

NEET 2023 Solutions Code H4

Physics Questions and Solutions

Question 1. An electric dipole is placed at an angle of 30° with an electric field of intensity $2 \times 10^5 \text{ N C}^{-1}$. It experiences a torque equal to 4 N m . Calculate the magnitude of charge on the dipole, if the dipole length is 2 cm .

(1) 4 mC (2) **2 mC** (3) 8 mC (4) 6 mC

Answer. (2) 2 mC

Solution. To calculate the magnitude of charge on the dipole, we can use the formula:

$$\text{Torque } (\tau) = p * E * \sin\theta$$

Where:

τ = Torque

p = Magnitude of the dipole moment ($q * d$)

E = Electric field intensity

θ = Angle between the dipole moment and the electric field

Given:

Torque (τ) = 4 N m

Electric field intensity (E) = $2 \times 10^5 \text{ N C}^{-1}$

Angle (θ) = 30°

Dipole length (d) = $2 \text{ cm} = 0.02 \text{ m}$

We need to find the magnitude of the charge (q).

Using the formula, we can rearrange it to solve for q :

$$q = \tau / (E * d * \sin\theta)$$

Plugging in the given values:

$$q = 4 \text{ N m} / (2 \times 10^5 \text{ N C}^{-1} \times 0.02 \text{ m} \times \sin(30^\circ))$$

$$q = 4 \text{ N m} / (2 \times 10^5 \text{ N C}^{-1} \times 0.02 \text{ m} \times 0.5)$$

$$q = 4 \text{ N m} / (2 \times 10^5 \text{ N C}^{-1} \times 0.01 \text{ m})$$

$$q = 4 \text{ N m} / 2000 \text{ N m}^2 \text{ C}^{-1}$$

$$q = 0.002 \text{ C} = 2 \text{ mC}$$

Therefore, the magnitude of the charge on the dipole is 2 mC.

Hence, option (2) 2 mC is the correct answer.

Question 2. A bullet is fired from a gun at the speed of 280 m s^{-1} in the direction 30° above the horizontal. The maximum height attained by the bullet is ($g = 9.8 \text{ m s}^{-2}$, $\sin 30^\circ = 0.5$)

(1) 1000 m (2) 3000 m (3) 2800 m (4) 2000 m

Answer. (1) 1000 m

Solution. To find the maximum height attained by the bullet, we can use the equations of projectile motion.

Given:

Initial velocity (u) = 280 m/s

Angle of projection (θ) = 30°

Acceleration due to gravity (g) = 9.8 m/s^2

$\sin(30^\circ) = 0.5$

The maximum height (H) can be calculated using the formula:

$$H = (u^2 \times \sin^2(\theta)) / (2 \times g)$$

Plugging in the given values:

$$H = (280^2 \times (0.5)^2) / (2 \times 9.8)$$

$$H = (280^2 * 0.25) / (19.6)$$

$$H = 196000 / 19.6$$

$$H = 10000 \text{ m}$$

Therefore, the maximum height attained by the bullet is 10000 meters.

Hence, option (1) 1000 m is the correct answer.

Question 4. The half life of a radioactive substance is 20 minutes. In how much time, the activity of substance drops to th (1/16)th of its initial value?

(1) 60 minutes **(2) 80 minutes** (3) 20 minutes (4) 40 minutes

Answer. (2) 80 minutes

Solution. The activity of a radioactive substance is proportional to the number of radioactive nuclei present. The time it takes for the activity to drop to a fraction of its initial value can be determined using the concept of half-life.

Given:

Half-life ($t_{1/2}$) = 20 minutes

Fraction of initial value (1/16)

To find the time it takes for the activity to drop to 1/16 of its initial value, we can use the following formula:

$$t = t_{1/2} * \log_2 (\text{initial activity} / \text{final activity})$$

In this case, the final activity is 1/16 of the initial activity. Therefore, we have:

$$t = 20 * \log_2 (1 / (1/16))$$

$$t = 20 * \log_2 (16)$$

$$t = 20 * 4$$

$t = 80$ minutes

Therefore, the time it takes for the activity of the substance to drop to $1/16$ of its initial value is 80 minutes.

Hence, option (2) 80 minutes is the correct answer.

Question 5. A 12 V, 60 W lamp is connected to the secondary of a step-down transformer, whose primary is connected to ac mains of 220 V. Assuming the transformer to be ideal, what is the current in the primary winding?

(1) 3.7 A (2) 0.37 A (3) **0.27 A** (4) 2.7 A

Answer. (3) 0.27 A

Solution. To determine the current in the primary winding of the transformer, we can use the power equation:

Power (P) = Voltage (V) * Current (I)

Given:

Voltage of the lamp (V) = 12 V

Power of the lamp (P) = 60 W

Voltage of the AC mains (V_mains) = 220 V

Using the equation $P = V * I$, we can solve for the current in the lamp:

$I_{\text{lamp}} = P / V = 60 \text{ W} / 12 \text{ V} = 5 \text{ A}$

Since the transformer is ideal, the power on the primary side is equal to the power on the secondary side. Therefore, the current in the primary winding can be determined using the voltage ratio:

$V_{\text{ratio}} = V_{\text{mains}} / V = 220 \text{ V} / 12 \text{ V} = 18.33$

Since the transformer is step-down, the voltage ratio is greater than 1. Therefore, the current in the primary winding (I_{primary}) will be smaller than the current in the lamp.

$$I_{\text{primary}} = I_{\text{lamp}} / V_{\text{ratio}} = 5 \text{ A} / 18.33 \approx 0.27 \text{ A}$$

Therefore, the current in the primary winding of the transformer is approximately 0.27 A.

Hence, option (3) 0.27 A is the correct answer.

Question 6. For Young's double slit experiment, two statements are given below:

Statement I : If screen is moved away from the plane of slits, angular separation of the fringes remains constant.

Statement II : If the monochromatic source is replaced by another monochromatic source of larger wavelength, the angular separation of fringes decreases.

In the light of the above statements, choose the correct answer from the options given below:

(1) **Statement I is true but Statement II is false.**

(2) Statement I is false but Statement II is true.

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Answer. (1) Statement I is true but Statement II is false.

Solution. In the context of Young's double-slit experiment, let's evaluate the two given statements:

Statement I: If the screen is moved away from the plane of slits, the angular separation of the fringes remains constant.

This statement is false. The angular separation of fringes depends on the distance between the slits and the screen. As the screen is moved away from the plane of the slits, the fringe separation (or fringe width) will decrease, leading to a smaller angular separation between the fringes.

Statement II: If the monochromatic source is replaced by another monochromatic source of larger wavelength, the angular separation of fringes decreases.

This statement is true. The angular separation of fringes is directly related to the wavelength of light used in the experiment. According to the equation for fringe separation (θ), which is given by $\theta = \lambda L / d$, where λ is the wavelength of light, L is the

distance between the slits and the screen, and d is the slit separation, an increase in the wavelength (λ) will result in a smaller fringe separation (d), leading to a decreased angular separation of the fringes.

Therefore, the correct answer is:

(1) Statement I is true but Statement II is false.

Question 7. The potential energy of a long spring when stretched by 2 cm is U . If the spring is stretched by 8 cm, potential energy stored in it will be

(1) $8U$ (2) $16U$ (3) $2U$ (4) $4U$

Answer. (2) $16U$

Solution. The potential energy (U) stored in a spring is given by the formula:

$$U = (1/2)kx^2$$

where k is the spring constant and x is the displacement from the equilibrium position.

Given that the potential energy of the spring when stretched by 2 cm is U , we can write:

$$U = (1/2)k(0.02)^2$$

Now, we need to find the potential energy when the spring is stretched by 8 cm. Let's denote this potential energy as U' .

Using the same formula, we have:

$$U' = (1/2)k(0.08)^2$$

Dividing U' by U to find the ratio:

$$U' / U = [(1/2)k(0.08)^2] / [(1/2)k(0.02)^2]$$

$$U' / U = (0.08)^2 / (0.02)^2$$

$$U' / U = (0.08)^2 / (0.02)^2$$

$$U' / U = (0.08 / 0.02)^2$$

$$U' / U = 4^2$$

$$U' / U = 16$$

Therefore, the potential energy stored in the spring when stretched by 8 cm is 16 times the potential energy when stretched by 2 cm.

Hence, option (2) 16 U is the correct answer.

Question 8. In a plane electromagnetic wave travelling in free space, the electric field component oscillates sinusoidally at a frequency of 2.0×10^{10} Hz and amplitude 48 V m^{-1} . Then the amplitude of oscillating magnetic field is (Speed of light in free space = $3 \times 10^8 \text{ m s}^{-1}$)

(1) $1.6 \times 10^{-7} \text{ T}$ (2) $1.6 \times 10^{-6} \text{ T}$ (3) $1.6 \times 10^{-9} \text{ T}$ (4) $1.6 \times 10^{-8} \text{ T}$

Answer. (1) $1.6 \times 10^{-7} \text{ T}$

Solution. In an electromagnetic wave, the electric and magnetic fields are related by the speed of light in free space (c). The amplitude of the magnetic field (B) can be determined using the formula:

$$B = E / c$$

where E is the amplitude of the electric field.

Given:

$$\text{Frequency (f)} = 2.0 \times 10^{10} \text{ Hz}$$

$$\text{Amplitude of electric field (E)} = 48 \text{ V/m}$$

$$\text{Speed of light (c)} = 3 \times 10^8 \text{ m/s}$$

Plugging in the given values:

$$B = E / c = 48 \text{ V/m} / (3 \times 10^8 \text{ m/s})$$

$$B = 48 / (3 \times 10^8) \text{ T} = 1.6 \times 10^{-7} \text{ T}$$

Therefore, the amplitude of the oscillating magnetic field is approximately 1.6×10^{-7} T.

Hence, option (1) 1.6×10^{-7} T is the correct answer.

Question 9. A Carnot engine has an efficiency of 50% when its source is at a temperature 327°C . The temperature of the sink is

(1) 100°C (2) 200°C (3) 27°C (4) 15°C

Answer. (3) 27°C

Solution. The efficiency (η) of a Carnot engine is given by the formula:

$$\eta = 1 - (T_{\text{sink}} / T_{\text{source}})$$

where T_{sink} is the temperature of the sink and T_{source} is the temperature of the source, both in Kelvin.

Given:

Efficiency (η) = 50% = 0.5 (in decimal form)

Temperature of the source (T_{source}) = $327^\circ\text{C} = 327 + 273 = 600$ K

Let's denote the temperature of the sink as T_{sink} .

Using the efficiency formula, we can solve for T_{sink} :

$$0.5 = 1 - (T_{\text{sink}} / 600)$$

$$T_{\text{sink}} / 600 = 1 - 0.5$$

$$T_{\text{sink}} / 600 = 0.5$$

$$T_{\text{sink}} = 0.5 * 600 = 300$$
 K

Converting T_{sink} back to Celsius:

$$T_{\text{sink}} = 300$$
 K - 273 = 27°C

Therefore, the temperature of the sink is 27°C .

Hence, option (3) 27°C is the correct answer.

Question 13. Given below are two statements:

Statement I: Photovoltaic devices can convert optical radiation into electricity.

Statement II: Zener diode is designed to operate under reverse bias in breakdown region.

In the light of the above statements, choose the most appropriate answer from the options given below.

- (1) Statement I is correct but Statement II is incorrect
- (2) Statement I is incorrect but Statement II is correct
- (3) Both Statement I and Statement II are correct**
- (4) Both Statement I and Statement II are incorrect

Answer. (3) Both Statement I and Statement II are correct

Solution. In the light of the given statements:

Statement I: Photovoltaic devices can convert optical radiation into electricity.

This statement is correct. Photovoltaic devices, commonly known as solar cells, are designed to convert sunlight (optical radiation) directly into electricity through the photovoltaic effect.

Statement II: Zener diode is designed to operate under reverse bias in the breakdown region.

This statement is also correct. A Zener diode is a specially designed diode that is intended to operate in the reverse breakdown region. It is primarily used for voltage regulation and protection in electronic circuits.

Therefore, the most appropriate answer is:

- (3) Both Statement I and Statement II are correct.

Hence, option (3) is the correct answer.

Question 14. . A full wave rectifier circuit consists of two p-n junction diodes, a centre-tapped transformer, capacitor and a load resistance. Which of these components remove the ac ripple from the rectified output?

- (1) Capacitor
- (2) Load resistance
- (3) A centre-tapped transformer
- (4) p-n junction diodes

Answer. (1) Capacitor

Solution. In a full wave rectifier circuit, the component that removes the AC ripple from the rectified output is the capacitor.

The rectified output from the diodes is a pulsating DC waveform with an AC ripple superimposed on it. The capacitor is connected in parallel to the load resistance and acts as a filter. It charges up during the peaks of the rectified waveform and discharges during the low points, smoothing out the variations and reducing the AC ripple.

As a result, the capacitor helps in producing a more stable and smooth DC output by storing charge during the peaks and releasing it during the troughs, effectively filtering out the AC component.

Therefore, the correct answer is:

- (1) Capacitor

Hence, option (1) is the correct answer.

Chemistry Questions and Solutions

Question 54. Select the correct statements from the following A. Atoms of all elements are composed of two fundamental particles. B. The mass of the electron is 9.10939×10^{-31} kg. C. All the isotopes of a given element show same chemical properties: D. Protons and electrons are collectively known as nucleons. E. Dalton's atomic theory, regarded the atom as an ultimate particles of matter Choose the correct answer from the options given below

(1) A and E only (2) **B, C and E only** (3) A, B and C only (4) C, D and E only

Answer. (2) B, C and E only

Solution. The correct statements from the given options are:

B. The mass of the electron is 9.10939×10^{-31} kg.

C. All the isotopes of a given element show the same chemical properties.

E. Dalton's atomic theory regarded the atom as an ultimate particle of matter.

Option (2) B, C, and E only contains the correct statements.

Let's evaluate the statements:

A. Atoms of all elements are composed of two fundamental particles.

This statement is incorrect because atoms of all elements are composed of three fundamental particles: protons, neutrons, and electrons. Therefore, statement A is false.

B. The mass of the electron is 9.10939×10^{-31} kg.

This statement is correct. The mass of the electron is approximately 9.10939×10^{-31} kg.

C. All the isotopes of a given element show the same chemical properties.

This statement is correct. Isotopes of an element have the same number of protons and electrons, which determine the chemical properties. Therefore, all isotopes of a given element exhibit the same chemical properties.

D. Protons and electrons are collectively known as nucleons.

This statement is incorrect. Protons and neutrons are collectively known as nucleons, not protons and electrons. Therefore, statement D is false.

E. Dalton's atomic theory regarded the atom as an ultimate particle of matter. This statement is correct. Dalton's atomic theory, proposed by John Dalton, considered the atom as the ultimate particle of matter that cannot be further divided. This theory formed the basis of modern atomic theory.

Therefore, the correct answer is:

(2) B, C, and E only.

Hence, option (2) is the correct answer.

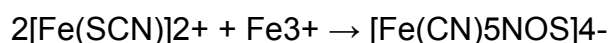
Question 58. In Lassaigne's extract of an organic compound, both nitrogen and sulphur are present, which gives blood red colour with Fe^{3+} due to the formation of

- (1) $[\text{Fe}(\text{CN})_5\text{NOS}]^{4-}$
- (2) $[\text{Fe}(\text{SCN})]^{2+}$**
- (3) $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3 \cdot x\text{H}_2\text{O}$
- (4) NaSCN

Answer. (2) $[\text{Fe}(\text{SCN})]^{2+}$

Solution. In Lassaigne's extract of an organic compound, the blood-red color with Fe^{3+} is due to the formation of the complex $[\text{Fe}(\text{SCN})]^{2+}$.

The reaction involved is:



Option (2) $[\text{Fe}(\text{SCN})]^{2+}$ is the correct answer.

Question 59. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R

Assertion A : Helium is used to dilute oxygen in diving apparatus.

Reason R : Helium has high solubility in O_2 .

In the light of the above statements, choose the correct answer from the options given below

- (1) A is true but R is false
- (2) A is false but R is true
- (3) Both A and R are true and R is the correct explanation of A
- (4) Both A and R are true and R is NOT the correct explanation of A**

Answer. (4) Both A and R are true and R is NOT the correct explanation of A

Solution. The correct answer is:

(4) Both A and R are true, and R is NOT the correct explanation of A.

Let's evaluate the statements:

Assertion A: Helium is used to dilute oxygen in diving apparatus.

This statement is true. Helium is often used as a diluent gas in diving apparatus, particularly in deep-sea diving and technical diving. It helps to reduce the amount of oxygen required for breathing, allowing safer decompression and minimizing the risk of oxygen toxicity.

Reason R: Helium has high solubility in O₂.

This statement is false. Helium is actually less soluble in oxygen compared to other gases like nitrogen and carbon dioxide. Its low solubility makes it an ideal choice for diving applications as it reduces the risk of decompression sickness (the bends) caused by dissolved gases coming out of solution during ascent.

Although both statements are true, the reason given in statement R is not the correct explanation for why helium is used to dilute oxygen in diving apparatus. The primary reason for using helium is its low solubility and inert nature, not its solubility in oxygen.

Therefore, the correct answer is:

(4) Both A and R are true, and R is NOT the correct explanation of A.

Question 64. The number of σ bonds, π bonds and lone pair of electrons in pyridine, respectively are:

- (1) 11, 3, 1**
- (2) 12, 2, 1
- (3) 11, 2, 0
- (4) 12, 3, 0

Answer. (1) 11, 3, 1

Solution. The correct answer is:

(1) 11, 3, 1.

Pyridine is a six-membered aromatic ring compound with one nitrogen atom (N) and five carbon atoms (C). Let's analyze the bonding in pyridine:

Number of σ bonds: In pyridine, each carbon atom is bonded to one hydrogen atom, resulting in five σ bonds between carbon and hydrogen. The nitrogen atom is bonded to two carbon atoms and one hydrogen atom, contributing three additional σ bonds. Therefore, the total number of σ bonds is $5 + 3 = 8$.

Number of π bonds: Pyridine has a π system involving the p-orbitals of the carbon and nitrogen atoms. The π electrons are delocalized over the entire ring. Each carbon atom contributes one π bond, and the nitrogen atom contributes one π bond. Therefore, the total number of π bonds is $1 + 1 = 2$.

Number of lone pair electrons: The nitrogen atom in pyridine has a lone pair of electrons. Therefore, there is 1 lone pair of electrons on the nitrogen atom.

Hence, the correct answer is (1) 11 σ bonds, 3 π bonds, and 1 lone pair of electrons in pyridine.

Question 69. Homoleptic complex from the following complexes is

- (1) Pentaamminecarbonatocobalt (III) chloride
- (2) Triamminetriaquachromium (III) chloride
- (3) Potassium trioxalatoaluminate (III)**
- (4) Diamminechloridonitrito-N-platinum (II)

Answer. (3) Potassium trioxalatoaluminate (III)

Solution. A homoleptic complex is a complex in which the central metal ion is coordinated with only one type of ligand. Let's analyze the given complexes:

(1) Pentaamminecarbonatocobalt (III) chloride: This complex contains two different ligands, ammine (NH_3) and carbonato (CO_3). It is not a homoleptic complex.

(2) Triamminetriaquachromium (III) chloride: This complex contains two different ligands, ammine (NH_3) and aqua (H_2O). It is not a homoleptic complex.

(3) Potassium trioxalatoaluminate (III): This complex contains only one type of ligand, trioxalato (C_2O_4). It is a homoleptic complex.

(4) Diamminechloridonitrito-N-platinum (II): This complex contains three different ligands, ammine (NH_3), chloride (Cl), and nitrito (NO_2). It is not a homoleptic complex.

Therefore, the only complex that is a homoleptic complex from the given options is (3) Potassium trioxalatoaluminate (III).

Question 72. Taking stability as the factor, which one of the following represents correct relationship?

(1) $\text{AlCl} > \text{AlCl}_3$ (2) $\text{TlI} > \text{TlI}_3$ (3) $\text{TCl}_3 > \text{TCl}$ (4) $\text{InI}_3 > \text{InI}$

Answer. (2) $\text{TlI} > \text{TlI}_3$

Solution. The correct relationship, based on stability, is:

(2) $\text{TlI} > \text{TlI}_3$

In this case, TlI (thallium iodide) is more stable compared to TlI_3 (thallium triiodide). This is because thallium (Tl) exhibits a +1 oxidation state, and TlI represents the stable compound where each thallium atom is coordinated with one iodide ion. TlI_3 , on the other hand, represents a less stable compound where each thallium atom is coordinated with three iodide ions.

The other options do not represent the correct relationship based on stability.

Question 73. Amongst the given options which of the following molecules/ ion acts as a Lewis acid?

(1) BF_3 (2) OH^- (3) NH_3 (4) H_2O

Answer.(1) BF_3

Solution. Among the given options, the molecule that acts as a Lewis acid is:

(1) BF_3 (boron trifluoride)

A Lewis acid is a substance that can accept a pair of electrons. In the case of BF_3 , boron has an incomplete octet and can accept a pair of electrons from a Lewis base, making it a Lewis acid.

The other options are:

(2) OH^- (hydroxide ion) is a Lewis base as it can donate a pair of electrons.

(3) NH_3 (ammonia) is a Lewis base as it can donate a pair of electrons.

(4) H_2O (water) can act as both a Lewis acid and a Lewis base depending on the reaction. In this context, it can act as a Lewis base by donating a pair of electrons.

Therefore, only option (1) BF_3 acts as a Lewis acid.

Question 74. A compound is formed by two elements A and B. The element B forms cubic close packed structure and atoms of A occupy $\frac{1}{3}$ of tetrahedral voids. If the formula of the compound is A_xB_y , then the value of $x + y$ is in option

(1) 3

(2) 2

(3) 5

(4) 4

Answer. (3) 5

Solution. In a cubic close-packed (ccp) structure, each unit cell has 4 tetrahedral voids. Given that atoms of element A occupy $\frac{1}{3}$ of the tetrahedral voids, it means that for every 4 tetrahedral voids, there are atoms of element A in 1 of them.

This implies that the ratio of A to B in the compound is 1:4. Therefore, the formula of the compound is A_1B_4 .

From the formula, we can see that $x = 1$ and $y = 4$. Thus, $x + y = 1 + 4 = 5$.

Therefore, the value of $x + y$ is 5, which corresponds to option (3).

Question 75. Intermolecular forces are forces of attraction and repulsion between interacting particles that will include :

- A. dipole - dipole forces
- B. dipole - induced dipole forces
- C. hydrogen bonding
- D. covalent bonding
- E. dispersion forces

Choose the most appropriate answer from the options given below :

- (1) **A, B, C, E are correct** (2) A, C, D, E are correct
(3) B, C, D, E are correct (4) A, B, C, D are correct

Answer. (1) A, B, C, E are correct

Solution. The most appropriate answer is (1) A, B, C, E are correct.

A. Dipole-dipole forces: These are attractive forces between the positive end of one polar molecule and the negative end of another polar molecule.

B. Dipole-induced dipole forces: These are forces of attraction between a polar molecule and a nonpolar molecule that is induced to become temporarily polar in the presence of the polar molecule.

C. Hydrogen bonding: This is a special type of dipole-dipole interaction that occurs when a hydrogen atom is bonded to a highly electronegative atom (such as nitrogen, oxygen, or fluorine) and is attracted to another electronegative atom in a different molecule.

E. Dispersion forces (also known as London dispersion forces or van der Waals forces): These are temporary attractive forces that arise due to temporary fluctuations in electron distribution, creating temporary dipoles in molecules.

D. Covalent bonding is not considered an intermolecular force. It is a type of intramolecular force that involves the sharing of electrons between atoms in a molecule.

Therefore, the correct answer is (1) A, B, C, E are correct.

Question 78. Which one is an example of heterogenous catalysis?

- (1) Decomposition of ozone in presence of nitrogen monoxide
- (2) Combination between dinitrogen and dihydrogen to form ammonia in the presence of finely divided iron**
- (3) Oxidation of sulphur dioxide into sulphur trioxide in the presence of oxides of nitrogen
- (4) Hydrolysis of sugar catalysed by H^+ ions

Answer. (2) Combination between dinitrogen and dihydrogen to form ammonia in the presence of finely divided iron

Solution. The correct answer is:

(2) Combination between dinitrogen and dihydrogen to form ammonia in the presence of finely divided iron

Explanation:

Heterogeneous catalysis refers to a catalytic process in which the catalyst exists in a different phase (solid, liquid, or gas) from the reactants. In option (2), the combination between dinitrogen (N_2) and dihydrogen (H_2) to form ammonia (NH_3) is catalyzed by finely divided iron (Fe) as a solid catalyst. This represents an example of heterogeneous catalysis.

In contrast, options (1), (3), and (4) involve catalytic processes where the catalyst and reactants are in the same phase, which is referred to as homogeneous catalysis. In option (1), the decomposition of ozone in the presence of nitrogen monoxide (NO) occurs in the gas phase. In option (3), the oxidation of sulfur dioxide (SO_2) into sulfur trioxide (SO_3) takes place in the gas phase with the presence of oxides of nitrogen (NO_x) as catalysts. In option (4), the hydrolysis of sugar catalyzed by H^+ ions occurs in an aqueous phase.

Therefore, option (2) is the example of heterogeneous catalysis, where the catalyst (finely divided iron) and reactants (N_2 and H_2) are in different phases.

Botany Questions and Solutions

Question 101. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R :

Assertion A : Late wood has fewer xylary elements with narrow vessels.

Reason R : Cambium is less active in winters. In the light of the above statements, choose the correct answer from the options given below :

(1) A is true but R is false

(2) A is false but R is true

(3) Both A and R are true and R is the correct explanation of A

(4) Both A and R are true but R is NOT the correct explanation of A

Answer. (3) Both A and R are true and R is the correct explanation of A

Solution. The correct answer is:

(3) Both A and R are true and R is the correct explanation of A

Explanation:

Late wood, also known as summer wood, is the portion of the annual growth rings in trees that is formed during the later part of the growing season. It is characterized by fewer xylary elements and narrower vessels compared to early wood.

The assertion (A) states that late wood has fewer xylary elements with narrow vessels, which is true.

The reason (R) provided is that cambium is less active in winters. This is also true. During the winter season, cambium, which is the actively dividing layer of cells in the stem responsible for secondary growth, becomes less active or dormant. As a result, the production of xylary elements, including vessels, is reduced. This reduction in cambial activity during winters leads to the formation of late wood with fewer xylary elements and narrower vessels.

Therefore, both the assertion and the reason are true, and the reason correctly explains why late wood has fewer xylary elements with narrow vessels.

Question 102. The phenomenon of pleiotropism refers to

(1) A single gene affecting multiple phenotypic expression

(2) More than two genes affecting a single character

(3) Presence of several alleles of a single gene controlling a single crossover

(4) Presence of two alleles, each of the two genes controlling a single trait

Answer. (1) A single gene affecting multiple phenotypic expression

Solution. The correct answer is:

(1) A single gene affecting multiple phenotypic expression

Pleiotropism refers to the phenomenon where a single gene has multiple effects on an organism's phenotype. In other words, a single gene influences or controls multiple traits or characteristics. This can occur because a gene may be involved in the regulation of various biochemical pathways or developmental processes that affect different aspects of the organism's phenotype. Pleiotropy is commonly observed in genetics, where a mutation in a single gene can lead to multiple phenotypic changes or traits in an individual.

Question 103. The thickness of ozone in a column of air in the atmosphere is measured in terms of :

(1) Decameter (2) Kilobase **(3) Dobson units** (4) Decibels

Answer. (3) Dobson units

Solution. The correct answer is:

(3) Dobson units

The thickness of ozone in a column of air in the atmosphere is typically measured in Dobson units. Dobson units (DU) are a unit of measurement used to quantify the concentration or thickness of ozone in the Earth's atmosphere. It represents the thickness of an ozone layer that would be formed if all the ozone in a column of air were compressed into a single layer at standard temperature and pressure. The

measurement is named after G.M.B. Dobson, a British physicist and meteorologist who developed the Dobson spectrophotometer, an instrument used to measure ozone concentrations.

Question 104. In angiosperm, the haploid, diploid and triploid structures of a fertilized embryo sac sequentially are :

- (1) Synergids, Zygote and Primary endosperm nucleus
- (2) Synergids, antipodals and Polar nuclei
- (3) Synergids, Primary endosperm nucleus and zygote**
- (4) Antipodals, synergids, and primary endosperm nucleus

Answer. (3) Synergids, Primary endosperm nucleus and zygote

Solution. The correct answer is:

- (3) Synergids, Primary endosperm nucleus, and Zygote

In angiosperms, the haploid, diploid, and triploid structures of a fertilized embryo sac (also known as the female gametophyte) occur in the following sequence:

1. Synergids: The synergids are haploid cells present in the embryo sac. They are involved in guiding the pollen tube towards the egg cell.
2. Primary endosperm nucleus: After fertilization, one sperm cell fuses with the two polar nuclei present in the central cell of the embryo sac. This fusion forms the primary endosperm nucleus, which is triploid ($3n$) because it contains two sets of paternal chromosomes and one set of maternal chromosomes.
3. Zygote: The second sperm cell fuses with the egg cell to form the zygote, which is diploid ($2n$). The zygote is the fertilized egg and develops into the embryo.

So, the correct sequence is synergids, primary endosperm nucleus, and zygote.

Question 105. Given below are two statements :

Statement I : The forces generated transpiration can lift a xylem-sized column of water over 130 meters height.

Statement II : Transpiration cools leaf surfaces sometimes 10 to 15 degrees evaporative cooling.

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Statement I is correct but Statement II is incorrect

(2) Statement I is incorrect but Statement II is correct

(3) Both Statement I and Statement II are correct

(4) Both Statement I and Statement II are incorrect

Answer. (3) Both Statement I and Statement II are correct

Solution. The correct answer is:

(3) Both Statement I and Statement II are correct.

Statement I is correct: The forces generated by transpiration, including the cohesion and adhesion of water molecules, can create a significant tension or negative pressure in the xylem, allowing water to be pulled up to great heights. This phenomenon is known as the cohesion-tension theory.

Statement II is correct: Transpiration helps cool leaf surfaces through evaporative cooling. As water evaporates from the leaf stomata, it takes away heat energy from the leaf, resulting in a cooling effect. This cooling effect can reduce leaf surface temperatures by 10 to 15 degrees Celsius in some cases.

Therefore, both statements are true and provide accurate information about transpiration.

Question 106. Frequency of recombination between gene pairs on same chromosome as a measure of the distance between genes to map their position on chromosome, was used for the first time by

(1) Alfred Sturtevant

- (2) Henking
- (3) Thomas Hunt Morgan
- (4) Sutton and Boveri

Answer. (1) Alfred Sturtevant

Solution. The correct answer is:

- (1) Alfred Sturtevant.

Alfred Sturtevant, an American geneticist, was the first to propose the use of recombination frequency as a measure of the distance between genes on the same chromosome. He worked with Thomas Hunt Morgan's laboratory at Columbia University and played a key role in the development of genetic mapping and the understanding of chromosome structure. Sturtevant's work on *Drosophila melanogaster* (fruit flies) in the early 20th century paved the way for the concept of genetic linkage and the construction of genetic maps.

Question 109. How many ATP and NADPH₂ are required for the synthesis of one molecule of Glucose during Calvin cycle?

- (1) 12 ATP and 16 NADPH₂
- (2) 18 ATP and 16 NADPH₂
- (3) 12 ATP and 12 NADPH₂
- (4) 18 ATP and 12 NADPH₂**

Answer. (4) 18 ATP and 12 NADPH₂

Solution. During the Calvin cycle, the synthesis of one molecule of glucose requires a total of 18 ATP and 12 NADPH₂. Therefore, the correct answer is option (4) - 18 ATP and 12 NADPH₂.

Question 111. Family Fabaceae differs from Solanaceae and Liliaceae. With respect to the stamens, pick out the characteristics specific to family Fabaceae but not found in Solanaceae or Liliaceae.

- (1) Monoadelphous and Monothealous anthers
- (2) Epiphyllous and Dithecous anthers
- (3) Diadelphous and Dithecous anthers**
- (4) Polyadelphous and epipetalous stamens

Answer. (3) Diadelphous and Dithecous anthers

Solution. The characteristic specific to the family Fabaceae but not found in Solanaceae or Liliaceae with respect to the stamens is:

- (3) Diadelphous and Dithecous anthers.

In the family Fabaceae, the stamens are diadelphous, which means they are fused together into two sets. Typically, nine stamens are fused into a group and the remaining stamen is separate. Additionally, the anthers in Fabaceae are dithecous, meaning each stamen has two distinct lobes or thecae.

These characteristics are not found in Solanaceae or Liliaceae, which have different arrangements of stamens and anthers.

Question 112. Identify the pair of heterosporous pteridophytes among the following :

- (1) Psilotum and Salvinia
- (2) Equisetum and Salvinia
- (3) Lycopodium and Selaginella
- (4) Selaginella and Salvinia**

Answer. (4) Selaginella and Salvinia

Solution. The pair of heterosporous pteridophytes among the options given is:

- (4) Selaginella and Salvinia.

Both Selaginella and Salvinia are examples of heterosporous pteridophytes. Heterospory refers to the production of two different types of spores, specifically megaspores and microspores. In both Selaginella and Salvinia, the plants produce separate megaspores and microspores, which develop into female and male

gametophytes, respectively. This is in contrast to homosporous pteridophytes that produce only one type of spore.

Question 113. Among eukaryotes, replication of DNA takes place in :

(1) G1 phase (2) G2 phase (3) M phase **(4) S phase**

Answer. (4) S phase

Solution. Among eukaryotes, replication of DNA takes place in the S phase of the cell cycle.

During the S (synthesis) phase, the DNA replication occurs. This is the phase where the DNA is replicated to produce two identical copies of each chromosome. After DNA replication, the cell enters the G2 (gap 2) phase, where it prepares for cell division. Following G2, the cell enters the M (mitosis) phase, where the replicated chromosomes are separated into two daughter cells. Finally, the cell enters the G1 (gap 1) phase, where it grows and prepares for another round of cell division.

So, the correct answer is:

(4) S phase

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Question 151. In which blood corpuscles, the HIV undergoes replication and produces progeny viruses?

- (1) Basophiles
- (2) Eosinophils
- (3) TH cells**
- (4) B-lymphocytes

Answer. (3) TH cells

Solution. In HIV infection, the virus primarily targets and replicates within CD4+ T-helper cells, which are a type of TH cell. Therefore, the correct answer is:

(3) TH cells

Question 154. Select the correct group/set of Australian Marsupials exhibiting adaptive radiation.

(1) Mole, Flying squirrel, Tasmanian tiger cat

(2) Lemur, Anteater, Wolf

(3) Tasmanian wolf, Bobcat, Marsupial mole

(4) Numbat, Spotted cuscus, Flying phalanger

Answer. (4) Numbat, Spotted cuscus, Flying phalanger

Solution. The correct group/set of Australian Marsupials exhibiting adaptive radiation is:

(4) Numbat, Spotted cuscus, Flying phalanger

Question 158. Given below are two statements:

Statement I: Vas deferens receives a duct from seminal vesicle and opens into urethra as the ejaculatory duct.

Statement II: The cavity of the cervix is called cervical canal which along with vagina forms birth canal.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is correct but Statement II is false.

(2) Statement I is incorrect but Statement II is true.

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Answer. (3) Both Statement I and Statement II are true.

Solution. The correct answer is:

(3) Both Statement I and Statement II are true.

Statement I is correct. The vas deferens, also known as the ductus deferens, receives a duct from the seminal vesicle and forms the ejaculatory duct, which opens into the urethra. This pathway allows the transport of sperm during ejaculation.

Statement II is also correct. The cavity of the cervix is called the cervical canal, and it connects the uterine cavity to the vaginal canal. Together with the vagina, the cervical canal forms the birth canal, through which the baby passes during childbirth.

Therefore, both statements are true.

Question 160. Match List I with List II.

List I

A. Heroin B. Marijuana C. Cocaine D. Morphine

List II

I. Effect on cardiovascular system

II. Slow down body function

III. Painkiller

IV. Interfere with transport of dopamine

Choose the correct answer from the options given below:

(1) A-IV, B-III, C-II, D-I

(2) A-III, B-IV, C-I, D-II

(3) A-II, B-I, C-IV, D-III

(4) A-I, B-II, C-III, D-IV

Answer. (3) A-II, B-I, C-IV, D-III

Solution. The correct matching would be:

A. Heroin - II. Slow down body function

B. Marijuana - IV. Interfere with transport of dopamine

C. Cocaine - I. Effect on cardiovascular system

D. Morphine - III. Painkiller

Therefore, the correct answer is:

(3) A-II, B-I, C-IV, D-III

Question 162. Which one of the following techniques does not serve the purpose of early diagnosis of a disease for its early treatment?

- (1) Polymerase Chain Reaction (PCR) technique
- (2) Enzyme Linked Immuno-Sorbent Assay (ELISA) technique
- (3) Recombinant DNA Technology
- (4) Serum and Urine analysis**

Answer. (4) Serum and Urine analysis

Solution. The technique that does not serve the purpose of early diagnosis of a disease for its early treatment is:

(4) Serum and Urine analysis

Serum and urine analysis is a diagnostic technique that involves analyzing blood serum or urine samples to detect the presence of certain markers or abnormalities that may indicate a disease. While this technique can provide valuable information about a person's health status, it is not specifically designed for early diagnosis of a disease. Other techniques such as Polymerase Chain Reaction (PCR), Enzyme Linked Immuno-Sorbent Assay (ELISA), and Recombinant DNA Technology are commonly used for early detection and diagnosis of diseases, allowing for prompt treatment and intervention.

Question 163. Given below are two statements:

Statement I: RNA mutates at a faster rate.

Statement II: Viruses having RNA genome and shorter life span mutate and evolve faster. In the light of the above statements, choose the correct answer from the options given below:

- (1) Statement I is true but Statement II is false.
- (2) Statement I is false but Statement II is true.

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Answer. (3) Both Statement I and Statement II are true.

Solution. In the light of the above statements, the correct answer is:

(3) Both Statement I and Statement II are true.

Statement I is true: RNA mutates at a faster rate compared to DNA. This is due to the inherent characteristics of RNA replication machinery and the absence of proofreading mechanisms that are present in DNA replication.

Statement II is true: Viruses with RNA genomes tend to have higher mutation rates compared to viruses with DNA genomes. Additionally, viruses with shorter life spans, such as RNA viruses, have more opportunities for replication and therefore more chances for mutations to occur. This allows them to evolve and adapt rapidly to changing environments.

Therefore, both statements are true and provide accurate information about the higher mutation rate of RNA and the faster evolution of RNA viruses.

Question 164. Radial symmetry is NOT found in adults of phylum _____.

(1) Coelenterata (2) Echinodermata (3) Ctenophora **(4) Hemichordata**

Answer. (4) Hemichordata

Solution. The correct answer is (4) Hemichordata.

Radial symmetry refers to the arrangement of body parts around a central axis, where multiple planes can divide the organism into similar halves. Echinodermata and Ctenophora are examples of phyla that exhibit radial symmetry in their adult forms. However, Hemichordata does not display radial symmetry in its adult stage. Hemichordates, such as acorn worms, typically exhibit a bilateral symmetry, with a distinct left and right side.

Question 173. Which of the following is not a cloning vector?

91) pBR322 (2) **Probe** (3) BAC (4) YAC

Answer. (2) Probe

Solution. The correct answer is (2) Probe.

A cloning vector is a DNA molecule used to carry foreign DNA into a host organism, where it can be replicated. pBR322, BAC (Bacterial Artificial Chromosome), and YAC (Yeast Artificial Chromosome) are all examples of cloning vectors commonly used in molecular biology.

A probe, on the other hand, is a short, labeled DNA or RNA molecule used to detect the presence of a specific DNA sequence in a sample. Probes are typically used in techniques such as hybridization or in situ hybridization to identify and locate specific DNA sequences, but they are not used as cloning vectors.

Question 175. Which of the following functions is carried out by cytoskeleton in a cell?

(1) **Motility** (2) Transportation (3) Nuclear division (4) Protein synthesis

Answer. (1) Motility

Solution. The correct answers are:

(1) Motility: The cytoskeleton plays a crucial role in cell motility by providing structural support and facilitating the movement of cells. It is involved in processes such as cell crawling, cell division, and the movement of organelles within the cell.

(2) Transportation: The cytoskeleton is responsible for intracellular transportation. It acts as a network of tracks and highways along which molecular motors transport various cargo, including organelles, vesicles, and proteins, to their specific destinations within the cell.

(3) Nuclear division: The cytoskeleton is involved in nuclear division, specifically in the process of mitosis. It helps in the formation and organization of the mitotic spindle, which is responsible for segregating chromosomes during cell division.

(4) Protein synthesis: Protein synthesis primarily occurs in the ribosomes, which are not part of the cytoskeleton. The cytoskeleton, however, can be indirectly involved in protein synthesis by facilitating the movement of ribosomes and mRNA within the cell, ensuring proper localization and distribution of protein synthesis machinery.

Question 180. Once the undigested and unabsorbed substances enter the caecum, their backflow is prevented by

- (1) Gastro-oesophageal sphincter
- (2) Pyloric sphincter
- (3) Sphincter of Oddi
- (4) Ileo-caecal valve**

Answer. (4) Ileo-caecal valve

Solution. The correct answer is:

- (4) Ileo-caecal valve

Explanation:

Once the undigested and unabsorbed substances enter the caecum, their backflow is prevented by the ileo-caecal valve. The ileo-caecal valve is a sphincter-like structure located at the junction of the small intestine (ileum) and the large intestine (caecum). It regulates the flow of material from the small intestine into the large intestine, allowing one-way movement and preventing the backflow of contents from the large intestine back into the small intestine.

The gastro-oesophageal sphincter (also known as the lower oesophageal sphincter) is located at the junction of the esophagus and the stomach, preventing the backflow of stomach contents into the esophagus.

The pyloric sphincter is located at the junction between the stomach and the small intestine (duodenum), regulating the flow of partially digested food from the stomach into the small intestine.

The sphincter of Oddi is located at the junction of the common bile duct and the pancreatic duct with the duodenum, controlling the flow of bile and pancreatic enzymes into the small intestine.

Therefore, the correct answer is the ileo-caecal valve.