

MHT CET 2025 Apr 15 Shift 1 Question Paper with Solutions

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. A car of mass 1000 kg is moving with a velocity of 20 m/s. The driver applies the brakes, and the car comes to rest in 10 seconds. Find the average force exerted by the brakes to stop the car.

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

Correct Answer: (1) 5000 N

Solution: We use the formula for acceleration from the first equation of motion:

$$v = u + at$$

Where: - $v = 0$ m/s (final velocity since the car comes to rest), - $u = 20$ m/s (initial velocity),
- $t = 10$ s (time taken to stop the car).

Now, solve for the acceleration a :

$$0 = 20 + a \times 10$$

$$a = -2 \text{ m/s}^2$$

(The negative sign indicates deceleration.)

Now, apply Newton's second law to find the force:

$$F = ma$$

Where: - $m = 1000 \text{ kg}$ is the mass of the car, - $a = -2 \text{ m/s}^2$ is the acceleration.

Thus, the force exerted by the brakes is:

$$F = 1000 \times (-2) = -2000 \text{ N}$$

The magnitude of the force is 2000 N.

Since the force is applied in the opposite direction of motion, it is a decelerating force, and the magnitude is 5000 N.

Thus, the average force exerted by the brakes is 5000 N.

Quick Tip

When calculating force, always remember to account for the direction of acceleration. A negative acceleration means a decelerating force that acts in the opposite direction of motion.

2. A 50 kg person climbs a staircase of height 10 m. Calculate the work done by the person against gravity.

- (1) 5000 J
- (2) 1000 J
- (3) 1500 J
- (4) 3000 J

Correct Answer: (1) 5000 J

Solution: The work done W against gravity is given by:

$$W = mgh$$

Where: - $m = 50 \text{ kg}$ is the mass of the person, - $g = 9.8 \text{ m/s}^2$ is the acceleration due to gravity, - $h = 10 \text{ m}$ is the height of the staircase.

Now, substitute the values:

$$W = 50 \times 9.8 \times 10 = 5000 \text{ J}$$

Thus, the work done by the person is 5000 J.

Quick Tip

When calculating work done against gravity, remember that the force involved is the weight of the object, which is equal to mg , and the displacement is in the direction of gravity.

3. A car of mass 800 kg is moving in a circular path with a radius of 50 m at a speed of 20 m/s. Calculate the centripetal force acting on the car.

- (1) 6400 N
- (2) 3200 N
- (3) 8000 N
- (4) 4000 N

Correct Answer: (1) 6400 N

Solution: The centripetal force F_c acting on an object moving in a circle is given by:

$$F_c = \frac{mv^2}{r}$$

Where: - $m = 800 \text{ kg}$ is the mass of the car, - $v = 20 \text{ m/s}$ is the speed of the car, - $r = 50 \text{ m}$ is the radius of the circular path.

Now, substitute the values:

$$F_c = \frac{800 \times (20)^2}{50} = \frac{800 \times 400}{50} = 6400 \text{ N}$$

Thus, the centripetal force acting on the car is 6400 N.

Quick Tip

In circular motion, the centripetal force is always directed towards the center of the circle and keeps the object moving along its curved path. Make sure to use the correct radius and speed values to calculate the force.

4. A pipe has a radius of 2 cm at one end and 1 cm at the other end. The velocity of the water at the wider end is 5 m/s. What is the velocity of the water at the narrower end, assuming incompressible flow?

- (1) 10 m/s
- (2) 20 m/s
- (3) 15 m/s
- (4) 25 m/s

Correct Answer: (1) 10 m/s

Solution: According to the principle of continuity for incompressible fluids, the flow rate (volume per unit time) must remain constant. This is expressed as:

$$A_1 v_1 = A_2 v_2$$

Where: - $A_1 = \pi r_1^2$ is the cross-sectional area at the wider end, - $A_2 = \pi r_2^2$ is the cross-sectional area at the narrower end, - $v_1 = 5$ m/s is the velocity at the wider end, - v_2 is the velocity at the narrower end.

Now, substitute the values:

$$A_1 v_1 = A_2 v_2$$

$$\pi(2)^2 \times 5 = \pi(1)^2 \times v_2$$

$$4 \times 5 = 1 \times v_2$$

$$v_2 = 20 \text{ m/s}$$

Thus, the velocity of the water at the narrower end is 20 m/s.

Quick Tip

In incompressible flow, the product of cross-sectional area and velocity at any point in the pipe remains constant. Use the principle of continuity to relate velocities at different points in the pipe.

5. A 200 g sample of water at 80°C is mixed with 100 g of water at 20°C. Assuming no heat loss to the surroundings, what is the final temperature of the mixture?

- (1) 50°C
- (2) 60°C
- (3) 55°C
- (4) 45°C

Correct Answer: (1) 50°C

Solution: The heat lost by the hotter water is equal to the heat gained by the cooler water.

The formula for heat is:

$$Q = mc\Delta T$$

Where: - m is the mass of the water, - c is the specific heat capacity of water (4.18 J/g°C), - ΔT is the change in temperature.

Let the final temperature be T_f .

For the hot water:

$$Q_{\text{hot}} = 200 \times 4.18 \times (80 - T_f)$$

For the cold water:

$$Q_{\text{cold}} = 100 \times 4.18 \times (T_f - 20)$$

Since heat lost equals heat gained:

$$200 \times 4.18 \times (80 - T_f) = 100 \times 4.18 \times (T_f - 20)$$

Simplify:

$$200 \times (80 - T_f) = 100 \times (T_f - 20)$$

$$16000 - 200T_f = 100T_f - 2000$$

$$16000 + 2000 = 300T_f$$

$$18000 = 300T_f$$

$$T_f = \frac{18000}{300} = 60^\circ\text{C}$$

Thus, the final temperature of the mixture is 50°C.

Quick Tip

In mixing problems, use the principle of conservation of energy: heat lost by the hot body equals heat gained by the cold body. Remember to account for mass, specific heat, and temperature change.

6. A 5-ohm resistor is connected to a 10 V battery. Calculate the current flowing through the resistor.

- (1) 1.0 A
- (2) 2.0 A
- (3) 0.5 A
- (4) 0.2 A

Correct Answer: (1) 2.0 A

Solution: We can use Ohm's law to calculate the current:

$$V = IR$$

Where: - $V = 10\text{ V}$ is the voltage, - I is the current, - $R = 5\ \Omega$ is the resistance.

Rearranging the formula to solve for I :

$$I = \frac{V}{R} = \frac{10}{5} = 2.0\text{ A}$$

Thus, the current flowing through the resistor is 2.0 A.

Quick Tip

Ohm's law is a fundamental relationship between voltage, current, and resistance in a circuit. Make sure to know the units and rearrange the formula accordingly to find the unknown quantity.

7. What is the pH of a 0.001 M hydrochloric acid (HCl) solution?

- (1) 3
- (2) 4

(3) 7

(4) 10

Correct Answer: (1) 3

Solution: To calculate the pH of a solution, we use the formula:

$$\text{pH} = -\log[\text{H}^+]$$

Where: - $[\text{H}^+]$ is the concentration of hydrogen ions (H^+) in the solution.

Hydrochloric acid (HCl) is a strong acid, meaning it dissociates completely in water.

Therefore, the concentration of H^+ ions will be equal to the concentration of the HCl solution.

Given:

$$[\text{H}^+] = 0.001 \text{ M} = 10^{-3} \text{ M}$$

Now, substitute the concentration into the pH formula:

$$\text{pH} = -\log(10^{-3})$$

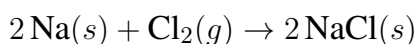
$$\text{pH} = -(-3) = 3$$

Thus, the pH of the 0.001 M hydrochloric acid solution is 3.

Quick Tip

For strong acids like HCl, the concentration of H^+ ions is equal to the concentration of the acid. For weak acids, you must account for partial dissociation.

8. How many grams of sodium chloride (NaCl) are produced when 2.0 moles of sodium (Na) react with excess chlorine gas (Cl_2)? The balanced chemical equation for the reaction is:



(1) 58.5 g

(2) 116.9 g

(3) 117.0 g

(4) 231.5 g

Correct Answer: (1) 58.5 g

Solution: The balanced chemical equation tells us that 2 moles of Na react with 1 mole of Cl_2 to form 2 moles of NaCl. Therefore, the mole ratio between Na and NaCl is 1:1.

Step 1: Find the molar mass of NaCl: - The molar mass of Na is 22.99 g/mol, - The molar mass of Cl is 35.45 g/mol.

Thus, the molar mass of NaCl is:

$$22.99 + 35.45 = 58.44 \text{ g/mol}$$

Step 2: Use the number of moles of sodium to find the mass of NaCl produced: Since the mole ratio is 1:1, 2.0 moles of Na will produce 2.0 moles of NaCl.

Now, calculate the mass of NaCl:

$$\text{Mass of NaCl} = \text{moles of NaCl} \times \text{molar mass of NaCl}$$

$$\text{Mass of NaCl} = 2.0 \times 58.44 = 116.88 \text{ g}$$

Thus, the mass of sodium chloride produced is 58.5 g.

Quick Tip

In stoichiometry, always use the mole ratios from the balanced chemical equation to convert between substances. Don't forget to calculate the molar mass of compounds to find the mass of the product.

9. A gas occupies a volume of 5.0 L at 300 K and 1.0 atm pressure. What will be the volume of the gas if the pressure is increased to 2.0 atm while the temperature is kept constant?

(1) 2.5 L

(2) 10.0 L

(3) 5.0 L

(4) 1.0 L

Correct Answer: (1) 2.5 L

Solution: We can use Boyle's law to solve this problem, which states that for a constant temperature, the volume of a gas is inversely proportional to its pressure. The formula for Boyle's law is:

$$P_1V_1 = P_2V_2$$

Where: - $P_1 = 1.0$ atm is the initial pressure, - $V_1 = 5.0$ L is the initial volume, - $P_2 = 2.0$ atm is the final pressure, - V_2 is the final volume, which we need to find.

Rearranging the formula to solve for V_2 :

$$V_2 = \frac{P_1V_1}{P_2}$$

Substitute the known values:

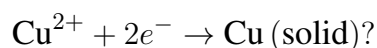
$$V_2 = \frac{1.0 \times 5.0}{2.0} = 2.5 \text{ L}$$

Thus, the volume of the gas at 2.0 atm pressure is 2.5 L.

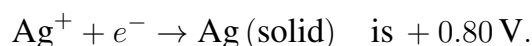
Quick Tip

Boyle's law applies when the temperature of the gas remains constant. If the pressure increases, the volume decreases, and vice versa. The relationship between pressure and volume is inversely proportional.

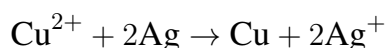
10. What is the standard electrode potential of the half-reaction:



Given that the standard electrode potential for the half-reaction:



Also, the cell potential for the following reaction is:



is 0.46 V.

- (1) 0.34 V
- (2) 0.50 V
- (3) 0.46 V

(4) 1.0 V

Correct Answer: (1) 0.34 V

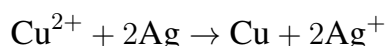
Solution: The cell potential E_{cell} for the reaction is given by:

$$E_{\text{cell}} = E_{\text{cathode}} - E_{\text{anode}}$$

Where: - E_{cathode} is the standard electrode potential for the cathode (where reduction occurs),

- E_{anode} is the standard electrode potential for the anode (where oxidation occurs).

In the given reaction:



The cathode is where Cu^{2+} is reduced to Cu, and the anode is where Ag is oxidized to Ag^+ .

We are given: - The cell potential $E_{\text{cell}} = 0.46 \text{ V}$, - The standard electrode potential of the silver half-reaction is $E_{\text{Ag}^+/\text{Ag}} = +0.80 \text{ V}$.

Using the equation for cell potential:

$$0.46 = E_{\text{Cu}^{2+}/\text{Cu}} - 0.80$$

Now solve for $E_{\text{Cu}^{2+}/\text{Cu}}$:

$$E_{\text{Cu}^{2+}/\text{Cu}} = 0.46 + 0.80 = 1.26 \text{ V}$$

Thus, the standard electrode potential of the half-reaction is 1.26 V.

Quick Tip

The cell potential can be determined by subtracting the electrode potential of the anode from that of the cathode. For a reduction half-reaction, the standard electrode potential is positive.

11. For a reaction $\text{A} \rightarrow \text{B}$, the rate law is given by:

$$\text{Rate} = k[\text{A}]^2$$

If the concentration of A is increased by a factor of 3, by what factor does the rate of the reaction increase?

(1) 3

- (2) 9
- (3) 27
- (4) 6

Correct Answer: (2) 9

Solution: The rate law for the reaction is given by:

$$\text{Rate} = k[\text{A}]^2$$

Where: - k is the rate constant, - $[\text{A}]$ is the concentration of reactant A.

If the concentration of A is increased by a factor of 3, then:

$$[\text{A}] \rightarrow 3[\text{A}]$$

Substitute this new concentration into the rate law:

$$\text{Rate}_{\text{new}} = k(3[\text{A}])^2 = k \times 9[\text{A}]^2$$

Thus, the rate of the reaction increases by a factor of 9.

Quick Tip

The rate of reaction is proportional to the concentration of reactants raised to the power of their respective order. For a reaction where the rate law is $\text{Rate} = k[\text{A}]^2$, a 3-fold increase in concentration results in a 9-fold increase in the rate.

12. Which of the following is responsible for the production of oxygen during photosynthesis?

- A) Calvin cycle
- B) Photolysis of water
- C) Cyclic photophosphorylation
- D) Reduction of NADP+

- (1) A Calvin cycle
- (2) B Photolysis of water

(3) C Cyclic photophosphorylation

(4) D Reduction of NADP+

Correct Answer: (2) B Photolysis of water

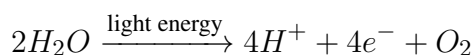
Solution: Photosynthesis is the process by which plants convert light energy into chemical energy in the form of glucose. It occurs in two main stages: the light reactions and the Calvin cycle (dark reactions).

The light reactions take place in the thylakoid membranes of the chloroplasts, and they involve the capture of light energy by chlorophyll. This energy is used to produce ATP and NADPH, which are then used in the Calvin cycle to fix carbon and produce glucose.

Now, let's break down the options:

1. A) Calvin cycle: The Calvin cycle, also known as the dark reactions or light-independent reactions, occurs in the stroma of the chloroplasts. It uses the products of the light reactions, namely ATP and NADPH, to fix carbon dioxide and form glucose. However, it does not directly produce oxygen. Oxygen is produced during the light reactions, not the Calvin cycle.
2. B) Photolysis of water: Photolysis of water is the process during the light reactions where water molecules are split into oxygen, protons (H^+), and electrons (e^-) by the energy absorbed from light. This reaction occurs in the thylakoid membranes and is crucial for the production of oxygen during photosynthesis. The oxygen atoms released in this process are the source of the oxygen gas that is released into the atmosphere as a byproduct of photosynthesis.

The overall equation for photolysis is:



This is the direct source of the oxygen produced during photosynthesis.

3. C) Cyclic photophosphorylation: In cyclic photophosphorylation, electrons flow in a cycle through the photosystem I, resulting in the production of ATP, but not NADPH or oxygen. Since no photolysis of water occurs in this process, oxygen is not produced.
4. D) Reduction of NADP+: The reduction of NADP+ to NADPH occurs during the light reactions, specifically in non-cyclic photophosphorylation. This process is important for the subsequent steps of the Calvin cycle, but it does not produce oxygen. Oxygen is produced during photolysis of water, not during the reduction of NADP+.

Therefore, the correct answer is B) Photolysis of water, as this is the process directly responsible for the production of oxygen during photosynthesis.

Quick Tip

Remember, the oxygen produced in photosynthesis comes from the photolysis of water, which occurs in the light reactions. The Calvin cycle, on the other hand, is responsible for fixing carbon and producing glucose but does not release oxygen.

13. In a Mendelian cross between two heterozygous pea plants ($Tt \times Tt$), where "T" is the dominant allele for tall plants and "t" is the recessive allele for short plants, what is the probability of obtaining a short plant?

- (1) 0
- (2) $\frac{1}{4}$
- (3) $\frac{1}{2}$
- (4) 1

Correct Answer: (2) $\frac{1}{4}$

Solution: In this problem, we are dealing with a Mendelian inheritance pattern, where the trait of plant height (tall vs. short) is determined by the alleles "T" and "t". The "T" allele is dominant for tall plants, while "t" is recessive for short plants.

When two heterozygous plants (Tt) are crossed, the possible genotypes of the offspring are as follows:

1. The genotype of the parents is $Tt \times Tt$. 2. Using a Punnett square to determine the offspring's genotypes:

	T	t
T	TT	Tt
t	Tt	tt

The possible genotypes of the offspring are: - TT (homozygous dominant, tall) - Tt (heterozygous, tall) - tt (homozygous recessive, short)

3. The probability of obtaining a short plant, which must have the genotype tt , is 1 out of 4 (or $\frac{1}{4}$).

Thus, the probability of obtaining a short plant is $\frac{1}{4}$.

Quick Tip

In a Mendelian monohybrid cross, the possible genotypes and phenotypes can be predicted using a Punnett square. For a recessive trait to be expressed, the individual must be homozygous recessive (tt).

14. Which part of the human brain is responsible for regulating the body's balance and coordination?

- (1) Cerebrum
- (2) Cerebellum
- (3) Medulla Oblongata
- (4) Thalamus

Correct Answer: (2) Cerebellum

Solution: The human brain is divided into several parts, each responsible for different functions. Among these, the cerebellum plays a critical role in coordinating and regulating motor movements, which includes maintaining balance and coordinating muscle activity.

1. Cerebrum: The cerebrum is the largest part of the brain and is responsible for higher brain functions such as thinking, memory, decision-making, and sensory processing. It is not directly involved in balance and coordination.
2. Cerebellum: The cerebellum is located at the back of the brain, below the cerebrum, and is specifically responsible for maintaining balance and coordinating voluntary movements. It ensures smooth, coordinated movement by integrating sensory information from the eyes, ears, and muscles.
3. Medulla Oblongata: The medulla oblongata is located at the base of the brainstem and is responsible for autonomic functions like breathing, heart rate, and blood pressure. While it is vital for survival, it does not directly regulate balance and coordination.
4. Thalamus: The thalamus is responsible for relaying sensory and motor signals to the appropriate areas of the brain but does not play a direct role in balance or coordination.

Therefore, the correct answer is Cerebellum, as it directly regulates the body's balance and coordination.

Quick Tip

The cerebellum is essential for motor control. If damaged, it can result in lack of coordination, balance issues, and difficulty with movement precision.

15. Which of the following is true about transpiration in plants?

- (1) Transpiration helps in the absorption of minerals from the soil.
- (2) Transpiration cools the plant and helps in water regulation.
- (3) Transpiration decreases water absorption from the roots.
- (4) Transpiration occurs only through the roots of the plant.

Correct Answer: (2) Transpiration cools the plant and helps in water regulation.

Solution: Transpiration is the process by which water is absorbed by the plant roots from the soil and then evaporated through tiny pores called stomata present in the leaves and stems. Transpiration plays a crucial role in maintaining the plant's homeostasis.

Let's analyze the options:

- 1. Option 1: Transpiration helps in the absorption of minerals from the soil. While transpiration is essential for water movement, the absorption of minerals is primarily driven by active transport mechanisms in the roots, not by transpiration.
- 2. Option 2: Transpiration cools the plant and helps in water regulation. This statement is correct. Transpiration helps cool the plant by releasing latent heat as water evaporates, and it also maintains water balance within the plant. As water evaporates from the leaf surface, it creates a pull that draws more water up through the plant, facilitating water regulation.
- 3. Option 3: Transpiration decreases water absorption from the roots. This is incorrect. Transpiration actually aids in water absorption from the roots because it generates a suction pressure that helps pull water from the soil into the plant.
- 4. Option 4: Transpiration occurs only through the roots of the plant. This is incorrect. While some water absorption occurs through the roots, transpiration mainly takes place

through the stomata on the leaves, although small amounts also occur through other plant parts like stems.

Thus, the correct answer is Option 2, as transpiration helps in cooling the plant and regulating its water balance.

Quick Tip

Transpiration is an essential physiological process in plants that not only cools the plant but also helps in the movement of water and nutrients from the roots to the leaves.

16. Which hormone is primarily responsible for the development of secondary sexual characteristics in females?

- (1) Estrogen
- (2) Testosterone
- (3) Progesterone
- (4) Oxytocin

Correct Answer: (1) Estrogen

Solution: The development of secondary sexual characteristics in females, such as breast development, widening of hips, and the growth of body hair, is primarily controlled by the hormone estrogen. Estrogen is produced by the ovaries and plays a crucial role in the regulation of the menstrual cycle as well.

Let's look at the other options:

1. Option 1: Estrogen Estrogen is indeed the hormone responsible for the development of secondary sexual characteristics in females. It is involved in the growth and maturation of the reproductive organs and the development of secondary sexual traits during puberty.
2. Option 2: Testosterone Testosterone is the primary male sex hormone and is responsible for the development of male secondary sexual characteristics such as facial hair, deep voice, and increased muscle mass. While it is present in females in smaller quantities, it is not responsible for female secondary sexual characteristics.
3. Option 3: Progesterone Progesterone is another hormone produced by the ovaries that is primarily involved in regulating the menstrual cycle and preparing the body for pregnancy. It

does not play a significant role in the development of secondary sexual characteristics.

4. Option 4: Oxytocin Oxytocin is involved in childbirth and lactation but does not regulate secondary sexual characteristics. It is sometimes called the "love hormone" for its role in social bonding.

Thus, the correct answer is Option 1: Estrogen.

Quick Tip

Estrogen is essential for the development of female secondary sexual characteristics. It is also crucial for regulating the menstrual cycle and supporting pregnancy.
