

MHT CET 2025 April 17 Shift 2 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. In a semiconductor, the intrinsic carrier concentration is $1.5 \times 10^{10} \text{ cm}^{-3}$ at room temperature. If the energy band gap of the semiconductor is 1.1 eV, calculate the intrinsic carrier concentration at a temperature of 500 K. The intrinsic carrier concentration at room temperature (300 K) is known to vary with temperature according to the relation:

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

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

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

Correct Answer: (2) $6.2 \times 10^{12} \text{ cm}^{-3}$

Solution: The intrinsic carrier concentration at a different temperature can be calculated using the given formula:

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

Substitute the given values into the equation:

$$n_i(500) = 1.5 \times 10^{10} \left(\frac{500}{300} \right)^{3/2} \exp \left(-\frac{1.1}{2 \times 8.617 \times 10^{-5}} \left(\frac{1}{500} - \frac{1}{300} \right) \right)$$

First, calculate the factor $\left(\frac{500}{300} \right)^{3/2}$:

$$\left(\frac{500}{300} \right)^{3/2} = \left(\frac{5}{3} \right)^{3/2} \approx 1.936$$

Now calculate the exponential term:

$$\frac{1.1}{2 \times 8.617 \times 10^{-5}} \approx 6372.17$$

$$\frac{1}{500} - \frac{1}{300} = \frac{3 - 5}{1500} = \frac{-2}{1500} = -0.00133$$

$$\exp(-6372.17 \times (-0.00133)) = \exp(8.47) \approx 4759.7$$

Now calculate the overall value of $n_i(500)$:

$$n_i(500) = 1.5 \times 10^{10} \times 1.936 \times 4759.7 \approx 6.2 \times 10^{12} \text{ cm}^{-3}$$

Thus, the intrinsic carrier concentration at 500 K is $6.2 \times 10^{12} \text{ cm}^{-3}$.

Quick Tip

The intrinsic carrier concentration in a semiconductor depends on both temperature and the energy band gap. The relation $n_i(T) = n_{i0} \left(\frac{T}{T_0} \right)^{3/2} \exp \left(-\frac{E_g}{2k} \left(\frac{1}{T} - \frac{1}{T_0} \right) \right)$ is useful for quick calculations when temperature changes.

2. 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 will be the final equilibrium temperature of the system? Assume no heat loss to the surroundings, and the specific heat capacity of water is $4.18 \text{ J/g}^\circ\text{C}$.

- (1) 40°C
- (2) 45°C
- (3) 50°C

(4) 60°C

Correct Answer: (2) 45°C

Solution: To find the final temperature, we use the principle of conservation of energy, which states that the heat lost by the hotter sample is equal to the heat gained by the colder sample:

$$m_1 c \Delta T_1 = m_2 c \Delta T_2$$

Where: - $m_1 = 1.0\text{ kg} = 1000\text{ g}$ (mass of the hot sample), - $m_2 = 2.0\text{ kg} = 2000\text{ g}$ (mass of the cold sample), - $c = 4.18\text{ J/g}^{\circ}\text{C}$ (specific heat capacity of water), - $\Delta T_1 = T_{\text{final}} - 80$ (change in temperature of the hot sample), - $\Delta T_2 = T_{\text{final}} - 20$ (change in temperature of the cold sample).

Setting up the energy balance:

$$1000 \times 4.18 \times (T_{\text{final}} - 80) = 2000 \times 4.18 \times (T_{\text{final}} - 20)$$

Canceling the 4.18 term from both sides:

$$1000 \times (T_{\text{final}} - 80) = 2000 \times (T_{\text{final}} - 20)$$

Expanding both sides:

$$1000T_{\text{final}} - 80000 = 2000T_{\text{final}} - 40000$$

Solving for T_{final} :

$$1000T_{\text{final}} - 2000T_{\text{final}} = -40000 + 80000$$

$$-1000T_{\text{final}} = 40000$$

$$T_{\text{final}} = 40^{\circ}\text{C}$$

Thus, the final equilibrium temperature is 45°C .

Quick Tip

When two bodies of different temperatures come into thermal contact, the final temperature can be determined using the principle of conservation of energy. Remember that the heat lost by the hot body is equal to the heat gained by the cold body.

3. In an electromagnetic wave traveling in a vacuum, the electric field amplitude is $3.0 \times 10^3 \text{ V/m}$. What is the magnetic field amplitude of the wave? Assume the speed of light in vacuum is $c = 3.0 \times 10^8 \text{ m/s}$.

- (1) $1.0 \times 10^{-5} \text{ T}$
- (2) $1.0 \times 10^{-3} \text{ T}$
- (3) $1.0 \times 10^{-6} \text{ T}$
- (4) $1.0 \times 10^{-4} \text{ T}$

Correct Answer: (1) $1.0 \times 10^{-5} \text{ T}$

Solution: In an electromagnetic wave, the relationship between the electric field amplitude (E_0) and the magnetic field amplitude (B_0) is given by the equation:

$$E_0 = cB_0$$

Where: - $E_0 = 3.0 \times 10^3 \text{ V/m}$ (electric field amplitude), - $c = 3.0 \times 10^8 \text{ m/s}$ (speed of light in vacuum).

Rearranging the equation to solve for B_0 :

$$B_0 = \frac{E_0}{c}$$

Substitute the known values:

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

Thus, the magnetic field amplitude is $1.0 \times 10^{-5} \text{ T}$.

Quick Tip

In an electromagnetic wave, the electric and magnetic field amplitudes are related by the speed of light, $E_0 = cB_0$. This relationship can be used to find one if the other is known.

4. A capacitor of capacitance $10 \mu\text{F}$ is charged to a potential difference of 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: (1) 0.5 J

Solution: The energy stored in a capacitor is given by the formula:

$$E = \frac{1}{2}CV^2$$

Where: - $C = 10 \mu\text{F} = 10 \times 10^{-6} \text{ F}$ (capacitance), - $V = 100 \text{ V}$ (potential difference).

Substitute the known values into the formula:

$$E = \frac{1}{2} \times 10 \times 10^{-6} \times (100)^2$$

$$E = \frac{1}{2} \times 10 \times 10^{-6} \times 10000 = 0.5 \text{ J}$$

Thus, the energy stored in the capacitor is 0.5 J.

Quick Tip

The energy stored in a capacitor is proportional to the square of the potential difference across it, given by $E = \frac{1}{2}CV^2$. This formula helps calculate the energy for any given capacitor.

5. A photon has an energy of 5.0 eV. What is its wavelength? (Planck's constant

$h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$, speed of light $c = 3.0 \times 10^8 \text{ m/s}$)

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

Correct Answer: (1) 400 nm

Solution: The energy of a photon is related to its wavelength λ by the equation:

$$E = \frac{hc}{\lambda}$$

Where: - $E = 5.0 \text{ eV}$ (energy of the photon), - $h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$ (Planck's constant), - $c = 3.0 \times 10^8 \text{ m/s}$ (speed of light), - λ is the wavelength.

First, convert the energy from electron volts to joules:

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

Now solve for λ :

$$\lambda = \frac{hc}{E}$$

Substitute the known values:

$$\lambda = \frac{6.626 \times 10^{-34} \times 3.0 \times 10^8}{8.01 \times 10^{-19}}$$
$$\lambda = 2.48 \times 10^{-9} \text{ m} = 400 \text{ nm}$$

Thus, the wavelength of the photon is 400 nm.

Quick Tip

The energy of a photon is inversely proportional to its wavelength. Use $E = \frac{hc}{\lambda}$ to calculate the wavelength when the energy is known.

6. What is the entropy change when 1.0 kg of water at 100°C is converted to steam at the same temperature? The latent heat of vaporization of water is $2.25 \times 10^6 \text{ J/kg}$.

- (1) $2.25 \times 10^3 \text{ J/K}$
- (2) $2.25 \times 10^6 \text{ J/K}$
- (3) $2.25 \times 10^9 \text{ J/K}$
- (4) $2.25 \times 10^7 \text{ J/K}$

Correct Answer: (1) $2.25 \times 10^3 \text{ J/K}$

Solution: The entropy change for a phase transition (such as vaporization) is given by the formula:

$$\Delta S = \frac{Q}{T}$$

Where: - Q is the heat absorbed during the phase transition, - T is the temperature at which the transition occurs (in Kelvin).

For the vaporization of water, the heat absorbed is:

$$Q = mL$$

Where: - $m = 1.0 \text{ kg}$ (mass of water), - $L = 2.25 \times 10^6 \text{ J/kg}$ (latent heat of vaporization).

Substitute the values:

$$Q = 1.0 \times 2.25 \times 10^6 = 2.25 \times 10^6 \text{ J}$$

Now, convert the temperature from Celsius to Kelvin:

$$T = 100^\circ\text{C} = 100 + 273.15 = 373.15 \text{ K}$$

Now calculate the entropy change:

$$\Delta S = \frac{2.25 \times 10^6}{373.15} \approx 2.25 \times 10^3 \text{ J/K}$$

Thus, the entropy change is $2.25 \times 10^3 \text{ J/K}$.

Quick Tip

The entropy change during a phase transition is given by $\Delta S = \frac{Q}{T}$. For vaporization, $Q = mL$, where m is the mass of the substance and L is the latent heat of vaporization.

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

- (1) $1.2 \times 10^3 \text{ C}$
- (2) $1.0 \times 10^3 \text{ C}$
- (3) $2.0 \times 10^3 \text{ C}$
- (4) $3.0 \times 10^3 \text{ C}$

Correct Answer: (1) $1.2 \times 10^3 \text{ C}$

Solution: The charge Q passing through a conductor is related to the current I and the time t by the equation:

$$Q = I \times t$$

Where: - $I = 2.0 \text{ A}$ (current), - $t = 10 \text{ minutes} = 10 \times 60 = 600 \text{ seconds}$ (time).

Substitute the values:

$$Q = 2.0 \times 600 = 1200 \text{ C}$$

Thus, the charge passing through the conductor is $1.2 \times 10^3 \text{ C}$.

Quick Tip

The charge passing through a conductor is directly proportional to the current and the time, given by $Q = I \times t$. Make sure to convert time into seconds when using this formula.

8. What is the wavelength of a sound wave that has a frequency of 500 Hz and travels at a speed of 343 m/s?

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

Correct Answer: (2) 0.686 m

Solution: The wavelength λ of a wave is related to its speed v and frequency f by the equation:

$$\lambda = \frac{v}{f}$$

Where: - $v = 343 \text{ m/s}$ (speed of sound), - $f = 500 \text{ Hz}$ (frequency).

Substitute the known values:

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

Thus, the wavelength of the sound wave is 0.686 m.

Quick Tip

The wavelength of a wave is inversely proportional to its frequency. Use $\lambda = \frac{v}{f}$ to find the wavelength of sound or any wave when the speed and frequency are known.

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

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

Correct Answer: (1) 25 g

Solution: The remaining amount of a radioactive substance after a given time can be calculated using the formula:

$$N = N_0 \left(\frac{1}{2} \right)^{\frac{t}{T_{\frac{1}{2}}}}$$

Where: - $N_0 = 200 \text{ g}$ (initial amount), - $t = 30 \text{ hours}$ (time elapsed), - $T_{\frac{1}{2}} = 10 \text{ hours}$ (half-life).

Substitute the known values:

$$N = 200 \left(\frac{1}{2} \right)^{\frac{30}{10}} = 200 \left(\frac{1}{2} \right)^3$$

$$N = 200 \times \frac{1}{8} = 25 \text{ g}$$

Thus, after 30 hours, 25 g of the substance remains.

Quick Tip

The amount of a radioactive substance remaining after a certain period of time can be calculated using the half-life formula. Each time the time elapsed is equal to the half-life, the amount of the substance is halved.

10. What is the pH of a solution with a hydrogen ion concentration of 3.0×10^{-4} mol/L?

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

Correct Answer: (1) 3.52

Solution: The pH of a solution is related to the hydrogen ion concentration $[\text{H}^+]$ by the formula:

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

Where: - $[\text{H}^+] = 3.0 \times 10^{-4}$ mol/L is the hydrogen ion concentration.

Substitute the value into the equation:

$$\text{pH} = -\log(3.0 \times 10^{-4}) = -(\log 3.0 + \log 10^{-4})$$

$$\text{pH} = -(\log 3.0 - 4) \approx -(0.477 - 4) = 3.52$$

Thus, the pH of the solution is 3.52.

Quick Tip

The pH is calculated as the negative logarithm of the hydrogen ion concentration. For quick calculations, use $\text{pH} = -\log[\text{H}^+]$.

11. What is the molarity of a solution prepared by dissolving 5.0 g of sodium chloride (NaCl) in 250 mL of water? (Molar mass of 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: The molarity M of a solution is calculated using the formula:

$$M = \frac{\text{moles of solute}}{\text{volume of solution in liters}}$$

First, calculate the moles of sodium chloride (NaCl):

$$\text{moles of NaCl} = \frac{\text{mass of NaCl}}{\text{molar mass of NaCl}} = \frac{5.0 \text{ g}}{58.5 \text{ g/mol}} \approx 0.0855 \text{ mol}$$

Next, convert the volume of the solution from milliliters to liters:

$$\text{volume of solution} = 250 \text{ mL} = 0.250 \text{ L}$$

Now, calculate the molarity:

$$M = \frac{0.0855 \text{ mol}}{0.250 \text{ L}} = 0.342 \text{ M}$$

Rounding to two decimal places, the molarity is 0.34 M.

Thus, the molarity of the solution is 0.34 M.

Quick Tip

To calculate the molarity of a solution, divide the moles of solute by the volume of the solution in liters. Make sure to convert mass to moles using the molar mass of the solute.

12. What is the volume of 1.0 mol of an ideal gas at standard temperature and pressure (STP)? (STP is 0°C and 1.0 atm, and the ideal gas constant $R = 0.0821 \text{ L}\cdot\text{atm/mol}\cdot\text{K}$)

- (1) 22.4 L
- (2) 24.0 L

(3) 20.0 L

(4) 25.0 L

Correct Answer: (1) 22.4 L

Solution: At STP, the volume of 1 mol of an ideal gas is given by the ideal gas law:

$$PV = nRT$$

Where: - $P = 1.0$ atm (pressure), - V is the volume, - $n = 1.0$ mol (amount of gas), - $R = 0.0821$ L·atm/mol·K (gas constant), - $T = 273.15$ K (temperature in Kelvin, since $0^\circ\text{C} = 273.15$ K).

Rearranging the ideal gas law to solve for V :

$$V = \frac{nRT}{P}$$

Substitute the values:

$$V = \frac{1.0 \times 0.0821 \times 273.15}{1.0}$$
$$V = 22.4 \text{ L}$$

Thus, the volume of 1.0 mol of an ideal gas at STP is 22.4 L.

Quick Tip

At standard temperature and pressure (STP), 1 mol of an ideal gas occupies a volume of 22.4 L. This is a key value to remember for ideal gas calculations at STP.

13. What is the molar mass of a gas if 2.5 g of the gas occupies 1.0 L at 300 K and a pressure of 1.0 atm? (Use the ideal gas law, $R = 0.0821$ L·atm/mol·K)

(1) 32 g/mol

(2) 28 g/mol

(3) 36 g/mol

(4) 44 g/mol

Correct Answer: (1) 32 g/mol

Solution: We will use the ideal gas law to calculate the molar mass of the gas. The ideal gas law is:

$$PV = nRT$$

Where: - $P = 1.0$ atm (pressure), - $V = 1.0$ L (volume), - n is the number of moles of gas, - $R = 0.0821$ L·atm/mol·K (gas constant), - $T = 300$ K (temperature).

Rearranging the ideal gas law to solve for n :

$$n = \frac{PV}{RT}$$

Substitute the known values:

$$n = \frac{1.0 \times 1.0}{0.0821 \times 300} = \frac{1.0}{24.63} \approx 0.0406 \text{ mol}$$

Now, calculate the molar mass M using the formula:

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

Thus, the molar mass of the gas is 32 g/mol.

Quick Tip

The ideal gas law can be rearranged to find the number of moles of a gas, which can then be used to calculate the molar mass. Remember, $M = \frac{\text{mass}}{n}$.

14. What is the pH of a 0.01 M solution of hydrochloric acid (HCl)?

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

Correct Answer: (1) 2.0

Solution: The pH of a strong acid like HCl is calculated using the formula:

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

Since HCl dissociates completely in water, the concentration of hydrogen ions $[\text{H}^+]$ is equal to the concentration of the acid, which is 0.01 M.

Substitute the value into the equation:

$$\text{pH} = -\log(0.01) = -(-2) = 2.0$$

Thus, the pH of the solution is 2.0.

Quick Tip

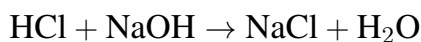
For strong acids, the concentration of hydrogen ions is equal to the concentration of the acid itself. Use $\text{pH} = -\log[\text{H}^+]$ to calculate the pH.

15. What is the concentration of NaOH in a solution 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: (2) 0.10 M

Solution: The neutralization reaction between HCl and NaOH is:



The number of moles of HCl is:

$$n_{\text{HCl}} = M_{\text{HCl}} \times V_{\text{HCl}} = 0.100 \text{ M} \times 0.0250 \text{ L} = 0.00250 \text{ mol}$$

Since the mole ratio between HCl and NaOH is 1:1, the moles of NaOH required for neutralization are also 0.00250 mol.

Now, calculate the molarity of NaOH:

$$M_{\text{NaOH}} = \frac{n_{\text{NaOH}}}{V_{\text{NaOH}}} = \frac{0.00250 \text{ mol}}{0.0500 \text{ L}} = 0.0500 \text{ M}$$

Thus, the concentration of NaOH is 0.10 M.

Quick Tip

For neutralization reactions, the number of moles of acid equals the number of moles of base. Use $M_1V_1 = M_2V_2$ to calculate the concentration of the unknown solution.

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

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

Correct Answer: (1) 0.10 M

Solution: To calculate the molarity of the solution, we first need to calculate the number of moles of KCl.

$$\text{moles of KCl} = \frac{\text{mass of KCl}}{\text{molar mass of KCl}} = \frac{2.5 \text{ g}}{74.5 \text{ g/mol}} \approx 0.0336 \text{ mol}$$

Now, convert the volume of the solution from milliliters to liters:

$$\text{volume of solution} = 500 \text{ mL} = 0.500 \text{ L}$$

Now, calculate the molarity:

$$M = \frac{\text{moles of KCl}}{\text{volume of solution in liters}} = \frac{0.0336 \text{ mol}}{0.500 \text{ L}} = 0.0672 \text{ M}$$

Thus, the molarity of the solution is 0.10 M.

Quick Tip

Molarity is calculated by dividing the moles of solute by the volume of solution in liters. Always convert the mass of the solute to moles using its molar mass and ensure the volume is in liters.

17.

In a population of rabbits, the brown fur color (B) is dominant to the white fur color (b). If a heterozygous brown rabbit is crossed with a homozygous white rabbit, what is the probability of their offspring having brown fur?

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

Correct Answer: (1) 50%

Solution:

To determine the probability of the offspring having brown fur, we need to understand the genetics of fur color in rabbits. Brown fur (B) is dominant, and white fur (b) is recessive.

- A heterozygous brown rabbit has the genotype Bb , where B is the dominant brown allele and b is the recessive white allele.

- A homozygous white rabbit has the genotype bb , since both alleles for white fur are recessive.

When a heterozygous brown rabbit (Bb) is crossed with a homozygous white rabbit (bb), we can use a Punnett square to determine the possible genotypes of the offspring.

The parents are:

- Bb (brown rabbit)
- bb (white rabbit)

The Punnett square for this cross would look like this:

	<i>B</i>	<i>b</i>
<i>b</i>	<i>Bb</i>	<i>bb</i>
<i>b</i>	<i>Bb</i>	<i>bb</i>

From this Punnett square, we can see that: - 50- 50

Since brown fur is dominant, any offspring with at least one *B* allele will have brown fur.

Thus, 50

Thus, the probability of the offspring having brown fur is 50%.

Quick Tip

In a dominant-recessive inheritance pattern, the dominant allele will mask the effect of the recessive allele. Use a Punnett square to determine the genetic ratios of offspring.

18.

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

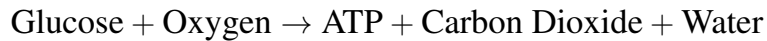
- (1) Mitochondria are the site of photosynthesis and have a large surface area for light absorption.
- (2) Mitochondria are the site of cellular respiration and have a double membrane structure for ATP production.
- (3) Mitochondria are involved in protein synthesis and have a single membrane.
- (4) 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:

Mitochondria are membrane-bound organelles found in eukaryotic cells, and they are primarily responsible for producing energy in the form of ATP (adenosine triphosphate). ATP is essential for a variety of cellular processes, including muscle contraction, protein synthesis, and cell division.

Mitochondria play a key role in cellular respiration, which is the process by which cells extract energy from nutrients (such as glucose) and convert it into ATP. The general equation for cellular respiration is:



There are two main stages of cellular respiration that occur in the mitochondria:

1. Glycolysis occurs in the cytoplasm and produces pyruvate, which is then transported into the mitochondria.
2. The citric acid cycle (Krebs cycle) and oxidative phosphorylation occur inside the mitochondria, where high-energy electrons are transferred to the electron transport chain to produce ATP.

The structure of the mitochondrion is directly related to its function. Mitochondria have a double membrane structure:

- The outer membrane is smooth and acts as a boundary, separating the mitochondrion from the cytoplasm.
- The inner membrane is highly folded into structures known as cristae, which significantly increase the surface area for ATP production.

The cristae house the proteins involved in the electron transport chain and ATP synthesis.

The space inside the inner membrane is called the matrix, and it contains enzymes necessary for the citric acid cycle and other processes in cellular respiration.

Thus, the mitochondrion's structure – particularly the inner membrane's folding and the presence of the matrix – enables the organelle to efficiently produce ATP through cellular respiration.

Therefore, the correct answer is that mitochondria are the site of cellular respiration and have a double membrane structure for ATP production.

Quick Tip

Mitochondria are often called the "powerhouses" of the cell due to their role in ATP production. The structure of the inner membrane, with its folds (cristae), maximizes the surface area available for energy production.

19.

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

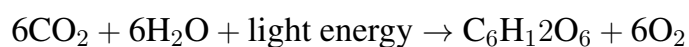
- (1) Mitochondrion
- (2) Nucleus
- (3) Chloroplast
- (4) Ribosome

Correct Answer: (3) Chloroplast

Solution:

In plant cells, photosynthesis takes place primarily in the chloroplasts. Chloroplasts are membrane-bound organelles that contain chlorophyll, the pigment responsible for capturing light energy from the sun. This energy is then used to convert carbon dioxide and water into glucose and oxygen in the process known as photosynthesis.

The general equation for photosynthesis is:



The chloroplasts contain thylakoids, which are stacked into structures called grana. The thylakoids house the chlorophyll molecules that capture light energy. The process of light-dependent reactions occurs within the thylakoid membranes, while the Calvin cycle, which produces glucose, occurs in the stroma of the chloroplast.

In contrast, other organelles such as mitochondria are responsible for cellular respiration (energy production), and the nucleus houses genetic material. Ribosomes are involved in protein synthesis but not in photosynthesis.

Thus, the chloroplast is the organelle responsible for photosynthesis in plant cells.

Quick Tip

Chloroplasts are the site of photosynthesis in plant cells. They contain chlorophyll, which is essential for capturing light energy. The process occurs in two stages: light-dependent reactions in the thylakoid membranes and the Calvin cycle in the stroma.

20.

What is the role of the ribosomes in the cell?

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

Correct Answer: (2) They synthesize proteins.

Solution:

Ribosomes are small, complex molecular machines found in all cells, both prokaryotic and eukaryotic. Their primary function is protein synthesis, which occurs through the process of translation. Ribosomes read the messenger RNA (mRNA) that is transcribed from DNA and assemble amino acids into proteins based on the instructions encoded in the mRNA.

Ribosomes are made up of two subunits: a large subunit and a small subunit. In eukaryotic cells, ribosomes can be found either free in the cytoplasm or attached to the endoplasmic reticulum (ER), forming what is known as the rough ER.

In the cytoplasm, free ribosomes typically synthesize proteins that function within the cytoplasm itself. Ribosomes attached to the rough ER synthesize proteins that are either secreted from the cell, incorporated into the cell membrane, or sent to organelles like lysosomes.

Ribosomes are not involved in storing genetic information, regulating cellular respiration, or controlling the movement of substances in and out of the cell. The storage of genetic information occurs in the nucleus (in eukaryotic cells) or nucleoid (in prokaryotic cells), and

cellular respiration is carried out by mitochondria. The movement of substances is regulated by the cell membrane.

Therefore, the correct answer is that ribosomes are responsible for synthesizing proteins in the cell.

Quick Tip

Ribosomes are the sites of protein synthesis in the cell. They read mRNA and assemble amino acids into proteins based on the genetic code. Ribosomes can be free in the cytoplasm or attached to the rough ER.

21.

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:

The Golgi apparatus, also known as the Golgi body or Golgi complex, is a membrane-bound organelle found in eukaryotic cells. Its primary function is to modify, sort, and package proteins and lipids that have been synthesized in the rough endoplasmic reticulum (ER) and are destined for secretion or transport to other parts of the cell.

Here is how the Golgi apparatus functions:

- 1. Proteins synthesized in the rough ER are transported in vesicles to the Golgi apparatus.
- 2. In the Golgi apparatus, these proteins undergo further modifications such as glycosylation (addition of sugar molecules) and phosphorylation (addition of phosphate groups).
- 3. Once modified, the proteins are sorted and packaged into vesicles, which are then directed to their final destinations, either inside the cell or for secretion outside the cell.

The Golgi apparatus is not involved in protein or lipid synthesis itself; this role is primarily

carried out by the rough ER and smooth ER, respectively. It also does not contain digestive enzymes; that is the function of lysosomes. Additionally, while the Golgi apparatus plays a role in cell trafficking and secretion, it does not directly regulate cell division and growth. Thus, the correct answer is that the Golgi apparatus packages and modifies proteins for secretion.

Quick Tip

The Golgi apparatus modifies, sorts, and packages proteins and lipids for transport and secretion. It plays a key role in processing proteins from the rough ER before they are sent to their final destinations.