MHT CET 2025 April 15 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. A sound wave travels through air with a frequency of 500 Hz and a wavelength of 0.68 m. Calculate the speed of sound in air.

(1) 340 m/s
(2) 500 m/s
(3) 200 m/s
(4) 680 m/s

Correct Answer: (1) 340 m/s

Solution:
Concept: Wave speed v is related to frequency f and wavelength λ by

$$v = f\lambda.$$

Calculation:

$$v = 500 \times 0.68 = 340 \text{ m/s}.$$

Explanation: Simple substitution into the wave relation; units: Hz·m = m/s.

Quick Tip

Use $v = f\lambda$. Check units: Hz (s^{-1}) times meters gives m/s.

Q2. In a silicon semiconductor at room temperature, the intrinsic carrier concentration is 1.5×10^{16} m^{-3}. Calculate the energy band gap E_g if

$$n_i = \sqrt{N_c N_v}\, e^{-E_g/(2kT)}$$

Given: $N_c = 2.8 \times 10^{25}\ \text{m}^{-3},\ N_v = 1.04 \times 10^{25}\ \text{m}^{-3},\ k = 1.38 \times 10^{-23}\ \text{J/K},\ T = 300\ \text{K}.$

(1) 1.1 eV
(2) 0.9 eV
(3) 2.0 eV
(4) 0.7 eV

Correct Answer: (1) 1.1 eV (approx.)

Solution:
Concept: Rearrange to solve for E_g:

$$E_g = 2kT \ln\left(\frac{\sqrt{N_c N_v}}{n_i}\right).$$

Calculation: Compute $\sqrt{N_c N_v}$:

$$\sqrt{N_c N_v} = \sqrt{(2.8 \times 10^{25})(1.04 \times 10^{25})} = \sqrt{2.912 \times 10^{50}} \approx 1.706 \times 10^{25}.$$

Ratio:

$$\frac{\sqrt{N_c N_v}}{n_i} = \frac{1.706 \times 10^{25}}{1.5 \times 10^{16}} \approx 1.137 \times 10^{9}.$$

Natural log:

$$\ln(1.137 \times 10^{9}) \approx 20.85.$$

Now

$$E_g = 2 \times (1.38 \times 10^{-23}) \times 300 \times 20.85 \approx 1.73 \times 10^{-19}\ \text{J}.$$

Convert to eV ($1\ \text{eV} = 1.602 \times 10^{-19}\ \text{J}$):

$$E_g \approx \frac{1.73 \times 10^{-19}}{1.602 \times 10^{-19}} \approx 1.08\ \text{eV} \approx 1.1\ \text{eV}.$$

Explanation: Using the effective density of states and Boltzmann factor yields $E_g \approx 1.1$ eV.

> Quick Tip
>
> Be careful with units (J vs eV). Compute $\sqrt{N_c N_v}$ first, take the ratio to n_i, then use $E_g = 2kT \ln(...)$.

Q3. An ideal gas undergoes an isothermal expansion from 2 L to 8 L at $T = 300$ K. The initial pressure is 2×10^5 Pa. Calculate the work done by the gas. (Use $R = 8.31\ \text{J/mol} \cdot \text{K}$).

(1) 7200 J
(2) 3600 J

(3) 1800 J
(4) 14400 J

Correct Answer: (None of the above) $\approx 5.545 \times 10^2$ J

Solution:
Concept: For an isothermal process, work done by the gas is

$$W = nRT \ln \frac{V_f}{V_i}.$$

Find n from $P_i V_i = nRT$. Convert volumes to m^3: $V_i = 2$ L $= 2 \times 10^{-3}$ m^3, $V_f = 8 \times 10^{-3}$ m^3.

Calculation:

$$n = \frac{P_i V_i}{RT} = \frac{(2 \times 10^5)(2 \times 10^{-3})}{8.31 \times 300} = \frac{400}{2493} \approx 0.1604 \text{ mol.}$$

$$W = nRT \ln \frac{8}{2} = (0.1604)(8.31)(300) \ln 4 = 400 \cdot 1.38629 \approx 554.5 \text{ J.}$$

Explanation: The correct isothermal-work value 5.55×10^2 J; none of the provided options match.

> Quick Tip
>
> Compute n from initial P, V, T (in SI), then use $W = nRT \ln(V_f/V_i)$. Use volumes in m^3.

Q4. A concave mirror has focal length 20 cm. An object is placed 60 cm in front of the mirror. Find the image distance.

(1) 30 cm
(2) 40 cm
(3) 60 cm
(4) 80 cm

Correct Answer: (1) 30 cm

Solution:
Concept: Mirror formula:

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}.$$

Take $f = 20$ cm, $u = 60$ cm (object distance).

Calculation:

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{20} - \frac{1}{60} = \frac{3-1}{60} = \frac{1}{30},$$

so $v = 30$ cm.

Explanation: Positive v indicates a real image on the same side as usual for concave mirrors when object is beyond focal length.

> Quick Tip
>
> Use $1/f = 1/v + 1/u$. For object beyond f, the image is real and formed between f and $2f$ if $u > 2f$ or beyond $2f$ if $u < 2f$.

Q5. A projectile is fired with an initial speed of 20 m/s at an angle of 30° above the horizontal. Find the maximum height reached by the projectile.

(1) 10 m
(2) 20 m
(3) 5 m
(4) 15 m

Correct Answer: (3) 5 m

Solution:

Concept: Maximum height H given by vertical component: $H = \dfrac{(v \sin\theta)^2}{2g}$.

Calculation:

$$v \sin\theta = 20 \sin 30^\circ = 20 \times 0.5 = 10 \text{ m/s},$$

$$H = \frac{10^2}{2 \times 9.8} = \frac{100}{19.6} \approx 5.102 \text{ m} \approx 5 \text{ m}.$$

Explanation: Use vertical component only; result 5.1 m, so option (3) 5 m.

> Quick Tip
>
> For projectile max height use $H = (v \sin\theta)^2/(2g)$. Keep g consistent (9.8 m/s^2 or 10 m/s^2 as per question).

Q6. The gravitational potential energy of an object of mass 5 kg at a height of 10 m above the surface of the Earth is:

(1) 490 J
(2) 500 J
(3) 450 J
(4) 550 J

Correct Answer: (1) 490 J

Solution:
Concept: Gravitational potential energy $U = mgh$. Use $g = 9.8$ m/s^2.

Calculation:

$$U = 5 \times 9.8 \times 10 = 490 \text{ J}.$$

Explanation: Straight application of mgh. If g approximated as 10, you would get 500 J (option 2), but with 9.8 it's 490 J.

> Quick Tip
>
> Use the given value of g. For many MCQs g=9.8 gives exact physics answer; g=10 sometimes used for rough estimates.

Q7. A car of mass 1000 kg is moving in a circular path of radius 50 m with a speed of 20 m/s. Calculate the centripetal force acting on the car.

(1) 4000 N
(2) 2000 N
(3) 5000 N
(4) 10000 N

Correct Answer: (None of the above) 8.0×10^3 N

Solution:
Concept: Centripetal force $F_c = \dfrac{mv^2}{r}$.

Calculation:

$$F_c = \frac{1000 \times (20)^2}{50} = \frac{1000 \times 400}{50} = 1000 \times 8 = 8000 \text{ N}.$$

Explanation: Computed value is 8000 N; none of the provided options equal 8000 N.

Quick Tip

Use $F_c = mv^2/r$. Double-check arithmetic: v squared grows quickly, so forces can be large even at moderate speeds.

Q8. Two charges $q_1 = +3\ \mu$C and $q_2 = -4\ \mu$C are placed 20 cm apart. Calculate the force between them. (Use $k = 9 \times 10^9\ \text{N} \cdot \text{m}^2/\text{C}^2$).

(1) 1.35 N
(2) 2.45 N
(3) 3.5 N
(4) 4.2 N

Correct Answer: (None of the above) 2.70 N (approx.)

Solution:
Concept: Coulomb's law $F = k\frac{|q_1 q_2|}{r^2}$. Convert microcoulombs to coulombs and distance to meters.

Calculation:

$$q_1 = 3 \times 10^{-6}\ \text{C},\ q_2 = 4 \times 10^{-6}\ \text{C},\ r = 0.20\ \text{m},$$

$$F = 9 \times 10^9 \frac{(3 \times 10^{-6})(4 \times 10^{-6})}{(0.20)^2} = 9 \times 10^9 \frac{12 \times 10^{-12}}{0.04} = 9 \times 10^9 \times 3 \times 10^{-10} = 2.7\ \text{N}.$$

Explanation: Force magnitude 2.7 N (attractive because charges are opposite). None of the choices match exactly.

Quick Tip

Always convert µC→C and cm→m. Check sign for attractive/repulsive, but magnitude uses absolute values.

Q9. A fluid of density 800 kg/m^3 flows through a pipe. Velocity at A is 2 m/s with area 1 m^2; velocity at B is 4 m/s. Find area at B.

(1) 0.5 m^2
(2) 1.5 m^2
(3) 2.0 m^2
(4) 4.0 m^2

Correct Answer: (1) 0.5 m^2

Solution:
Concept: Continuity equation for incompressible flow: $A_1 v_1 = A_2 v_2$.

Calculation:

$$A_2 = \frac{A_1 v_1}{v_2} = \frac{1 \times 2}{4} = 0.5 \text{ m}^2.$$

Explanation: Density irrelevant for continuity (incompressible); area decreases as velocity increases.

> Quick Tip
>
> Use $A_1 v_1 = A_2 v_2$. For incompressible fluids, volumetric flow rate is conserved.

Q10. For reaction $2A + B \rightarrow 3C$ with rate law Rate $= k[A]^2[B]$: If $[A]$ is doubled and $[B]$ is halved, how does the rate change?

(1) It remains the same.
(2) It doubles.
(3) It increases by a factor of 4.
(4) It decreases by a factor of 2.

Correct Answer: (2) It doubles.

Solution:
Concept: Rate $\propto [A]^2[B]$. If $[A] \rightarrow 2[A]$ and $[B] \rightarrow \frac{1}{2}[B]$:

Calculation:

$$\text{New rate} = k(2[A])^2 \left(\frac{1}{2}[B]\right) = k \cdot 4[A]^2 \cdot \frac{1}{2}[B] = 2k[A]^2[B].$$

Explanation: Net factor $= 4 \times \frac{1}{2} = 2$, so the rate doubles.

> Quick Tip
>
> Apply multipliers directly into the rate law; combine factors algebraically to get the overall change.

Q11. The enthalpy of formation of HCl is -92.3 kJ/mol. If 2 moles of HCl form from H_2 and Cl_2, calculate total heat released.

(1) -184.6 kJ
(2) -92.3 kJ
(3) 92.3 kJ
(4) 184.6 kJ

Correct Answer: (1) -184.6 kJ

Solution:
Concept: Enthalpy released = $\Delta H_f^\circ \times$ moles formed.

Calculation:

$$Q = 2 \times (-92.3) = -184.6 \text{ kJ}.$$

Explanation: Negative sign indicates exothermic release of heat.

> Quick Tip
>
> Multiply formation enthalpy per mole by number of moles formed; sign indicates released (negative) or absorbed (positive).

Q12. For $N_2 + 3H_2 \rightleftharpoons 2NH_3$ with $K_c = 4.0$, given $[N_2] = 0.2$ M, $[H_2] = 0.6$ M, $[NH_3] = 0.4$ M, calculate Q_c and state if system is at equilibrium.

(1) $Q_c = 1.2$, reaction will shift to the left.
(2) $Q_c = 4.0$, reaction is at equilibrium.
(3) $Q_c = 2.0$, reaction will shift to the right.
(4) $Q_c = 0.5$, reaction will shift to the left.

Correct Answer: (None of the above) $Q_c \approx 3.70$, reaction will shift to the right (toward products) since $Q_c < K_c$.

Solution:
Concept: Reaction quotient:

$$Q_c = \frac{[NH_3]^2}{[N_2][H_2]^3}.$$

Calculation:

$$Q_c = \frac{(0.4)^2}{(0.2)(0.6)^3} = \frac{0.16}{0.2 \times 0.216} = \frac{0.16}{0.0432} \approx 3.7037.$$

Compare Q_c with $K_c = 4.0$: $Q_c < K_c$ so reaction shifts to the right to produce more products.

Explanation: Reaction not at equilibrium; it will proceed forward until $Q_c = K_c$.

> Quick Tip
>
> Compute Q using current concentrations; if Q ¡ K, move right (products); if Q ¿ K, move left (reactants).

Q13. Freezing point depression: $K_f = 1.86\ ^\circ\text{C} \cdot \text{kg/mol}$. If 0.5 mol of non-volatile solute is dissolved in 1 kg water, calculate ΔT_f.

(1) 0.93 °C
(2) 1.86 °C
(3) 3.72 °C
(4) 2.79 °C

Correct Answer: (1) 0.93 °C

Solution:
Concept: $\Delta T_f = K_f \times m$ where m = molality = moles solute / kg solvent.

Calculation:

$$m = \frac{0.5}{1} = 0.5 \text{ mol/kg},$$

$$\Delta T_f = 1.86 \times 0.5 = 0.93\ ^\circ\text{C}.$$

Explanation: The freezing point is depressed by 0.93 °C relative to pure water.

> Quick Tip
>
> Molality uses kg solvent, not solution volume. Multiply Kf by molality for freezing point depression.

Q14. The energy of the nth orbit of hydrogen is $E_n = -\dfrac{13.6}{n^2}$ eV. What is the energy for $n = 2$?

(1) -3.4 eV
(2) -13.6 eV
(3) -6.8 eV

(4) -1.36 eV

Correct Answer: (1) -3.4 eV

Solution:
Concept: Plug $n = 2$ into formula:

$$E_2 = -\frac{13.6}{2^2} = -\frac{13.6}{4} = -3.4 \text{ eV}.$$

Explanation: Energy levels become less negative as n increases.

> Quick Tip
>
> Use $E_n = -13.6/n^2$. For n=1 → -13.6 eV, n=2 → -3.4 eV, n=3 → -1.51 eV, etc.

Q15. In the reaction $\text{Zn(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{ZnSO}_4\text{(aq)} + \text{Cu(s)}$**, which is the correct oxidation half-reaction?**

(1) $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$
(2) $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
(3) $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$
(4) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$

Correct Answer: (1) $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$

Solution:
Concept: Oxidation is loss of electrons. In the reaction, Zn (0) becomes Zn^{2+} (oxidation), while Cu^{2+} is reduced to Cu(0).

Explanation: The correct oxidation half-reaction is $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$.

> Quick Tip
>
> Oxidation: increase in oxidation state (loss of e^-); reduction: decrease in oxidation state (gain of e^-).

Q16. Which of the following is the primary function of the human respiratory system?

(1) To transport oxygen to tissues and carbon dioxide to the lungs.
(2) To remove waste products from the body.
(3) To facilitate digestion and absorption of nutrients.
(4) To maintain homeostasis by regulating blood pH.

Correct Answer: (1) To transport oxygen to tissues and carbon dioxide to the lungs.

Solution:
Concept: Main role of respiratory system is gas exchange: bring in O_2 for cellular respiration and remove CO_2. While respiration also helps regulate blood pH, the primary, direct function is gas exchange/transport.

Explanation: Transport to tissues is achieved by blood after pulmonary gas exchange, but the respiratory system's core job is O_2 intake and CO_2 removal.

Quick Tip

Remember: respiratory system = gas exchange (O_2 in, CO_2 out); circulatory system transports gases to/from tissues.

Q17. In a monohybrid cross between two heterozygous pea plants (Pp × Pp), what is the expected phenotypic ratio?

(1) 3:1
(2) 1:2:1
(3) 1:1
(4) 4:0

Correct Answer: (1) 3:1

Solution:
Concept: Cross Pp × Pp yields genotype ratio 1 PP : 2 Pp : 1 pp; phenotype (dominant:recessive) = 3:1.

Explanation: Three offspring show dominant phenotype (PP and 2×Pp) and one shows recessive (pp).

Quick Tip

Monohybrid heterozygous cross → 3 dominant : 1 recessive phenotypic ratio; genotype 1:2:1.

Q18. Which of the following is an example of a primary consumer in an ecosystem?

(1) Grasshopper
(2) Snake
(3) Fox
(4) Deer

Correct Answer: (1) Grasshopper (also deer are primary consumers; grasshopper is a correct insect example)

Solution:
Concept: Primary consumers are herbivores that feed on producers (plants). Both grasshoppers and deer are herbivores; snake and fox are carnivores.

Explanation: Among the options, the grasshopper is a classic primary consumer (herbivore feeding on plants).

Quick Tip

Primary consumer = herbivore (eats plants). Secondary/tertiary consumers eat animals.

Q19. Which part of the human brain primarily regulates basic life functions (heart rate, breathing)?

(1) Cerebrum
(2) Cerebellum
(3) Medulla Oblongata
(4) Hypothalamus

Correct Answer: (3) Medulla Oblongata

Solution:
Concept: The medulla oblongata (brainstem) controls autonomic functions: cardiac and res-

piratory centers regulate heart rate and breathing.

Explanation: Cerebrum handles higher functions; cerebellum controls coordination; hypothalamus regulates endocrine/homeostasis but basic rhythmic functions are medulla's role.

> Quick Tip
>
> Medulla = vital reflex centers (heart, breathing, vasomotor). Damage is life-threatening.

Q20. Which equation correctly represents photosynthesis?

(1) $6CO_2 + 6H_2O + \text{light} \rightarrow C_6H_{12}O_6 + 6O_2$
(2) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$
(3) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + \text{light}$
(4) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{light}$

Correct Answer: (1) $6CO_2 + 6H_2O + \text{light} \rightarrow C_6H_{12}O_6 + 6O_2$

Solution:
Concept: Photosynthesis uses CO_2, H_2O and light to produce glucose and O_2. Option (1) correctly shows light as an input.

Explanation: Option (2) and (4) are respiration (reverse), and (3) incorrectly puts light on product side.

> Quick Tip
>
> Remember: photosynthesis consumes CO_2 + H_2O + light $\rightarrow$ sugar + O_2. Light is a reactant.

Q21. Which organelle is primarily responsible for producing ATP in a cell?

(1) Nucleus
(2) Mitochondria
(3) Endoplasmic Reticulum
(4) Golgi Apparatus

Correct Answer: (2) Mitochondria

Solution:
Concept: ATP (adenosine triphosphate) is the energy currency of the cell, and its primary site of synthesis is the mitochondrion, often called the "powerhouse of the cell." Within mitochondria, ATP is generated through oxidative phosphorylation using the electron transport chain.

Explanation: During cellular respiration, glucose is broken down to release energy, which drives the phosphorylation of ADP to form ATP inside mitochondria. Other organelles such as the nucleus or Golgi apparatus do not play a direct role in ATP synthesis.

Quick Tip

Remember — mitochondria generate ATP through oxidative phosphorylation, making them essential for all energy-dependent cellular processes.

Q22. In a DNA molecule, which of the following base-pairings is correct?

(1) Adenine pairs with Cytosine.
(2) Thymine pairs with Guanine.
(3) Adenine pairs with Thymine.
(4) Cytosine pairs with Uracil.

Correct Answer: (3) Adenine pairs with Thymine.

Solution:
Concept: According to Chargaff's rule and the Watson–Crick model of DNA, nitrogenous bases pair through hydrogen bonds as follows:

$$\text{Adenine (A)} \leftrightarrow \text{Thymine (T)} \quad \text{via 2 hydrogen bonds,}$$

$$\text{Cytosine (C)} \leftrightarrow \text{Guanine (G)} \quad \text{via 3 hydrogen bonds.}$$

Explanation: This complementary base pairing ensures the double helix structure and accurate replication of DNA. Uracil (U) occurs only in RNA, replacing Thymine.

Quick Tip

Remember: A–T (2 H-bonds) and G–C (3 H-bonds). Uracil appears only in RNA.

Q23. Which of the following processes occurs during the second meiotic division (Meiosis II)?

(1) Homologous chromosomes are separated.
(2) Sister chromatids are separated.
(3) DNA replication occurs.
(4) Crossing over occurs.

Correct Answer: (2) Sister chromatids are separated.

Solution:
Concept: Meiosis consists of two divisions — Meiosis I and Meiosis II.
- Meiosis I: Homologous chromosomes separate (reductional division).
- Meiosis II: Sister chromatids separate (equational division), similar to mitosis.

Explanation: During Meiosis II, each daughter cell from Meiosis I divides again, separating sister chromatids into individual gametes, resulting in four haploid cells. DNA replication does not occur between Meiosis I and II.

Quick Tip

Think of Meiosis II as "mitosis of haploid cells" — sister chromatids separate, producing four genetically unique cells.

Q24. Which of the following factors does NOT affect the rate of an enzyme-catalyzed reaction?

(1) Temperature
(2) pH
(3) Substrate concentration
(4) Color of the enzyme

Correct Answer: (4) Color of the enzyme

Solution:
Concept: Enzyme activity depends on several physicochemical factors:
- *Temperature:* Influences kinetic energy and rate of molecular collisions.
- *pH:* Alters the enzyme's active site structure and charge.
- *Substrate concentration:* Affects the rate until enzyme saturation.
The *color* of an enzyme is unrelated to its catalytic activity.

Explanation: Enzymes are biological catalysts whose efficiency depends on structural conformation, not physical appearance. Color changes may indicate cofactors or prosthetic groups

but do not directly influence activity.

Quick Tip

Enzyme activity depends on structure, not color. Focus on temperature, pH, and substrate concentration.
