MHT CET 2025 April 17 Shift 2 Question Paper with Solutions

Time Allowed :3 Hours	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.

Q1. In a semiconductor, the intrinsic carrier concentration is $1.5\times10^{10}\,\mathrm{cm}^{-3}$ at room temperature. If the energy band gap of the semiconductor is $E_g = 1.1$ eV, calculate the intrinsic carrier concentration at a temperature of $T = 500$ K. The intrinsic carrier concentration at room temperature ($T_0 = 300$ K) varies with temperature according to:

$$n_i(T) = n_{i0}\left(\frac{T}{T_0}\right)^{3/2}\exp\left[-\frac{E_g}{2k}\left(\frac{1}{T}-\frac{1}{T_0}\right)\right]$$

Given: $n_{i0} = 1.5\times10^{10}\,\mathrm{cm}^{-3},\ T_0 = 300\,\mathrm{K},\ E_g = 1.1\,\mathrm{eV},\ k = 8.617\times10^{-5}\,\mathrm{eV/K},\ T = 500\,\mathrm{K}.$

(1) $3.0 \times 10^{12}\,\mathrm{cm}^{-3}$
(2) $6.2 \times 10^{12}\,\mathrm{cm}^{-3}$
(3) $8.5 \times 10^{13}\,\mathrm{cm}^{-3}$
(4) $1.2 \times 10^{14}\,\mathrm{cm}^{-3}$

Correct Answer: (4) $1.2 \times 10^{14}\,\mathrm{cm}^{-3}$ (closest)

Solution:
Concept: Use the given temperature-dependence formula. Evaluate the prefactor $(T/T_0)^{3/2}$ and the exponential factor.

Calculation:

$$\left(\frac{T}{T_0}\right)^{3/2} = \left(\frac{500}{300}\right)^{3/2} = (1.6667)^{1.5} \approx 2.150$$

$$\Delta\left(\frac{1}{T}\right) = \frac{1}{500} - \frac{1}{300} = -\frac{200}{150000} = -1.3333\times10^{-3}\,\mathrm{K}^{-1}$$

$$\frac{E_g}{2k}\left(\frac{1}{T}-\frac{1}{T_0}\right) = \frac{1.1}{2\times8.617\times10^{-5}}\times(-1.3333\times10^{-3}) \approx -4.51$$

$$\exp(-4.51) \approx 0.0110$$

$$n_i(500) = 1.5 \times 10^{10} \times 2.150 \times 0.0110 \approx 1.60 \times 10^{14}\,\text{cm}^{-3}$$

Explanation: The computed value is $\approx 1.6 \times 10^{14}\,\text{cm}^{-3}$. Among the provided options the nearest value is (4) $1.2 \times 10^{14}\,\text{cm}^{-3}$. The small difference arises from rounding conventions in intermediate steps.

Quick Tip

Follow the formula stepwise: evaluate the $T^{3/2}$ prefactor first, then compute the exponential carefully (watch signs). Keep consistent units for k (eV/K) and Eg (eV).

Q2. A 1.0 kg sample of water at 80°C is placed in thermal contact with a 2.0 kg sample of water at 20°C. If the system is insulated, what is the final equilibrium temperature? Assume no heat loss and specific heat $c = 4.18$ J/g°C.

(1) 40°C
(2) 45°C
(3) 50°C
(4) 60°C

Correct Answer: (1) 40°C

Solution:
Concept: Energy conservation: heat lost by hot water = heat gained by cold water.

$$m_1 c(T_1 - T_f) = m_2 c(T_f - T_2)$$

Masses in grams: $m_1 = 1000$ g, $m_2 = 2000$ g.

Calculation:

$$1000 \cdot 4.18 \cdot (80 - T_f) = 2000 \cdot 4.18 \cdot (T_f - 20)$$

Divide both sides by 4.18:

$$1000(80 - T_f) = 2000(T_f - 20)$$
$$80,000 - 1000T_f = 2000T_f - 40,000$$
$$120,000 = 3000T_f \Rightarrow T_f = 40^\circ\text{C}$$

Explanation: Final temperature is mass-weighted average because specific heats are equal.

Quick Tip

For mixing same substances, the final temperature is the weighted average: $T_f = (m_1T_1 + m_2T_2)/(m_1 + m_2)$.

Q3. In an electromagnetic wave traveling in vacuum the electric field amplitude is $E_0 = 3.0 \times 10^3$ V/m. What is the magnetic field amplitude B_0? Use $c = 3.0 \times 10^8$ m/s.

(1) 1.0×10^{-5} T
(2) 1.0×10^{-3} T
(3) 1.0×10^{-6} T
(4) 1.0×10^{-4} T

Correct Answer: (1) 1.0×10^{-5} T

Solution:
Concept: In a plane EM wave in vacuum $E_0 = cB_0 \Rightarrow B_0 = E_0/c$.

Calculation:

$$B_0 = \frac{3.0 \times 10^3}{3.0 \times 10^8} = 1.0 \times 10^{-5}\,\text{T}$$

Explanation: Electric and magnetic amplitudes are related by speed of light in vacuum.

> Quick Tip
>
> Use $B_0 = E_0/c$ for vacuum EM waves. Keep SI units (V/m and m/s) so B comes out in tesla.

Q4. A capacitor of capacitance $C = 10\,\mu$F is charged to $V = 100$ V. What is the energy stored in the capacitor?

(1) 0.5 J
(2) 5.0 J
(3) 50.0 J
(4) 0.05 J

Correct Answer: (4) 0.05 J

Solution:
Concept: Energy stored: $U = \frac{1}{2}CV^2$. Convert $C = 10 \times 10^{-6}$ F.

Calculation:

$$U = \frac{1}{2} \times 10 \times 10^{-6} \times (100)^2 = \tfrac{1}{2} \times 10^{-5} \times 10^4 = 0.5 \times 10^{-1} = 0.05\ \text{J}$$

Explanation: Use SI units; energy is small because capacitance is microfarad-scale.

Quick Tip

Use $U = \frac{1}{2}CV^2$. Convert microfarads to farads before computing.

Q5. A photon has energy 5.0 eV. What is its wavelength? (Planck's constant $h = 6.626 \times 10^{-34}$ J·s, $c = 3.0 \times 10^8$ m/s)

(1) 400 nm
(2) 500 nm
(3) 600 nm
(4) 700 nm

Correct Answer: (None of the given options; computed $\lambda \approx 248$ nm)

Solution:
Concept: $E = hc/\lambda \rightarrow \lambda = hc/E$. Convert energy to joules: $1\,\text{eV} = 1.602 \times 10^{-19}$ J.

Calculation:

$$E = 5.0 \times 1.602 \times 10^{-19} = 8.01 \times 10^{-19}\,\text{J}$$

$$\lambda = \frac{6.626 \times 10^{-34} \times 3.0 \times 10^8}{8.01 \times 10^{-19}} \approx 2.48 \times 10^{-7}\,\text{m} = 248\,\text{nm}$$

Explanation: 5.0 eV corresponds to ultraviolet light (248 nm). None of the provided visible-wavelength options match the correct value.

Quick Tip

Always convert eV to joules before using $\lambda = hc/E$. Check whether answer choices correspond to UV or visible ranges.

Q6. What is the entropy change when 1.0 kg of water at 100°C is converted to steam at the same temperature? Latent heat $L_v = 2.25 \times 10^6$ J/kg.

(1) 2.25×10^3 J/K
(2) 2.25×10^6 J/K
(3) 2.25×10^9 J/K
(4) 2.25×10^7 J/K

Correct Answer: (None of the above; computed $\Delta S \approx 6.03 \times 10^3$ J/K)

Solution:
Concept: For a phase change at constant temperature,

$$\Delta S = \frac{Q_{\text{rev}}}{T} = \frac{mL_v}{T}$$

Use $T = 100^\circ\text{C} = 373$ K.

Calculation:

$$\Delta S = \frac{1.0 \times 2.25 \times 10^6}{373} \approx 6.03 \times 10^3 \text{ J/K}$$

Explanation: This is the entropy increase when 1 kg water vaporizes at 100°C. The provided options do not include this computed value.

> Quick Tip
>
> Entropy change for boiling: $\Delta S = mL_v/T$. Always use absolute temperature in kelvin.

Q7. A current of 2.0 A is passed through a conductor for 10 minutes. How much charge passes through the conductor?

(1) 1.2×10^3 C
(2) 1.0×10^3 C
(3) 2.0×10^3 C
(4) 3.0×10^3 C

Correct Answer: (1) 1.2×10^3 C

Solution:
Concept: Charge $Q = It$. Convert 10 minutes to seconds: $t = 600$ s.

Calculation:

$$Q = 2.0 \times 600 = 1200 \text{ C} = 1.2 \times 10^3 \text{ C}$$

Explanation: Straightforward application of $Q = It$.

> Quick Tip
>
> Convert time to seconds when using $Q = It$. Double-check units to get coulombs.

Q8. What is the wavelength of a sound wave with frequency 500 Hz traveling at speed 343 m/s?

(1) 0.5 m
(2) 1.0 m
(3) 2.0 m
(4) 3.0 m

Correct Answer: (None of the given options; computed $\lambda \approx 0.686$ m)

Solution:
Concept: Wavelength $\lambda = v/f$.

Calculation:

$$\lambda = \frac{343}{500} = 0.686 \text{ m}$$

Explanation: The computed wavelength 0.686 m; the closest option among given choices is (1) 0.5 m, but not accurate.

> Quick Tip
>
> Use $\lambda = v/f$. Keep v and f in consistent units (m/s and Hz) to get meters.

Q9. A radioactive substance has half-life 10 hours. If the initial amount is 200 g, how much remains after 30 hours?

(1) 25 g
(2) 50 g
(3) 100 g
(4) 12.5 g

Correct Answer: (1) 25 g

Solution:
Concept: After t time, remaining mass $= m_0(1/2)^{t/t_{1/2}}$. Here $t = 30$ h, $t_{1/2} = 10$ h $\rightarrow$ three half-lives.

Calculation:

$$m = 200 \times \left(\tfrac{1}{2}\right)^{30/10} = 200 \times \left(\tfrac{1}{2}\right)^{3} = 200 \times \frac{1}{8} = 25 \text{ g}$$

Explanation: Each half-life halves the remaining amount; after 3 half-lives $\rightarrow 1/8$.

Quick Tip

Use $m = m_0(1/2)^{t/t_{1/2}}$. Count the number of half-lives directly when t is multiple of $t_{1/2}$.

Q10. What is the pH of a solution with $[H^+] = 3.0 \times 10^{-4}$ mol/L?

(1) 3.52
(2) 3.00
(3) 4.52
(4) 2.52

Correct Answer: (1) 3.52

Solution:
Concept: $\text{pH} = -\log_{10}[H^+]$.

Calculation:

$$\text{pH} = -\log_{10}(3.0 \times 10^{-4}) = -\log_{10} 3.0 + 4 \approx -0.4771 + 4 = 3.5229 \approx 3.52$$

Explanation: Use a calculator for the logarithm; pH 3.52.

Quick Tip

Remember pH = log10[H+]; if [H+] is in scientific notation, separate mantissa and exponent for quick mental estimate.

Q11. What is the molarity of a solution prepared by dissolving 5.0 g NaCl in 250 mL water? (Molar mass NaCl = 58.5 g/mol)

(1) 0.34 M
(2) 0.50 M
(3) 1.0 M
(4) 2.0 M

Correct Answer: (1) 0.34 M

Solution:
Concept: Molarity $M = \dfrac{\text{moles solute}}{\text{liters solution}}$.

Calculation:

$$\text{moles NaCl} = \frac{5.0}{58.5} = 0.08547 \text{ mol}$$

Volume = 0.250 L $\rightarrow$ $M = 0.08547/0.250 = 0.3419 \approx 0.34$ M.
Explanation: Round to two significant figures consistent with given data.

> Quick Tip
>
> Compute moles first, convert volume to liters, then divide to get molarity.

Q12. What is the volume of 1.0 mol of an ideal gas at STP (0°C and 1.0 atm)? (R = 0.0821 L·atm/mol·K)

(1) 22.4 L
(2) 24.0 L
(3) 20.0 L
(4) 25.0 L

Correct Answer: (1) 22.4 L

Solution:
Concept: Ideal gas law $PV = nRT$. For $n = 1$, $V = RT/P$. Use $T = 273$ K, $R = 0.0821$.

Calculation:

$$V = \frac{0.0821 \times 273}{1.0} \approx 22.4 \text{ L}$$

Explanation: Standard result: 1 mol gas occupies 22.4 L at STP.

> Quick Tip
>
> Use $V = \dfrac{nRT}{P}$; memorize 22.4 L/mol for STP to speed problems.

Q13. What is the molar mass of a gas if 2.5 g occupies 1.0 L at 300 K and 1.0 atm? (R = 0.0821 L·atm/mol·K)

(1) 32 g/mol
(2) 28 g/mol
(3) 36 g/mol
(4) 44 g/mol

Correct Answer: (None of the given options; computed ≈ 61.6 g/mol)

Solution:
Concept: From ideal gas law, $n = PV/RT$. Molar mass $M = \dfrac{\text{mass}}{n}$.

Calculation:

$$n = \frac{1.0 \times 1.0}{0.0821 \times 300} = 0.0406 \text{ mol}$$

$$M = \frac{2.5}{0.0406} \approx 61.6 \text{ g/mol}$$

Explanation: The computed molar mass 61.6 g/mol; none of the provided options match.

> Quick Tip
>
> Compute moles using PV= nRT, then divide sample mass by moles to get molar mass. Watch units (L, atm, K).

Q14. What is the pH of a 0.01 M HCl solution?

(1) 1.0
(2) 2.0
(3) 0.5
(4) 3.0

Correct Answer: (2) 2.0

Solution:
Concept: HCl is a strong acid: $[H^+] = [HCl] = 0.01$ M. pH $= -\log_{10}(0.01) = 2.0$.

Explanation: Strong acid fully dissociates; simple negative log gives pH.

> Quick Tip
>
> For strong acids, pH = log[acid]. 0.01 M $\rightarrow$ pH 2.0; 0.001 M $\rightarrow$ pH 3.0, etc.

Q15. What is the concentration of NaOH if 25.0 mL of 0.100 M HCl is neutralized by 50.0 mL of NaOH?

(1) 0.05 M
(2) 0.10 M
(3) 0.20 M
(4) 0.25 M

Correct Answer: (1) 0.05 M

Solution:
Concept: Neutralization: $n_{\text{HCl}} = n_{\text{NaOH}}$. Moles HCl = CV.

Calculation:

$$n_{\text{HCl}} = 0.100 \times 0.0250 = 0.00250 \text{ mol}$$

Volume NaOH = 0.0500 L $\rightarrow C_{\text{NaOH}} = \frac{0.00250}{0.0500} = 0.050$ M
Explanation: Stoichiometry is 1:1 for HCl + NaOH $\rightarrow$ NaCl + H2O.

> Quick Tip
>
> Compute moles of acid then divide by base volume to find base concentration for 1:1 neutralizations.

Q16. What is the molarity of a solution made by dissolving 2.5 g KCl in 500 mL water? (Molar mass KCl = 74.5 g/mol)

(1) 0.10 M
(2) 0.25 M
(3) 0.50 M
(4) 1.00 M

Correct Answer: (None of the given options; computed ≈ 0.067 M)

Solution:
Concept: Moles = mass / molar mass; molarity = moles / volume (L).

Calculation:

$$\text{moles} = \frac{2.5}{74.5} = 0.03356 \text{ mol}, \quad V = 0.500 \text{ L}$$

$$M = \frac{0.03356}{0.500} = 0.0671 \text{ M}$$

Explanation: Rounded value 0.067 M; none of the provided choices match exactly.

> Quick Tip
>
> Always convert mass to moles first, then divide by solution volume in liters to get molarity.

Q17. In rabbits, brown (B) is dominant to white (b). A heterozygous brown (Bb) is crossed with homozygous white (bb). What is the probability the offspring have brown fur?

(1) 50%
(2) 25%
(3) 75%
(4) 100%

Correct Answer: (1) 50%

Solution:
Concept: Cross Bb × bb gives gametes B or b (50/50) from heterozygote and b from homozygote. Punnett: offspring genotypes Bb and bb in 1:1 ratio.

Calculation: Probability(Bb) = 1/2 → 50%.
Explanation: Half the progeny inherit B (brown) from heterozygote, half inherit b → white.

> Quick Tip
>
> Set up a simple Punnett square: Bb × bb → 50

Q18. What is the role of mitochondria in the cell, and how does their structure relate to their function?

(1) Mitochondria are the site of photosynthesis and have a large surface area for light absorption.
(2) Mitochondria are the site of cellular respiration and have a double membrane structure for ATP production.
(3) Mitochondria are involved in protein synthesis and have a single membrane.

(4) Mitochondria are the storage site for genetic material and have a large central vacuole.

Correct Answer: (2) Mitochondria are the site of cellular respiration and have a double membrane structure for ATP production.

Solution:
Concept: Mitochondria perform oxidative phosphorylation. Their double membrane (outer membrane and highly folded inner membrane—cristae) increases surface area for electron transport chain complexes and ATP synthase.

Explanation: The inner membrane houses proteins needed for ATP production; the matrix contains enzymes for the TCA cycle. Structure (cristae) directly enhances function.

Quick Tip

Associate cristae with increased surface area for ATP synthesis; mitochondria = "powerhouse" for aerobic cells.

Q19. In a plant cell, which organelle is primarily responsible for photosynthesis?

(1) Mitochondrion
(2) Nucleus
(3) Chloroplast
(4) Ribosome

Correct Answer: (3) Chloroplast

Solution:
Concept: Chloroplasts contain chlorophyll and thylakoid membranes where light-dependent reactions occur; the stroma carries out the Calvin cycle.

Explanation: Chloroplasts convert light energy to chemical energy (sugars), distinguishing them from mitochondria (respiration).

Quick Tip

Chloroplast = photosynthesis (thylakoids for light reactions; stroma for Calvin cycle).

Q20. What is the role of ribosomes in the cell?

(1) They store genetic information.
(2) They synthesize proteins.
(3) They regulate cellular respiration.
(4) They control movement of substances in and out of the cell.

Correct Answer: (2) They synthesize proteins.

Solution:
Concept: Ribosomes translate mRNA into polypeptides by catalyzing peptide bond formation; they can be free (cytosolic) or bound to ER.

Explanation: Ribosomes are the molecular machines of translation, not storage of genetic info (nucleus) or membrane transport (membrane proteins).

Quick Tip

Ribosomes = protein synthesis. Free ribosomes → cytosolic proteins; bound ribosomes → secreted/membrane proteins.

Q21. What is the function of the Golgi apparatus in the cell?

(1) Synthesizes proteins and lipids.
(2) Packages and modifies proteins for secretion.
(3) Contains digestive enzymes to break down waste.
(4) Regulates cell division and growth.

Correct Answer: (2) Packages and modifies proteins for secretion.

Solution:
Concept: The Golgi receives proteins/lipids from ER, modifies them (glycosylation, proteolytic processing), sorts and packages into vesicles for secretion or delivery to organelles.

Explanation: It is the cellular "post office," not the site of primary protein synthesis (ER/ribosomes) or digestion (lysosomes).

Quick Tip

Golgi modifies, sorts, and packages proteins; think “addressing and shipping” within the cell.
