MET 2023 Question Paper

Time Allowed :2 Hours	Maximum Marks :200	Total Questions :50

General Instructions

Read the following instructions very carefully and strictly follow them:

- Check the question paper for completeness and correctness of printing. In case of any discrepancy, inform the Invigilator immediately.
- The question paper consists of three sections: Physics, Chemistry, and Mathematics.
- Each section contains both Multiple Choice Questions (MCQs) and Numerical Answer Type questions.
- All MCQs have four options, out of which only one is correct.
- For numerical answer type questions, write the correct numerical value as the answer.
- Each correct answer carries 4 marks.
- There is a negative marking of 1 for incorrect answers in MCQs.
- Attempt all questions within the given time limit.
- Use of calculators, mobile phones, smart watches, or any electronic devices is strictly prohibited.
- Rough work should be done only in the space provided in the question booklet.
- Do not leave the examination hall before the completion of the exam.
- Follow all instructions given by the Invigilator.

PART I - PHYSICS

1. Two stones having different masses m_1 and m_2 are projected at angles θ and $(90^\circ - \theta)$ with same velocity from the same point. The ratio of their maximum heights is:
(A) $1 : 1$
(B) $1 : \tan\theta$
(C) $\tan\theta : 1$
(D) $\tan^2\theta : 1$

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2. A force $F = (2 + x)$ acts on a particle in x-direction, where F is in newton and x in metre. The work done during displacement from $x = 1$ m to $x = 2$ m is:

(A) $2\,J$
(B) $3.5\,J$
(C) $4.5\,J$
(D) None of these

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3. A disc of mass 5 kg and radius 50 cm rolls on the ground at 10 m/s. Find the kinetic energy.

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4. The acceleration due to gravity becomes $\frac{g}{2}$ at a height equal to:
(A) $\frac{R}{4}$
(B) $\frac{R}{2}$
(C) $\frac{R}{3}$
(D) $\frac{R}{5}$

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5. Two steel wires having same length are suspended from a ceiling under the same load. If the ratio of their energy stored per unit volume is $1:4$, then the ratio of their diameters is found to be $\sqrt{k}:1$. Find the value of k.

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6. The lower end of a capillary tube is dipped into water and it is seen that water rises through 7.5 cm in the capillary. Given, surface tension of water is $7.5\times10^{-2}\,\mathbf{Nm}^{-1}$ and angle of contact is zero. Find the diameter (in mm) of the capillary tube. (Given $g=10\,\mathbf{ms}^{-2}$)

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7. A function of time is represented as follows $\sin\omega t+\cos 2\omega t+\sin 4\omega t$. The motion represented by it is:
(A) non-periodic
(B) periodic
(C) both non-periodic and periodic
(D) data insufficient

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8. A charged capacitor when filled with a dielectric $K=3$ has charge Q_0, voltage V_0 and field E_0. If the dielectric is replaced with another one having $K=9$, the new values of charge, voltage and field will be respectively:
(A) $3Q_0, 3V_0, 3E_0$
(B) $Q_0, 3V_0, 3E_0$
(C) $Q_0, \frac{V_0}{3}, 3E_0$
(D) $Q_0, \frac{V_0}{3}, \frac{E_0}{3}$

9. The resistance of a wire at $20°C$ is 20Ω and at $50°C$ is 60Ω. At which temperature its resistance will be 25Ω?
(A) $50°C$
(B) $60°C$
(C) $70°C$
(D) $80°C$

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10. A vertical disc of diameter 10 cm makes 20 revolutions per second about a horizontal axis through its centre. A uniform magnetic field 10^{-1} T acts perpendicular to the plane. If potential difference between centre and rim is $\frac{\pi}{x} \times 10^{-p}$ Volt, find x/p.

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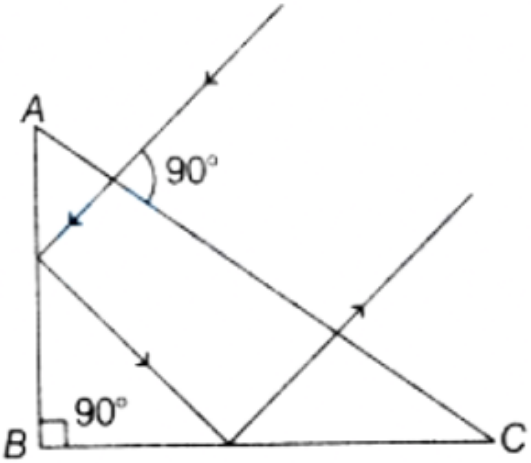
11. A ray falls on a prism ABC (AB = BC) and travels as shown in the figure. The minimum refractive index of the prism material should be:



(A) $\frac{4}{3}$
(B) $\sqrt{2}$
(C) 1.5
(D) $\sqrt{3}$

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12. In Young's double slit experiment, if the source of light changes from orange to blue, then
(A) the central bright fringe will become a dark fringe
(B) the distance between consecutive fringes will decrease
(C) the distance between consecutive fringes will increase
(D) the intensity of the minima will increase.

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13. A proton accelerated through a potential difference of 100 V has de-Broglie wavelength λ_0. The de-Broglie wavelength of an α-particle accelerated through 800 V is:
(A) $\frac{\lambda_0}{\sqrt{2}}$
(B) $\frac{\lambda_0}{2}$
(C) $\frac{\lambda_0}{4}$
(D) $\frac{\lambda_0}{8}$

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14. Light of wavelength 2475Å is incident on barium. Photoelectrons emitted describe a circle of radius 100 cm in a magnetic field of flux density $\frac{1}{\sqrt{17}} \times 10^{-5}$ tesla. The value of work function of barium is ____ eV. (Given $e/m = 1.7 \times 10^{11}$)

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15. Ionisation potential of hydrogen atom is 13.6 eV. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 eV. The spectral lines emitted by hydrogen atoms according to Bohr's theory will be:
(A) one
(B) two
(C) three
(D) four

PART II - CHEMISTRY

1. The number of Cl^- ions in 100 mL of 0.001 M NaCl solution is:
(A) 6.022×10^{23}
(B) 6.022×10^{20}
(C) 6.022×10^{19}
(D) 6.022×10^{21}

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2. Which of the following conclusion is correct regarding photoelectric effect?
(A) Energy of a photon depends upon frequency of light absorbed.
(B) Energy of a photon depends upon intensity of light.
(C) Kinetic energy of electrons increases due to increase in intensity of light.
(D) All the energy of photon is absorbed by metal surface.

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3. Which of the following species have same bond order?
I. H_2
II. B_2
III. O_2^{2-}

IV. Be_2
V. N_2

Correct option is:
(A) I and II
(B) I, II and III
(C) I, II and IV
(D) I, IV and V

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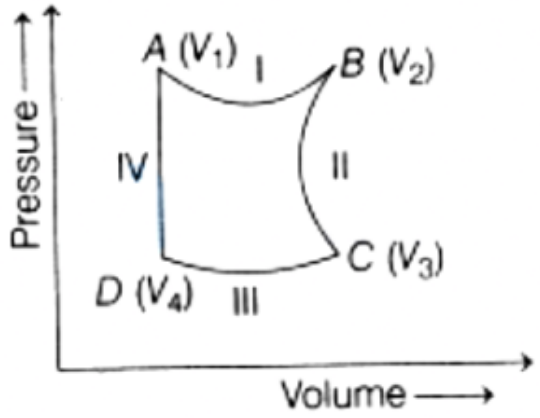
4. Consider the graph for cyclic process. The isothermal compression process among them is:



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

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5. The pK_a of acetic acid is 4.74. The concentration of CH_3COOH is $0.01\,M$. The pH of CH_3COOH is ___.

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6. The hydroxide of alkaline earth metal not soluble in water is:
(A) magnesium hydroxide
(B) calcium hydroxide
(C) beryllium hydroxide
(D) barium hydroxide

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7. Total number of $2c-2e^-$ and $3c-2e^-$ bonds present in diborane is ___.

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8. Which of the following reagents are used to convert propene to propyne?
(A) $SOCl_2$/Py, alc. KOH, H^+/H_2O
(B) Br_2/CCl_4, alc. KOH/Δ
(C) alc. KCN, $SOCl_2$
(D) alc. KOH, B_2H_6/H_2O_2

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9. A 5% solution of a substance is isotonic with a 1.5% solution of urea (molar mass = 60 g mol^{-1}) in the same solvent. If densities of both solutions are 1 g cm^{-3}, the molar mass of the substance is ___.

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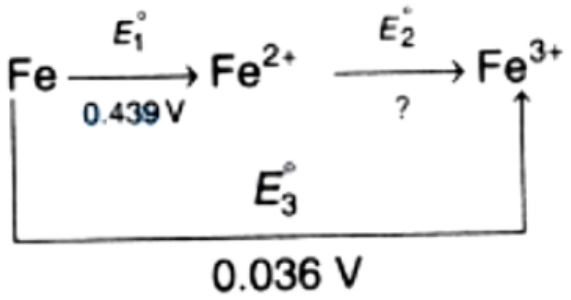
10. Value of E_2° in the given diagram (ignore negative sign).



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11. Among $Cu^{2+}, Fe^{3+}, Ti^{3+}$ and Zn^{2+} ions, the number of ions that impart colour is ___.

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12. Match the complexes in Column-I with their hybridisation in Column-II.

Column-I	Column-II
A. $[Ni(CO)_4]$	1. dsp^2
B. $[Ni(CN)_4]^{2-}$	2. sp^3
C. $[Ni(NH_3)_6]^{2+}$	3. d^2sp^3
D. $[Fe(CN)_6]^{3-}$	4. sp^3d^2

(A) A-1, B-2, C-3, D-4
(B) A-2, B-1, C-4, D-3
(C) A-1, B-3, C-2, D-4
(D) A-2, B-3, C-1, D-4

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13. Find the product Z in the series of reactions.

$$\text{Phenol} \xrightarrow{\text{Zn dust}} X \xrightarrow{CH_3Cl \text{ / anhyd. } AlCl_3} Y \xrightarrow{\text{alkaline } KMnO_4} Z$$

(A) benzaldehyde
(B) benzene
(C) benzoic acid
(D) benzophenone

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14. Which of the following reaction does not form benzaldehyde as product?
(A) Rosenmund reaction
(B) Etard reaction
(C) Gattermann Koch reaction
(D) Cannizzaro reaction

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15. In which form styrene exists at room temperature?
(A) Liquid
(B) Solid
(C) Gas
(D) Pseudo solid

PART III - MATHEMATICS

1. If complex number z lies in the interior or on the boundary of circle of radius 3 units, then maximum and minimum values of $|z+1|$ are:
(A) $(6, 0)$
(B) $(3, 0)$
(C) $(6, 3)$
(D) $(4, 1)$

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2. The number of words (with or without meaning) that can be formed from all the letters of the word "LETTER" in which vowels never come together is ___.

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3. If a^2, b^2, c^2 are in A.P., then $b+c, c+a, a+b$ are in:
(A) AP
(B) GP
(C) HP
(D) None of these

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4. If the coefficients of x^3 and x^4 in the expansion of $(1+ax+bx^2)(1-2x)^{18}$ are both zero, then (a, b) is equal to:

(A) $\left(14, \frac{272}{3}\right)$
(B) $\left(16, \frac{272}{3}\right)$
(C) $\left(16, \frac{251}{3}\right)$
(D) $\left(14, \frac{251}{3}\right)$

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5. Last two digits in 9^{50} are ___.

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6. The differential equation of all circles which pass through the origin and whose centres lie on Y-axis is:
(A) $\frac{dy}{dx} = \frac{xy}{x^2+y^2}$
(B) $\frac{dy}{dx} = \frac{2xy}{x^2+y^2}$
(C) $\frac{dy}{dx} = \frac{2xy}{x^2-y^2}$
(D) None of these

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7. If $f : \mathbb{R} \to \mathbb{R}$ is a differentiable function and $f(3) = 6$, then

$$\lim_{x\to 3} \int_6^{f(x)} \frac{2t\,dt}{t-2} \text{ is equal to}$$

(A) $18f'(3)$
(B) 0
(C) $24f'(3)$
(D) $3f'(3)$

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8. The value of $\lim_{x\to 0} \left(\frac{e^x+2^x+4^x}{3}\right)^{\frac{2}{x}}$ is:

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9. If $\sum_{i=1}^{9}(x_i - 5) = 9$ and $\sum_{i=1}^{9}(x_i - 5)^2 = 45$, then the standard deviation of the 9 items $x_1, x_2, \ldots, x_9$ is:
(A) 9
(B) 4
(C) 3
(D) 2

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10. Let $A = \{1, 2, 3, 4, 5, 6, 7\}$ and $B = \{3, 6, 7, 9\}$. Then, the number of elements in the set $\{C \subseteq A : C \cap B \neq \phi\}$ is:
(A) 112
(B) 120

(C) 108
(D) 96

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11. If $A = \begin{bmatrix} 2 & -1 \\ -7 & 4 \end{bmatrix}$ **and** $B = \begin{bmatrix} 4 & 1 \\ 7 & 2 \end{bmatrix}$**, then** $B^T A^T$ **is:**
(A) null matrix
(B) an identity matrix
(C) scalar but not an identity matrix
(D) such that $\mathrm{Tr}(B^T A^T) = 4$

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12. Let $f(x) = \frac{1}{\sqrt{1+x^2}}$**, then:**
(A) $f(x, y) = f(x) \cdot f(y)$
(B) $f(x, y) \geq f(x) \cdot f(y)$
(C) $f(x, y) \leq f(x) \cdot f(y)$
(D) $f(x, y) = f(x) - f(y)$

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13. Set of values of x **lying in** $[0, 2\pi]$ **satisfying the inequality** $|\sin x| > 2\sin^2 x$ **contains:**
(A) $(0, \frac{\pi}{6}) \cup (\pi, \frac{7\pi}{6})$
(B) $(0, \frac{7\pi}{6})$
(C) $\frac{\pi}{6}$
(D) None of these

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14. If $\int f(x)\,dx = g(x)$**, then** $\int \cos x\, f(\sin x)\,dx$ **is equal to:**
(A) $g(\cos x) + C$
(B) $g(\sin x) + C$
(C) $\int g(x) + \sin x + C$
(D) $f(\sin x) + g(\cos x) + C$

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15. The area of the region bounded by the curves $y = |5 - x|$**,** $x = 1$**,** $x = 6$ **and the X-axis is:**
(A) 15 sq units
(B) $\frac{17}{2}$ sq units
(C) 13 sq units
(D) 16 sq units

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16. The area bounded by the curves $y = \tan x,\ -\frac{\pi}{3} \leq x \leq \frac{\pi}{3}$**,** $y = \cot x,\ \frac{\pi}{6} \leq x \leq \frac{\pi}{2}$ **and the X-axis is:**

(A) $\ln\sqrt{3}$
(B) $\ln\sqrt{2}$
(C) $\ln 2$
(D) $\ln\left(\frac{3}{2}\right)$

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17. If the vectors $\vec{p}=(a+1)\hat{i}+a\hat{j}+a\hat{k},\ \vec{q}=a\hat{i}+(a+1)\hat{j}+a\hat{k}$ and $\vec{r}=a\hat{i}+a\hat{j}+(a+1)\hat{k}$ are coplanar, then the value of a is ___.

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18. If the lines $\frac{x-1}{2}=\frac{y+1}{3}=\frac{z-1}{4}$ and $\frac{x-3}{1}=\frac{y-k}{2}=\frac{z}{1}$ intersect, then k is equal to:
(A) -1
(B) $\frac{2}{9}$
(C) $\frac{9}{2}$
(D) 0

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19. If the foot of the perpendicular drawn from the point $(2,0,1)$ on a line passing through $(\alpha,5,1)$ is $\left(\frac{7}{3},\frac{5}{3},\frac{11}{4}\right)$, then α is equal to ___.

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20. An unbiased coin is tossed n times. If the probability of getting 5 heads is equal to the probability of getting 6 heads, then the probability of getting 3 heads is:
(A) ${}^{11}C_5\left(\frac{1}{2}\right)^5$
(B) ${}^{11}C_6\left(\frac{1}{2}\right)^6$
(C) ${}^{11}C_3\left(\frac{1}{2}\right)^{11}$
(D) $\frac{11}{1024}$
