MHT CET 2025 Apr 12 Shift 2 Question Paper

Time Allowed :3 Hour	Maximum Marks :200	Total Questions :200

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 200 questions. The maximum marks are 200.
3. There are three parts in the question paper consisting of Physics, Chemistry and Biology (Botany and Zoology) having 50 questions in each part of equal weightage.

1. Using the Nernst equation, calculate the cell potential (E_{cell}) under non-standard conditions.

The Nernst equation is given as:

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{0.0591}{n} \log k$$

(1) $E_{\text{cell}} = 1.10\,\text{V}$

(2) $E_{\text{cell}} = 1.00\,\text{V}$

(3) $E_{\text{cell}} = 1.01\,\text{V}$

(4) $E_{\text{cell}} = 0.90\,\text{V}$

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2. Given the first-order reaction with rate constant k, calculate the rate of the reaction at a certain concentration of reactant $[A]$.

The rate constant k is given by the equation:

$$k = \frac{2.303}{t} \log \left(\frac{A_0}{A_t} \right)$$

(1) $R = 0.5\,\text{mol/L}$

(2) $R = 1.5\,\text{mol/L}$

(3) $R = 2.0\,\text{mol/L}$

(4) $R = 3.0\,\text{mol/L}$

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3. Given the following information about a chemical reaction:

- Change in Gibbs free energy (ΔG) = $-100\,\text{kJ/mol}$
- Change in enthalpy (ΔH) = $-150\,\text{kJ/mol}$
- Temperature (T) = $298\,\text{K}$

Calculate the change in entropy (ΔS) for the reaction.

The relationship between Gibbs free energy (ΔG), enthalpy (ΔH), and entropy (ΔS) is given by the equation:

$$\Delta G = \Delta H - T\Delta S$$

(1) $\Delta S = 0.17\,\text{kJ/mol·K}$

(2) $\Delta S = 0.25\,\text{kJ/mol·K}$

(3) $\Delta S = 0.35\,\text{kJ/mol·K}$

(4) $\Delta S = 0.45\,\text{kJ/mol·K}$

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4. What is silicon?

(1) A metal

(2) A non-metal

(3) A metalloid

(4) An alkali metal

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5. What is the coordination number of the atoms in a cubic close-packed (CCP) structure?

(1) 4

(2) 6

(3) 8

(4) 12

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6. Three springs having spring constants k, $2k$, and $3k$ are connected (i) in series and (ii) in parallel. Let the effective spring constants for the series and parallel combinations be k_s and k_p respectively. What is the ratio $\frac{k_p}{k_s}$?

(A) 11:1

(B) 1:1

(C) 6:11

(D) 1:11

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7. Which of the following logic gates produces a LOW output when a HIGH input is applied?

(A) AND gate

(B) OR gate

(C) NOT gate

(D) NAND gate

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8. A sonometer wire gives frequency f_1 with tension T_1. If the tension is made 4 times greater, what is the new frequency?

The frequency of a vibrating wire is related to the tension in the wire by the equation:

$$f \propto \sqrt{T}$$

where: - f is the frequency, - T is the tension in the wire.

If the tension is increased by a factor of 4, how does the frequency change?

(A) $f_2 = 2f_1$

(B) $f_2 = 4f_1$

(C) $f_2 = f_1$

(D) $f_2 = \sqrt{4} \times f_1$

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9. In a parallel bridge circuit involving capacitors, the circuit's resultant capacitance is to be determined. If the capacitance values are given, calculate the resultant capacitance in the parallel combination.

Assume the capacitors have the following capacitance values: - $C_1 = 2\,\mu$F - $C_2 = 3\,\mu$F - $C_3 = 4\,\mu$F

The capacitors are connected in parallel.

(1) $C_{\text{eq}} = 9\,\mu$F

(2) $C_{\text{eq}} = 6\,\mu$F

(3) $C_{\text{eq}} = 5\,\mu\text{F}$

(4) $C_{\text{eq}} = 7\,\mu\text{F}$

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10. A magnetic field is produced along the axis of a current-carrying loop. The direction and magnitude of the magnetic field at the center of the loop can be determined using the Biot-Savart law. What will be the direction of the magnetic field along the axis of the current loop?

The magnetic field produced along the axis of a circular current loop is given by the equation:

$$B = \frac{\mu_0 I R^2}{2(R^2 + x^2)^{3/2}}$$

where: - B is the magnetic field, - μ_0 is the permeability of free space, - I is the current, - R is the radius of the loop, - x is the distance from the center of the loop along the axis.

(A) Into the plane of the loop

(B) Out of the plane of the loop

(C) Parallel to the loop

(D) Zero

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11. Which of the following compounds has the highest thermal stability?

(A) Li_2CO_3

(B) Na_2CO_3

(C) K_2CO_3

(D) Rb_2CO_3

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12. A beam of unpolarized light is incident on a polarizer. The intensity of the transmitted light is measured as it passes through the polarizer. If the angle between the light's initial direction and the axis of the polarizer is θ, what is the intensity of the transmitted light?

The intensity of the transmitted light is given by Malus' law:

$$I = I_0 \cos^2 \theta$$

where: - I_0 is the intensity of the unpolarized light before passing through the polarizer, - θ is the angle between the light's initial direction and the axis of the polarizer.

(A) $I = I_0 \cos\theta$

(B) $I = I_0 \cos^2\theta$

(C) $I = I_0 \sin^2\theta$

(D) $I = I_0 \sin\theta$

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13. A body is floating in oil. The density of the oil is ρ_{oil} and the density of the body is ρ_{body}. If the body is partially submerged, what is the fraction of the body's volume submerged in the oil?

Given: - ρ_{oil} = density of the oil, - ρ_{body} = density of the body.

(A) $\frac{\rho_{\text{body}}}{\rho_{\text{oil}}}$

(B) $\frac{\rho_{\text{oil}}}{\rho_{\text{body}}}$

(C) $1 - \frac{\rho_{\text{oil}}}{\rho_{\text{body}}}$

(D) $1 - \frac{\rho_{\text{body}}}{\rho_{\text{oil}}}$

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14. In a photoelectric effect experiment, light of wavelength λ, $\lambda/2$, and $\lambda/6$ are incident on a metal surface. The stopping potential for these wavelengths are given as V_1, V_2, and V_3, respectively. If the work function of the metal is ϕ, calculate the work function using the given wavelengths.

The photoelectric equation is given by:

$$E_k = h\nu - \phi$$

where: - E_k is the kinetic energy of the emitted electrons (which is related to the stopping potential), - h is Planck's constant, - ν is the frequency of the incident light, - ϕ is the work function of the metal.

The frequency ν is related to the wavelength λ by the equation:

$$\nu = \frac{c}{\lambda}$$

where c is the speed of light.

(A) $\phi = \frac{hc}{\lambda}$

(B) $\phi = \frac{hc}{2\lambda}$

(C) $\phi = \frac{hc}{6\lambda}$

(D) $\phi = \frac{hc}{\lambda} + \frac{hc}{2\lambda} + \frac{hc}{6\lambda}$