $\lim_{x \to 2} \{[2 - x] + [x - 2] - x\}$ is equal to *k* then |*k*| _____.

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••• End of JEE Main Home Practice Test - 2 [JEE - 2024] •••