MHT CET 2024 Solutions (April 23 - Shift 2)

Physics Questions

Ques 1. Find the ratio of K.E. and P.E. when a particle performs SHM when it is at (1 / n) times of its amplitude from mean position.

A. n^2 / 2
B. n^2 + 1
C. N^2 - 1
D. n^2

Ans. C
Solu. In SHM, total energy (E) is constant. Let E = 1/2 * k * A^2 (PE at extreme positions).
At (1/n)th amplitude, PE = k * A^2 / (2n^2).
Therefore, KE = E - PE = n^2 - 1 times the PE.
So, KE / PE = n^2 - 1.

Ques 2. Two spheres are given that r = 10 cm and distance between them is 20 cm and axis is passing between the middle of the distance. What is the moment of inertia?

Ans. 14/5 MR^2
Solu. Each sphere has moment of inertia I = (2/5) * m * r^2 (assuming equal masses, m).

1. Parallel axis theorem adds m*(distance from axis to center)^2 to the moment of inertia for an off-center axis. Here, distance is d/2 (halfway between spheres).

2. Combine moments of inertia and account for the distance: I_combined = I + I + m*(d/2)^2 = (4/5)mr^2 + m/100.
3. Ratio of I_combined to mr^2 (assuming equal masses for simplicity): I_combined / (mr^2) = (4/5) + (1/100) = 14/5.

Therefore, the moment of inertia ratio is 14/5.

Ques 3. Safety speed for vehicle moving along curved horizontal banked road.

Ans. V =√ (rgtanθ)
Solu. The safe speed (V) for a car on a banked curve is:
V = √(rgtanθ)

- V: Speed (meters per second or kilometers per hour depending on units)
- r: Curve radius (meters)
- g: Gravity (approx. 9.81 m/s²)
- θ: Banking angle (degrees or radians)

Explanation:
Banking balances the car's outward inertia (centrifugal force) with an inward force from the tilted road surface. The formula finds the speed where these forces cancel out, ensuring safe travel without relying solely on friction.

Ques 4. In hydrosere succession, which stage comes just before the sedge meadow stage?
A. Rooted submerged stage
B. Phytoplankton stage
C. Reed swamp stage
D. Climax stage

Ans. C
Solu. The answer is C. Reed swamp stage.
In hydrosere succession, the stages progress from open water to land. Here's the typical order:

1. Phytoplankton stage: Microscopic organisms dominate the open water.
2. Rooted submerged stage: Rooted underwater plants establish themselves.
3. Reed swamp stage: Reeds and other emergent plants take hold, creating a marshy area.
4. Sedge meadow stage: Sedges and grasses become dominant as the water depth decreases further.
5. Woodland stage: Trees eventually establish themselves, leading to a land-based ecosystem.
6. Climax stage: A stable, self-sustaining forest ecosystem.

Therefore, the reed swamp stage with its emergent plants precedes the sedge meadow stage.

Ques 5. The maximum kinetic energy of the photoelectrons varies.

Ans. K.E $\propto$ 1/λ

Solu. The relationship between the maximum kinetic energy (KE) of photoelectrons and the wavelength (λ) of incident light:

The maximum kinetic energy (KE) of photoelectrons is inversely proportional to the wavelength (λ) of incident light.

This can be expressed mathematically as:

$KE \propto 1 / \lambda$

Here's a breakdown of the concept:

- Photoelectric Effect: When light strikes a metal surface, it can eject electrons from the metal atoms. This phenomenon is called the photoelectric effect.
- Work Function (Φ): Each metal has a characteristic minimum energy, called the work function (Φ), required to eject an electron. This energy is used to overcome the binding energy of the electron in the atom.
- Energy and Wavelength: Light carries energy in the form of photons. The energy (E) of a photon is related to its wavelength (λ) by the equation:

  $E = hc / \lambda$

where h is Planck's constant and c is the speed of light.

Explanation:

1. Photon Energy and Electron Ejection: When a photon strikes a metal atom, its energy can be absorbed by an electron. If the photon's energy is greater than or equal to the metal's work function ($E \geq \Phi$), the electron can be ejected from the atom.
2. Excess Energy as Kinetic Energy: The remaining energy of the photon after overcoming the work function becomes the kinetic energy (KE) of the ejected electron.
3. Wavelength and Energy: Since the energy of a photon is inversely proportional to its wavelength ($E \propto 1 / \lambda$), longer wavelengths (λ) have less energy.

Therefore:

- If the incident light has a shorter wavelength (higher energy), the remaining energy after overcoming the work function is greater, resulting in a higher maximum kinetic energy for the photoelectrons.
- Conversely, if the incident light has a longer wavelength (lower energy), the remaining energy is lower, leading to a lower maximum kinetic energy for the photoelectrons.

Ques 6. If L is the inductance and R is the resistance then the unit of L/R is:

Ans. Sec.

Solu.

- Inductance (L) is in henrys (H) and opposes current changes.
- Resistance (R) is in ohms (Ω) and opposes current flow.
- Dividing L by R (L/R) cancels out current units, leaving the time unit: seconds (sec).

L/R represents the circuit's time constant, which describes how quickly current changes.

Ques 7. A lift weighing 250 kg is to be lifted up at a constant velocity of 0.20m. what would be the minimum horsepower of the motor to be used.

Ans. 0.66 hp
Solu. we can find the minimum horsepower required for the motor to lift the weight at a constant velocity. Here's the approach:

1. Calculate Force:
    - Weight of the lift (W) = 250 kg
    - Since weight is the force due to gravity, W = m * g (where m is mass and g is acceleration due to gravity, approximately 9.81 m/s^2)
    - Force (F) = W = 250 kg * 9.81 m/s^2 ≈ 2452.5 Newtons (N)
2. Power Calculation:
    - Power (P) is the rate of doing work (W). Here, work is done against gravity to lift the weight at a constant velocity.
    - P = F * v (where v is the velocity)
    - P = 2452.5 N * 0.20 m/s ≈ 490.5 Watts
3. Convert Watts to Horsepower:
    - 1 horsepower (hp) is approximately equal to 746 watts.
    - Minimum horsepower (hp) = P (Watts) / 746
    - Minimum horsepower ≈ 490.5 W / 746 ≈ 0.66 hp (round to two decimal places)

Therefore, the minimum horsepower of the motor required is approximately 0.66 hp.

Ques 8. A large number of bullets are fired in all directions with same speed v. What is the maximum area on the ground on which these bullets will spread.

Ans. $A= \pi (u^2/g)^2$
Solu. The provided answer, $A = \pi(u^2/g)^2$, is incorrect for this scenario. Here's why:

- The formula $A = \pi(u^2/g)^2$ represents the maximum horizontal distance a projectile travels (assuming air resistance is negligible) when

launched at an initial velocity (u) and subject to gravitational acceleration (g).
- In this problem, we're interested in the maximum area on the ground covered by the bullets.

Here's how to approach the problem:

1. Trajectory: Since the bullets are fired in all directions with the same speed (v), their trajectories will be parabolic arcs due to gravity.
2. Maximum Height: The bullets will reach their maximum height at the peak of their parabolic trajectories.
3. Landing Points: The bullets will eventually land on the ground, forming a circular area around the firing point.

Biology Questions

Ques 1. Which of the following best describes sympatric speciation ?

A. Speciation that occurs due to geographic isolation
B. Speciation that occurs in the same geographic region without physical separation
C. Speciation that occurs due to migration to a new habitat
D. Speciation that occurs through gradual accumulation of small changes over time

Ans. B
Solu. The correct answer is:
B. Speciation that occurs in the same geographic region without physical separation
Sympatric speciation is a fascinating evolutionary process where new species arise from a single ancestral population within the same geographic location. This means there are no physical barriers like mountains or oceans separating the populations. Instead, reproductive

isolation evolves within the same area, leading to the formation of two distinct species.

Ques 2. Which of the following causes typhoid fever ?

A. Salmonella typhi
B. Mosquito
C. Plasmodium
D. Nicotine

Ans. A
Solu. The answer is: A. Salmonella typhi
Typhoid fever is a bacterial infection caused by the bacterium Salmonella Typhi. This bacterium is spread through contaminated food or water that has been in contact with fecal matter from an infected person. The other options listed are not causes of typhoid fever:

- Mosquito: Mosquitoes transmit diseases like malaria (caused by Plasmodium) and dengue fever, but not typhoid fever.
- Plasmodium: As mentioned above, Plasmodium is the parasite that causes malaria.
- Nicotine: Nicotine is a stimulant found in tobacco and is not a cause of any infectious disease.

Ques 3. Which scientists are credited with proposing the transpiration pull theory, also known as the cohesion-tension theory?

A. Charles Darwin and Francis Darwin
B. Stephen Hales
C. Henry Dixon and John Joly
D. Ernst Münch

Ans. D
Solu. The credit for proposing the transpiration pull theory, also known as the cohesion-tension theory, goes to:

C. Henry Dixon and John Joly
In the early 1890s, Henry Dixon and John Joly conducted experiments that provided strong evidence for the role of transpiration pull in the ascent of sap in plants. Their work helped solidify the understanding of this crucial mechanism in plant physiology.
Here's a brief overview of other scientists you mentioned:

- Charles Darwin and Francis Darwin: While Charles Darwin made significant contributions to evolutionary biology, he wasn't directly involved in proposing the transpiration pull theory. His son, Francis Darwin, collaborated with others on plant research, but not specifically on this theory.
- Stephen Hales: Stephen Hales, a scientist from the 18th century, conducted pioneering experiments on plant physiology, including transpiration. However, he didn't propose the complete theory of transpiration pull.
- Ernst Münch: Ernst Münch, a botanist from the early 20th century, is credited with proposing the mass flow hypothesis for sap transport in plants. This theory complements the transpiration pull theory by explaining the role of root pressure in sap ascent.

Ques 4. Between which among the following, the relationship is not an example of common syllogism

A. Orchid and the tree on which it grows
B. Cattle egret and grazing cattle
C. Sea anemone and clown fish
D. Female wasp and fig species

Ans. D
Solu. The answer is D. Female wasp and fig species.
Here's why:

- Common syllogism: A common syllogism is a form of deductive reasoning where two premises (general statements) lead to a conclusion that is specific.

D. Female wasp and fig species: This relationship is more complex than a simple syllogism. While there might be specific wasp species that pollinate specific fig species, it's not a universal truth. Different wasp species might pollinate different fig species, and some fig species might have other pollinators. Therefore, it doesn't fit the structure of a common syllogism with a general statement and a specific conclusion.

Ques 5. How do most arthropods circulate nutrients and gases throughout their bodies ?

A. Open circulatory system
B. Closed circulatory system
C. No circulatory system
D. Diffusion through body tissues

Ans. A
Solu. Most arthropods rely on an open circulatory system to circulate nutrients and gases throughout their bodies.
Here's a breakdown of this system in arthropods:

- Hemolymph: Unlike a closed circulatory system with blood confined in vessels, arthropods have hemolymph. This is a fluid that bathes the organs and tissues directly within a body cavity called the hemocoel.
- Heart: A simple, elongated heart pumps the hemolymph throughout the hemocoel, ensuring some circulation within the body cavity.
- Diffusion: Crucially, nutrients and gases like oxygen and carbon dioxide exchange directly between the hemolymph and body tissues through diffusion. This is a simpler method compared to a closed system with dedicated vessels, but it becomes less efficient for larger and more active arthropods.

Limitations of Open Circulatory System:

Diffusion has limitations. As an arthropod grows larger, the distance between the hemolymph and some tissues increases. This makes it harder for essential nutrients and gases to reach all parts of the body effectively through diffusion alone.
Comparison with Closed Circulatory System:
For comparison, vertebrates and some mollusks have a closed circulatory system. Blood flows within a network of vessels, delivering nutrients and gases directly to tissues with greater efficiency.

Ques 6. What is the movement of cytoplasm within a cell called ?

A. Endocytosis
B. Exocytosis
C. Cytokinesis
D. Cytoplasmic streaming

Ans. D
Solu. The movement of cytoplasm within a cell is called cytoplasmic streaming.
Here's a breakdown of the terms:

- Endocytosis: The process by which a cell engulfs material from outside the cell by forming vesicles from the cell membrane.
- Exocytosis: The process by which a cell releases materials out of the cell by fusing vesicles with the cell membrane.
- Cytokinesis: The physical division of the cytoplasm and organelles during cell division to form two daughter cells.
- Cytoplasmic streaming: The flow or movement of the cytoplasm within a cell. This movement helps transport organelles, nutrients, and waste products throughout the cell.

Therefore, cytoplasmic streaming refers specifically to the bulk flow of the cytoplasm itself, not the movement of materials into or out of the cell or the division of the cell.

Ques 7.

Assertion : Insects are important pollinators for many flowering plants.
Reasoning : Insects visit flowers to obtain nectar or pollen, and in the process, they inadvertently transfer pollen from one flower to another, facilitating cross - pollination.

A. **Both the assertion and reasoning are correct, and the reasoning correctly explains the assertion**
B. **Both the assertion and reasoning are correct, but the reasoning does not correctly explain the assertion**
C. **The assertion is correct, but the reasoning is incorrect**
D. **Both the assertion and reasoning are incorrect**

Ans. A
Solu. The answer is: Both the assertion and reasoning are correct, and the reasoning correctly explains the assertion.
Here's why:

- Assertion: Insects are important pollinators for many flowering plants. (This is true. Many flowering plants rely on insects for transferring pollen between flowers, which is essential for reproduction.)
- Reasoning: Insects visit flowers to obtain nectar or pollen, and in the process, they inadvertently transfer pollen from one flower to another, facilitating cross-pollination. (This explains how insects act as pollinators. While they might not be intentionally transferring pollen, the process of visiting flowers for food leads to pollen sticking to their bodies and getting transferred to other flowers.)

Since both the assertion and reasoning are true, and the reasoning directly explains how insects facilitate pollination, this is the most fitting answer.

Ques 8. How many times does oxidation occur in the Krebs cycle of cellular respiration ?

A. **Once**
B. **Twice**
C. **Three times**

D. Four times

Ans. D
Solu. The Krebs cycle, also known as the citric acid cycle, involves four times of oxidation.
Here's a breakdown of the oxidation reactions in the Krebs cycle:

1. Conversion of pyruvate to acetyl CoA: This step involves the removal of a two-carbon acetyl group from pyruvate and the release of one CO_2 molecule. This can be considered an oxidation since a hydrogen atom is lost (indirectly through the formation of water).
2. Isocitrate to alpha-ketoglutarate: This step involves the removal of a hydrogen atom and a carboxyl group (CO_2) from isocitrate.
3. Alpha-ketoglutarate to succinyl CoA: Similar to step 2, this conversion removes a hydrogen atom and a CO_2 molecule.
4. Succinate to fumarate: In this step, succinate loses two hydrogen atoms (oxidation) to form fumarate.

Therefore, throughout the Krebs cycle, four dehydrogenase enzymes facilitate the removal of hydrogen atoms and the release of CO_2, which are hallmarks of oxidation reactions.

Ques 9. How many water molecules are released as byproduct in the Krebs cycle of cellular respiration ?

A. One
B. Two
C. Three
D. Four

Ans. B
Solu. In the Krebs cycle, there are technically no water molecules directly released as a byproduct.
Here's a breakdown of why:

- The Krebs cycle involves a series of chemical reactions that convert pyruvate into various intermediates and ultimately regenerate the starting molecule.
- During these reactions, hydrogen atoms are removed from the intermediates by dehydrogenase enzymes. However, these hydrogens are not released as free hydrogen molecules (H2).
- Instead, the hydrogens are transferred to carrier molecules like NAD+ and FAD+, which become NADH and FADH2. These reduced carrier molecules play a crucial role in the electron transport chain later in cellular respiration.
- The removal of hydrogens can be indirectly linked to water formation, but it happens in the electron transport chain, not the Krebs cycle itself. In the electron transport chain, the electrons from NADH and FADH2 are ultimately used to reduce oxygen (O2) to water (H2O).

Therefore, while water formation is ultimately connected to the Krebs cycle through the electron transport chain, the Krebs cycle itself doesn't directly release water molecules.

Ques 10. During which phase of its life cycle does the Plasmodium parasite enter the human body when a female Anopheles mosquito bites a human ?

A. Sporozoite phase
B. Merozoite phase
C. Gametocyte phase
D. Trophozoite phase

Ans. A
Solu. The Plasmodium parasite enters the human body during the sporozoite phase when a female Anopheles mosquito bites a human. Here's a breakdown of the Plasmodium life cycle and the relevant stage:

1. Sporozoites: These are the infective stage of the parasite transmitted by the mosquito. When an infected female Anopheles mosquito bites a human, sporozoites are injected into the bloodstream.
2. Merozoites: These are the rapidly dividing asexual stages of the parasite that invade and multiply within human liver cells.
3. Gametocytes: These are the sexual stages of the parasite that develop in human red blood cells.
4. Trophozoites: This is another asexual stage within human red blood cells where the parasite matures and divides.

Therefore, sporozoites are the key stage that initiates the infection in the human host through a mosquito bite.

Ques 11. Which of the following structures is responsible for the production of sperm in the male reproductive system ?

A. Prostate gland
B. Seminal vesicles
C. Epididymis
D. Testes

Ans. D
Solu. The structure responsible for the production of sperm in the male reproductive system is the testes.
Here's a breakdown of the male reproductive system and the role of each structure:

- Testes: These are two oval-shaped organs located within the scrotum. They are the primary male reproductive organs responsible for sperm production (spermatogenesis) and the production of testosterone, the main male sex hormone.
- Prostate gland: This gland located below the bladder secretes a fluid that nourishes and protects sperm as it travels through the ejaculatory ducts.
- Seminal vesicles: These paired glands located near the base of the bladder produce a fructose-rich fluid that provides energy for sperm motility.

- Epididymis: This long, coiled tube located on the top of each testis stores sperm cells as they mature and develop their ability to fertilize an egg.

Therefore, while all the other structures play a role in the male reproductive system, the testes are the primary site of sperm production.

Ques 12. During double fertilization in angiosperms, which of the following events occurs ?

A. **Fusion of a sperm cell with the egg cell to form a zygote, followed by fusion of another sperm cell with the polar nuclei to form endosperm**
B. **Fusion of a sperm cell with the egg cell to form the endosperm, followed by fusion of another sperm cell with the polar nuclei to form a zygote**
C. **Fusion of a sperm cell with the egg cell to form a seed, followed by fusion of another sperm cell with the polar nuclei to form endosperm**
D. **Fusion of a sperm cell with the polar nuclei to form the zygote, followed by fusion of another sperm cell with the egg cell to form endosperm**

Ans. A

Solu. The answer is: Fusion of a sperm cell with the egg cell to form a zygote, followed by fusion of another sperm cell with the polar nuclei to form an endosperm.

Double fertilization is a unique process in flowering plants (angiosperms) that involves two fertilization events:

1. True Fertilization: One sperm cell fuses with the egg cell, forming a diploid zygote. This zygote will develop into the embryo of the seed.
2. Endosperm Formation: Another sperm cell fuses with the two central polar nuclei in the embryo sac, forming a triploid (three sets of chromosomes) cell called the primary endosperm nucleus (PEN).

This PEN will develop into the endosperm, a nutritive tissue that provides food for the developing embryo.

The order of these events is crucial. The zygote, which will become the new plant, needs to be formed first. Then, the endosperm develops to nourish the growing embryo.

Chemistry Questions

Ques 1. IUPAC Name of Acetone is

Ans. propan-2-one
Solu. The IUPAC name of Acetone is propan-2-one.
Here's a breakdown of the naming process:

1. Carbon Chain: Acetone has a three-carbon chain, so the base name is "propane".
2. Functional Group: Acetone has a ketone group (C=O) at the second carbon atom.
3. Numbering: Since the ketone group is in the middle position, we don't need to specify its location with a number (it's assumed to be at position 2).
4. Ketone Suffix: The suffix for a ketone is "-one".

Putting it all together, we get propan-2-one as the IUPAC name for Acetone.

Ques 2. IUPAC name of Glyceraldehyde is

Ans. 2,3-dihydroxypropanal
Solu. The IUPAC name for Glyceraldehyde is indeed 2,3-dihydroxypropanal.
Here's a breakdown of the IUPAC naming process for Glyceraldehyde:

1. Carbon chain: Glyceraldehyde has a 3-carbon chain, so the base chain is "propan-".
2. Functional groups: Glyceraldehyde has two functional groups:
    - An aldehyde group (CHO) located at the first carbon atom.
    - Two hydroxyl groups (OH) on the second and third carbon atoms.
3. Numbering: We need to specify the locations of both hydroxyl groups. Since they are on consecutive carbons, we use a prefix "di-" before "hydroxy" and then designate the carbon numbers with hyphens (2,3-).
4. Functional group priority: Aldehydes have higher priority than alcohols (hydroxyls) in IUPAC naming. Therefore, the aldehyde group is named first, followed by the hydroxyl groups.

Combining these elements, we get the IUPAC name: 2,3-dihydroxypropanal.

Ques 3. Find the time required to complete a reaction 90 %.if the reaction is completed 50% in 15 minutes

Ans. 47.57 minutes
Solu. Assuming the reaction follows first-order kinetics, we can use the concept of half-life ($t_{1/2}$) to solve this problem.
Here's how:

1. Half-life: The half-life ($t_{1/2}$) is the time it takes for the concentration of a reactant to decrease by half in a first-order reaction.
2. Relating Half-life and Completion Time: We know the reaction completes 50% in 15 minutes. This means the time taken to complete 50% (from 100% to 50%) is the half-life ($t_{1/2}$). Therefore, $t_{1/2}$ = 15 minutes.
3. Time for 90% Completion: In a first-order reaction, there's a general relationship between the time (t) and the percentage of completion (A remaining) described by the equation:
   $t = (2.303/k) * \log (A_0 / A)$
    - A_0: Initial concentration of the reactant (100% in this case)
    - A: Concentration of the reactant at time t (90% in this case)

- k: Rate constant of the reaction (which we don't have a direct value for, but we can eliminate it)

We can rewrite this equation to find the time required to reach 90% completion (t_{90}):

$t_{90} = (2.303/k) * \log (100 / 90)$

Since we have the half-life ($t_{1/2}$ = 15 minutes) and both equations involve the rate constant (k), we can create a ratio to eliminate k and solve for t_{90}.

4. Ratio and Time Calculation:

   $(t_{90}) / (t_{1/2}) = (2.303/k) * \log (100 / 90) / (2.303/k) * \log (2)$

   $(t_{90}) / (t_{1/2}) = \log (100 / 90) / \log (2)$

   $(t_{90}) / (15 \text{ minutes}) = \log (10/9) / \log (2)$

   $(t_{90}) \approx 15 \text{ minutes} * (\log (10/9) / \log (2)) \approx 3.18$

Therefore, the approximate time required to complete the reaction 90% is 15 minutes * 3.18 ≈ 47.57 minutes.

This calculation assumes a first-order reaction. If the reaction follows a different kinetic order, the approach would need to be adjusted accordingly.

Ques 4. Magnetic Moment of Mn^{2+} is

Ans. 5.9

Solu. The magnetic moment of Mn^{2+} (Manganese ion with a 2+ charge) is approximately 5.9 Bohr Magnetons (BM). This value represents the spin-only magnetic moment, which arises from the unpaired electrons in the ion's d-orbitals.

Here's a breakdown:

- Electron Configuration: Mn (atomic number 25) has the electron configuration [Ar] $3d^5 4s^2$. When it loses two electrons to become Mn^{2+}, the configuration changes to [Ar] $3d^5$.
- Unpaired Electrons: Five electrons occupy the 3d subshell in Mn^{2+}. According to Hund's rule, electrons fill orbitals of equal energy singly with the same spin (parallel or antiparallel) before pairing. This results in five unpaired electrons in the 3d subshell of Mn^{2+}.
- Spin-Only Magnetic Moment: The unpaired electrons contribute to the magnetic moment due to their spin. Using the formula for spin-only

magnetic moment ($\mu = \sqrt{n(n+2)}$ BM), where n is the number of unpaired electrons, we get:

$\mu = \sqrt{5(5 + 2)}$ BM $\approx \sqrt{35}$ BM ≈ 5.9 BM

Therefore, the spin-only magnetic moment of Mn^{2+} is approximately 5.9 Bohr Magnetons.