KEAM 2026 Pharmacy April 19

Question Paper with Solutions

Conducted by CEE Kerala

General Instructions

(i) **Duration:** The total duration of the examination is 3 hours (180 minutes).

(ii) **Total Marks:** The complete paper carries a maximum of 600 marks.

(iii) **Structure:** The paper has 3 Sections:

- **Section A:** 45 Multiple Choice Questions (Physics).
- **Section B:** 30 Multiple Choice Questions (Chemistry).
- **Section B:** 75 Multiple Choice Questions (Mathematics).

(iv) **Compulsory Questions:** All 150 questions are compulsory.

(v) Each question has four options. Only **one** option is correct.

(vi) **Correct Answer:** +4 marks.

(vii) **Incorrect Answer:** −1 (Negative marking).

(viii) **Unanswered/Marked for Review:** 0 marks.

Physics(Pharmacy)

1. If orbital radius of geostationary satellite decreases, gravitational potential energy

(A) Increases

(B) Decreases

(C) Remains same

Correct Answer: (B) Decreases

Solution:

Step 1: Understanding the Concept:

Gravitational potential energy is the energy possessed by a mass due to its position in a gravitational field.

For a satellite orbiting the Earth, the potential energy is always negative, which indicates that it is a gravitationally bound system.

Step 2: Key Formula or Approach:

The formula for the gravitational potential energy U of a satellite of mass m orbiting a planet of mass M at an orbital radius r is given by:

$$U = -\frac{GMm}{r}$$

Step 3: Detailed Explanation:

In this formula, the gravitational constant G, the mass of the Earth M, and the mass of the satellite m are all positive constants.

When the orbital radius r decreases, the denominator becomes smaller, which makes the magnitude of the fraction $\frac{GMm}{r}$ larger.

However, because of the negative sign in the formula, an increase in the magnitude means the actual value of the potential energy becomes more negative.

Becoming more negative corresponds to a mathematical decrease in the total value.

Step 4: Final Answer:

The gravitational potential energy decreases.

Quick Tip: Always remember that bound systems have negative potential energy.

A decrease in orbital distance makes the system more tightly bound, thus lowering the potential energy further (making it more negative).

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2. A ball falls from a height of 20 m, and then bounces back up to 17 m height. The loss of energy is

Correct Answer: 15%

Solution:

Step 1: Understanding the Concept:

When a ball falls from an initial height and bounces back up to a lower final height, it has lost a portion of its initial mechanical energy.

This energy loss is typically due to non-conservative forces like air resistance and the inelastic nature of the collision with the ground.

Step 2: Key Formula or Approach:

The potential energy of the ball at any given height is $E = mgh$.

The percentage loss of energy is calculated using the formula:

$$\text{Percentage Loss} = \left(\frac{E_i - E_f}{E_i} \right) \times 100\%$$

Step 3: Detailed Explanation:

Let the initial height be $h_1 = 20$ m.

Let the final height reached after the bounce be $h_2 = 17$ m.

The initial potential energy before falling is $E_i = mgh_1$.

The final potential energy after the bounce is $E_f = mgh_2$.

The loss in energy is $\Delta E = mgh_1 - mgh_2 = mg(h_1 - h_2)$.

Substituting the values, the percentage energy loss is:

$$\text{Percentage Loss} = \frac{mg(20-17)}{mg(20)} \times 100\%$$

$$\text{Percentage Loss} = \frac{3}{20} \times 100\%$$

$$\text{Percentage Loss} = 3 \times 5\% = 15\%$$

Step 4: Final Answer:

The percentage loss of energy is 15%.

Quick Tip: The ratio of the final height to the initial height corresponds to the square of the coefficient of restitution, $e^2 = \frac{h_2}{h_1}$.

The fractional loss of mechanical energy is directly given by $1 - e^2$.

3. A body of mass 'm' is acted upon by two perpendicular forces 4N and 3N. Find mass 'm' if acceleration of a body is 2 m/s^2

Correct Answer: 2.5 kg

Solution:

Step 1: Understanding the Concept:

When multiple forces act simultaneously on a single body, the resulting acceleration is caused by the net vector sum of all forces.

Since the two given forces are perfectly perpendicular to each other, their resultant can be found using the Pythagorean theorem.

Step 2: Key Formula or Approach:

The magnitude of the resultant force F_{net} of two perpendicular forces F_1 and F_2 is $F_{net} = \sqrt{F_1^2 + F_2^2}$.

By Newton's Second Law of Motion, the relationship between force, mass, and acceleration is given by $F_{net} = m \times a$.

Step 3: Detailed Explanation:

The two applied forces are $F_1 = 4$ N and $F_2 = 3$ N.

Calculating the net force acting on the body:

$$F_{net} = \sqrt{4^2 + 3^2}$$

$$F_{net} = \sqrt{16+9} = \sqrt{25} = 5 \text{ N}$$

We are given that the resulting acceleration is $a = 2$ m/s^2.

Substituting the net force and acceleration into Newton's Second Law formula:

$$5 = m \times 2$$

$$m = \frac{5}{2} = 2.5 \text{ kg}$$

Step 4: Final Answer:

The mass of the body is 2.5 kg.

Quick Tip: Whenever forces are given as perpendicular vectors, they naturally form a right-angled triangle.

Recognizing the classic $3-4-5$ Pythagorean triplet instantly saves you from manually calculating the resultant force!

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4. The work function for a metal having threshold frequency 5×10^7 Hz is?

Correct Answer: 3.31×10^{-26} J

Solution:

Step 1: Understanding the Concept:

The work function of a metal describes the minimum amount of energy required to eject an electron completely from its surface.

This energy is directly proportional to the threshold frequency, which is the absolute minimum frequency of incident light needed to trigger photoelectric emission.

Step 2: Key Formula or Approach:

The work function Φ is calculated using the equation $\Phi = h\nu_0$.

Here, h represents Planck's constant (6.626×10^{-34} J $\cdot$ s) and ν_0 is the given threshold frequency.

Step 3: Detailed Explanation:

The problem states the threshold frequency is $\nu_0 = 5 \times 10^7$ Hz.

Substituting this value into the work function formula yields:

$$\Phi = (6.626 \times 10^{-34}\ \text{J} \cdot \text{s}) \times (5 \times 10^7\ \text{Hz})$$

$$\Phi = 33.13 \times 10^{-27}\ \text{J}$$

Adjusting the decimal place to express the answer in standard scientific notation:

$$\Phi = 3.313 \times 10^{-26}\ \text{J}$$

Step 4: Final Answer:

The work function of the metal is approximately 3.31×10^{-26} J.

Quick Tip: Memorizing the approximate value of Planck's constant $h \approx 6.63 \times 10^{-34}$ J $\cdot$ s is essential for modern physics problems.

If a question ever requires the final answer in electron-volts (eV), divide the calculated Joules by 1.6×10^{-19}.

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5. An effective power of a combination of 5 identical convex lens having focal length f= 20 cm is

Correct Answer: +25 D

Solution:

Step 1: Understanding the Concept:

When multiple thin lenses are placed in close physical contact, the total effective power of the system is the algebraic sum of their individual powers.

A convex lens acts as a converging lens and has a positive focal length, meaning its optical power is also strictly positive.

Step 2: Key Formula or Approach:

The optical power P of a single lens in diopters (D) is given by $P = \frac{100}{f}$ where f is measured in centimeters.

For n identical lenses placed in contact, the total effective power is $P_{\text{eff}} = n \times P$.

Step 3: Detailed Explanation:

The focal length of a single convex lens is given as $f = +20$ cm.

Calculating the power of one individual lens:

$$P = \frac{100}{+20} = +5 \text{ D}$$

Because there are 5 identical lenses placed together in combination, we multiply the single power by 5:

$$P_{\text{eff}} = 5 \times (+5 \text{ D}) = +25 \text{ D}$$

Step 4: Final Answer:

The effective combined power of the lenses is +25 D.

Quick Tip: Always ensure you use the correct sign convention: positive for convex (converging) lenses and negative for concave (diverging) lenses.
Power must be calculated with the focal length strictly in meters, or by using the $100/f$ formula for centimeters.

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6. Potential difference between two points in a region having uniform electric field of 800 N/C is 16V. Find the distance between two points.

Correct Answer: 2 cm

Solution:

Step 1: Understanding the Concept:
In a region with a perfectly uniform electric field, the potential difference between two distinct points along the field lines is directly proportional to the separation distance between them. This is because the electric field represents the negative gradient of the electric potential.

Step 2: Key Formula or Approach:
The exact mathematical relationship between a uniform electric field E, the potential difference ΔV, and the distance d is given by $E = \frac{\Delta V}{d}$.
Rearranging this formula allows us to solve directly for the distance as $d = \frac{\Delta V}{E}$.

Step 3: Detailed Explanation:
The magnitude of the uniform electric field is $E = 800$ N/C.
The given potential difference between the points is $\Delta V = 16$ V.
Substituting these values into our rearranged equation:

$$d = \frac{16}{800} \text{ m}$$

$$d = \frac{1}{50} \text{ m}$$

$$d = 0.02 \text{ m}$$

To express this distance more conveniently in centimeters, multiply the result by 100:

$$d = 0.02 \times 100 \text{ cm} = 2 \text{ cm}$$

Step 4: Final Answer:

The absolute distance between the two points is 2 cm.

Quick Tip: The standard SI unit for an Electric Field can be written as either N/C or V/m.
Thinking of the unit specifically as V/m serves as a great shortcut to remember the formula $E = \frac{V}{d}$.

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7. In a Young's double slit experiment with a light having wavelength 500 nm, separation between slit is 0.2 mm, distance between slit and screen is 2m. Find fringe width.

Correct Answer: 5 mm

Solution:

Step 1: Understanding the Concept:

In Young's Double Slit Experiment (YDSE), light waves from two coherent sources interfere to create a pattern of alternating bright and dark fringes on a distant screen.
The constant spatial distance between any two consecutive bright or dark fringes is defined as the fringe width.

Step 2: Key Formula or Approach:

The standard expression for calculating the fringe width β is:

$$\beta = \frac{\lambda D}{d}$$

Where λ represents the wavelength of light, D is the macroscopic distance to the screen, and d is the microscopic distance between the two slits.

Step 3: Detailed Explanation:

First, identify and carefully convert all given values into standard SI units (meters).
Wavelength $\lambda = 500$ nm $= 500 \times 10^{-9}$ m.
Distance to screen $D = 2$ m.
Slit separation $d = 0.2$ mm $= 0.2 \times 10^{-3}$ m $= 2 \times 10^{-4}$ m.
Now, substitute these formatted values directly into the fringe width formula:

$$\beta = \frac{(500 \times 10^{-9}) \times 2}{2 \times 10^{-4}}$$

$$\beta = \frac{1000 \times 10^{-9}}{2 \times 10^{-4}}$$

$$\beta = \frac{10^{-6}}{2 \times 10^{-4}}$$

$$\beta = 0.5 \times 10^{-2} \text{ m} = 5 \times 10^{-3} \text{ m}$$

Converting the final result from meters to millimeters yields 5 mm.

Step 4: Final Answer:

The calculated fringe width is 5 mm.

Quick Tip: To avoid extremely common power-of-ten calculation errors, strictly convert all lengths (nm, mm, cm) into meters before plugging them into the formula.

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8. What is the specific heat capacity at constant volume for non-rigid diatomic gas.

Correct Answer: $\frac{7}{2}R$

Solution:

Step 1: Understanding the Concept:

The molar specific heat capacity at constant volume, denoted as C_v, of an ideal gas depends fundamentally on its active degrees of freedom f.

The Law of Equipartition of Energy states that each active degree of freedom contributes exactly $\frac{1}{2}RT$ to the internal molar energy of the gas.

Step 2: Key Formula or Approach:

The internal energy for one mole of a gas is given by $U = \frac{f}{2}RT$.

The molar specific heat capacity at constant volume is then defined as the derivative of internal energy with respect to temperature: $C_v = \frac{dU}{dT} = \frac{f}{2}R$.

Step 3: Detailed Explanation:

A standard rigid diatomic gas possesses exactly 5 degrees of freedom (3 translational modes

and 2 rotational modes).

However, for a non-rigid diatomic gas, typically considered at higher temperatures, an additional vibrational mode becomes active.

A single active vibrational mode inherently introduces two extra degrees of freedom (one for kinetic energy and one for potential energy).

Therefore, the total degrees of freedom for a non-rigid diatomic gas is $f = 3 + 2 + 2 = 7$.

Substituting $f = 7$ into the C_v formula gives:

$$C_v = \frac{7}{2}R$$

Step 4: Final Answer:

The specific heat capacity at constant volume is $\frac{7}{2}R$.

Quick Tip: Do not forget that one active vibrational mode always contributes a full R (or two degrees of freedom) to the specific heat capacity because it involves both kinetic and potential energies!

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9. A constant current of 3A flows through a conductor having potential difference of 200V. Find heat developed in conductor in 25s.

Correct Answer: 15 kJ

Solution:

Step 1: Understanding the Concept:

When an electric current flows steadily through a conductor across a specific potential difference, electrical work is done.

This work is entirely dissipated into the surrounding environment as thermal energy, a phenomenon widely known as Joule's heating effect.

Step 2: Key Formula or Approach:

The total heat H developed in a conductor over a time period is given by the foundational formula $H = VIt$.

Here, V stands for the potential difference, I is the constant current, and t is the elapsed time.

Step 3: Detailed Explanation:

The given values extracted from the problem statement are:

Constant Current $I = 3$ A.

Potential difference $V = 200$ V.

Time duration $t = 25$ s.

Substitute these explicit values directly into the heating formula:

$$H = 200 \times 3 \times 25$$

$$H = 600 \times 25$$

$$H = 15000 \text{ J}$$

To express this large standard value in a more concise form like kilojoules (kJ), simply divide by 1000:

$$H = 15 \text{ kJ}$$

Step 4: Final Answer:

The total heat developed in the conductor is 15 kJ.

Quick Tip: The formula $H = VIt$ is generally the fastest method to compute dissipated heat when both voltage and current are explicitly provided.

It is mathematically identical to the alternative forms $H = I^2Rt$ and $H = \frac{V^2}{R}t$.

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10. In a forward biased semiconductor potential changes from 0.9V to 0.6 V. Find current if resistance is 1Ω

(A) 300 mA

(B) 200 mA

(C) 450 mA

Correct Answer: (A) 300 mA

Solution:

Step 1: Understanding the Concept:

In a forward-biased semiconductor diode, the voltage-current relationship is intrinsically non-linear.

However, for small localized variations, the change in potential is linearly related to the change in current through a parameter called dynamic resistance.

Step 2: Key Formula or Approach:

The dynamic resistance r_d of a semiconductor diode is explicitly defined by the formula $r_d = \frac{\Delta V}{\Delta I}$.

We can easily rearrange this relationship to solve for the change in current as $\Delta I = \frac{\Delta V}{r_d}$.

Step 3: Detailed Explanation:

First, compute the magnitude of the change in the applied potential difference:

$$\Delta V = |0.9 \text{ V} - 0.6 \text{ V}| = 0.3 \text{ V}$$

The given dynamic resistance for this specific semiconductor region is $r_d = 1\ \Omega$.

Using the rearranged formula to calculate the corresponding current change:

$$\Delta I = \frac{0.3 \text{ V}}{1\ \Omega} = 0.3 \text{ A}$$

To formally convert the calculated current from Amperes to milliamperes (mA), multiply by 1000:

$$\Delta I = 0.3 \times 1000 \text{ mA} = 300 \text{ mA}$$

Step 4: Final Answer:

The resulting change in current is 300 mA.

Quick Tip: When dealing with active semiconductor devices operating in non-linear regions, always utilize the dynamic resistance ($\frac{\Delta V}{\Delta I}$) rather than the static resistance ($\frac{V}{I}$).

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11. If external force acting on a body is zero, centre of mass of body

(A) decreases

(B) remains constant

(C) increases

(D) first increases then decreases

Correct Answer: (B) remains constant

Solution:

Step 1: Understanding the Concept:

The translational motion of the center of mass of a mechanical system depends entirely and only on the net external force applied to it.

Internal forces between particles inside the body cannot alter the velocity or the state of motion of the center of mass.

Step 2: Key Formula or Approach:

According to Newton's Second Law applied to a system of particles, the net external force governs the acceleration of the center of mass: $F_{ext} = M a_{cm}$.

If $F_{ext} = 0$, it directly implies that $a_{cm} = 0$.

Step 3: Detailed Explanation:

The problem explicitly states that the external force acting on the body is zero ($F_{ext} = 0$).

Substituting this into the dynamic equation yields an acceleration of zero for the center of mass ($a_{cm} = 0$).

Since acceleration is defined as the rate of change of velocity, a zero acceleration means that the velocity of the center of mass does not change over time.

Therefore, the physical state of motion (velocity) of the center of mass remains perfectly constant.

Step 4: Final Answer:

The correct option is that the state of the center of mass remains constant.

Quick Tip: Even if a body explodes into multiple fragments due to internal forces, as long as no external force is present, the center of mass of the fragments will continue on its original path undisturbed!

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12. A cyclotron has frequency f and energy E. If the energy is doubled, frequency becomes

(A) f

(B) 2f

(C) $\frac{f}{2}$

(D) 4f

Correct Answer: (A) f

Solution:

Step 1: Understanding the Concept:

A cyclotron is a device used to accelerate charged particles outwards from the center along a spiral path.

A fundamental characteristic of a standard non-relativistic cyclotron is that the time period of revolution and the orbital frequency do not depend on the speed or kinetic energy of the particle.

Step 2: Key Formula or Approach:

The orbital cyclotron frequency f of a charged particle of mass m and charge q moving in a uniform magnetic field B is given by the formula:

$$f = \frac{qB}{2\pi m}$$

Step 3: Detailed Explanation:

Looking closely at the formula for the cyclotron frequency f, we can observe that it is determined solely by the charge q, the magnetic field strength B, and the rest mass m.

The formula entirely lacks any variable related to the particle's velocity v, orbital radius r, or kinetic energy E.

Therefore, even if the particle accelerates and its kinetic energy is doubled, the frequency of revolution strictly remains unchanged (assuming the speeds remain safely non-relativistic).

Step 4: Final Answer:

The cyclotron frequency remains f.

Quick Tip: This energy-independence is precisely the principle that allows cyclotrons to work effectively with an alternating voltage of a constant fixed frequency!

13. Which of the following is diamagnetic

(A) Bi

(B) Gd

(C) Co

(D) Na

(E) Fe

Correct Answer: (A) Bi

Solution:

Step 1: Understanding the Concept:

Magnetic materials are broadly classified into three main categories based on their behavioral response in an external magnetic field: diamagnetic, paramagnetic, and ferromagnetic. Diamagnetic materials develop an induced magnetic dipole moment in a direction strictly opposite to the applied magnetic field and are thus weakly repelled by magnets.

Step 2: Key Formula or Approach:

Solving this problem primarily requires factual knowledge of common chemical elements and their standardized magnetic properties at normal room temperature.

Step 3: Detailed Explanation:

Let's systematically evaluate the magnetic nature of each given element option.

Option (E) Iron (Fe) and Option (C) Cobalt (Co) are classic and well-known ferromagnetic materials.

Option (B) Gadolinium (Gd) is strongly ferromagnetic at low temperatures but transitions to paramagnetic at room temperature.

Option (D) Sodium (Na) is an alkali metal that typically exhibits paramagnetic properties.

Option (A) Bismuth (Bi) is fundamentally characterized as a strong diamagnetic material.

Step 4: Final Answer:

Bi (Bismuth) is the diamagnetic material.

Quick Tip: Common examples of diamagnetic substances to memorize for exams include Bismuth, Copper, Water, Gold, and Silicon.

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14. Which of the following is incorrect

(A) Stress is not a vector quantity.

(B) Young's modulus is only applicable for solids.

(C) Compressibility is applicable for solids, liquids and gases.

(D) Young's modulus is greater for elastomers than metal.

Correct Answer: (D) Young's modulus is greater for elastomers than metal.

Solution:

Step 1: Understanding the Concept:

The mechanical properties of materials heavily dictate how they respond to applied forces, stresses, and pressures.

We must systematically verify the validity of each provided statement based on fundamental definitions.

Step 2: Key Formula or Approach:

The approach involves fact-checking each distinct statement against standard physics definitions for Stress, Young's Modulus, and Bulk Modulus (Compressibility).

Step 3: Detailed Explanation:

Statement (A) says "Stress is not a vector quantity." This is entirely correct, as stress is mathematically defined as a second-order tensor, not a simple vector.

Statement (B) says "Young's modulus is only applicable for solids." This is correct because Young's modulus measures resistance to changes in linear length, and only solid bodies have defined independent lengths that can support tension and compression.

Statement (C) says "Compressibility is applicable for solids, liquids and gases." This is correct since compressibility is the reciprocal of the bulk modulus, and all states of matter can undergo volumetric compression under uniform pressure.

Statement (D) says "Young's modulus is greater for elastomers than metal." This statement is distinctly false.

Young's modulus represents stiffness. Metals are incredibly stiff and require massive forces to

stretch slightly, resulting in a very high Young's modulus. Elastomers (like rubber) stretch very easily with little force, yielding a very small Young's modulus.

Step 4: Final Answer:

The demonstrably incorrect statement is (D).

Quick Tip: Do not confuse the everyday usage of the word "elastic" with the physics definition of "elasticity."

In physics, highly elastic materials (like steel) resist deformation strongly and swiftly return to shape, whereas elastomers have low elasticity and stretch easily.

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15. If fundamental frequency of an open pipe is 200 Hz, then find the fundamental frequency if one end is closed.

Correct Answer: 100 Hz

Solution:

Step 1: Understanding the Concept:

A pipe perfectly open at both ends supports a standing wave pattern with antinodes at both the boundaries.

If one end of the exact same pipe is firmly closed, the wave pattern fundamentally shifts to having a node at the closed boundary and an antinode at the open boundary, effectively altering the supported resonant wavelengths.

Step 2: Key Formula or Approach:

The fundamental frequency f_{open} of a pipe open at both ends is given by $f_{\text{open}} = \frac{v}{2L}$.

The fundamental frequency f_{closed} of a pipe closed at one single end is given by $f_{\text{closed}} = \frac{v}{4L}$.

Step 3: Detailed Explanation:

By strictly observing the formulas, we can easily establish a direct relationship between the two frequencies.

Since $f_{\text{closed}} = \frac{v}{4L}$ and $f_{\text{open}} = \frac{v}{2L}$, we can write:

$$f_{\text{closed}} = \frac{1}{2}\left(\frac{v}{2L}\right) = \frac{1}{2}f_{\text{open}}$$

The problem states that the initial open pipe fundamental frequency is $f_{\text{open}} = 200$ Hz. Substituting this into our derived relationship gives:

$$f_{\text{closed}} = \frac{200}{2} = 100 \text{ Hz}$$

Step 4: Final Answer:

The fundamental frequency of the closed pipe is 100 Hz.

Quick Tip: A highly useful shortcut to memorize is that closing one end of an open pipe immediately halves its fundamental frequency!

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16. Energy of electron of hydrogen atom in 3^{rd} excited state is

Correct Answer: -0.85 eV

Solution:

Step 1: Understanding the Concept:

In Bohr's highly successful model of the hydrogen atom, electrons occupy specific, discrete, and quantized circular orbits (energy levels).

The lowest possible energy level is correctly referred to as the ground state, while the higher energy levels above it are categorized sequentially as excited states.

Step 2: Key Formula or Approach:

The total energy E_n of an electron orbiting in the n^{th} principal quantum state of a hydrogen atom is calculated using the established formula:

$$E_n = -\frac{13.6}{n^2} \text{ eV}$$

Step 3: Detailed Explanation:

First, we must correctly identify the principal quantum number n corresponding to the "3^{rd}

excited state."

The ground state is inherently $n = 1$.

The 1^{st} excited state corresponds to $n = 2$.

The 2^{nd} excited state corresponds to $n = 3$.

Therefore, the 3^{rd} excited state strictly corresponds to $n = 4$.

Now, substitute $n = 4$ directly into the quantized energy formula:

$$E_4 = -\frac{13.6}{4^2} \text{ eV}$$

$$E_4 = -\frac{13.6}{16} \text{ eV}$$

Executing the division yields the numerical value:

$$E_4 = -0.85 \text{ eV}$$

Step 4: Final Answer:

The energy of the electron in the 3^{rd} excited state is -0.85 eV.

Quick Tip: Be very careful with terminology: the n^{th} excited state always strictly corresponds to principal quantum number $n + 1$.

Memorize the first four energy levels for hydrogen to save time: -13.6 eV, -3.4 eV, -1.51 eV, and -0.85 eV.

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17. The displacement of a body at any time t is given by

$$x = -\frac{3}{4}t^2 + 12t + 3$$

The velocity of the body is zero after:

Correct Answer: 8 s

Solution:

Step 1: Understanding the Concept:

In classical kinematics, the instantaneous velocity of a moving body is defined precisely as the time derivative of its position or displacement vector.

To find the exact time when the body briefly comes to rest, we must calculate the velocity function and explicitly set it equal to zero.

Step 2: Key Formula or Approach:

The instantaneous velocity v is derived from the displacement x using basic differential calculus: $v = \frac{dx}{dt}$.

Once the generalized expression for v is obtained, solve the algebraic equation $v(t) = 0$ for time t.

Step 3: Detailed Explanation:

The given displacement function with respect to time is:

$$x = -\frac{3}{4}t^2 + 12t + 3$$

Differentiate this entire equation with respect to t to find the instantaneous velocity v:

$$v = \frac{d}{dt}\left(-\frac{3}{4}t^2 + 12t + 3\right)$$

Applying basic power rule differentiation:

$$v = -\frac{3}{4}(2t) + 12(1) + 0$$

$$v = -\frac{3}{2}t + 12$$

To precisely find when the velocity becomes absolute zero, we set $v = 0$:

$$-\frac{3}{2}t + 12 = 0$$

Rearranging the simple linear equation:

$$\frac{3}{2}t = 12$$

$$t = 12 \times \frac{2}{3}$$

$$t = \frac{24}{3} = 8 \text{ s}$$

Step 4: Final Answer:

The velocity of the moving body drops to zero exactly after 8 s.

Quick Tip: Always double-check the signs when differentiating quadratic displacement equations. A negative t^2 term indicates constant deceleration, meaning the object will inevitably stop and reverse its direction.

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18. Two syringes have piston in the ratio 1 : 5. If the pressure exerted in both syringes is same, find the ratio of the forces applied on the piston.

Correct Answer: 1 : 5

Solution:

Step 1: Understanding the Concept:

According to the fundamental definition of fluid pressure, pressure is mathematically defined as the magnitude of the normal force applied per unit surface area.

When two connected or identical systems operate under the exact same fluid pressure, the required force becomes strictly directly proportional to the cross-sectional area of the specific piston.

Step 2: Key Formula or Approach:

The formula relating pressure P, force F, and area A is universally given by $P = \frac{F}{A}$.

Since the pressure is constant across both syringes, $P_1 = P_2$, which algebraically rearranges to $\frac{F_1}{A_1} = \frac{F_2}{A_2}$, meaning the ratio of forces is equal to the ratio of areas: $\frac{F_1}{F_2} = \frac{A_1}{A_2}$.

Step 3: Detailed Explanation:

The problem states that the pistons are in the strict ratio of 1 : 5.

In physics problems involving hydraulic lifts and interconnected syringes, a "ratio of pistons" typically refers directly to their effective cross-sectional areas (unless explicitly designated as radii or diameters).

Assuming the given ratio perfectly represents the area ratio, we have:

$$\frac{A_1}{A_2} = \frac{1}{5}$$

Because the pressure exerted is entirely identical for both systems ($P_1 = P_2$), we can substitute the area ratio directly into our derived force relationship:

$$\frac{F_1}{F_2} = \frac{A_1}{A_2} = \frac{1}{5}$$

Therefore, the necessary force applied on the first piston is one-fifth of the force strictly required on the second piston.

Step 4: Final Answer:

The ratio of the applied forces is 1 : 5.

Quick Tip: This concept forms the entire foundational basis of Pascal's Law and hydraulic machinery! A tiny force on a small area creates identical pressure to lift a massive weight on a larger area.

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19. A spring of spring constant 'k' cut into n pieces. What is the spring constant of each piece?

(A) $\frac{k}{n}$

(B) $\frac{n}{k}$

(C) $\frac{n^2}{k}$

(D) nk

Correct Answer: (D) nk

Solution:

Step 1: Understanding the Concept:

The effective stiffness or spring constant k of a uniform coiled spring depends heavily on its total unstretched natural length.

Specifically, the spring constant is entirely inversely proportional to the original length of the spring material.

Step 2: Key Formula or Approach:

The defining mathematical relationship is $k \propto \frac{1}{L}$, which means the product of the spring constant and its length is always a constant value: $k_{\text{initial}} L_{\text{initial}} = k_{\text{final}} L_{\text{final}}$.

Step 3: Detailed Explanation:

Let the initial spring constant strictly be k and the initial total length be L.

When this uniform spring is systematically cut into n perfectly equal smaller pieces, the new length of each individual piece naturally becomes $L' = \frac{L}{n}$.

Using our established inverse relationship $k \times L = \text{constant}$, we can directly equate the initial and final states:

$$k \times L = k' \times L'$$

Substitute the new reduced length into the equation:

$$k \times L = k' \times \left(\frac{L}{n}\right)$$

We safely cancel out the common length variable L from both sides of the equation:

$$k = \frac{k'}{n}$$

Rearranging to formally solve for the new spring constant k':

$$k' = nk$$

Step 4: Final Answer:

The newly determined spring constant of each individual piece is genuinely nk.

Quick Tip: Intuitively, making a spring shorter drastically reduces the amount of elastic material available to stretch, rendering it much stiffer and significantly harder to pull!

---

20. The capacitance of a capacitor is C when there is air (or vacuum) between its plates. When a dielectric is completely inserted between the plates, the capacitance becomes 2C. Find the dielectric constant of the material.

Correct Answer: 2

Solution:

Step 1: Understanding the Concept:

Introducing an insulating dielectric material tightly between the metallic plates of a capacitor reduces the effective internal electric field.

Because the potential difference necessarily drops while the charge fundamentally remains the same, the overall capacitance of the system strictly increases.

Step 2: Key Formula or Approach:

The formula strictly relating the original capacitance in a vacuum C_0 to the new capacitance C_d with a dielectric is given by $C_d = KC_0$.

Here, K represents the dimensionless dielectric constant (also precisely known as the relative permittivity ϵ_r) of the inserted material.

Step 3: Detailed Explanation:

The initial capacitance with air acting as the medium is securely given as $C_0 = C$.

The final capacitance heavily modified by the complete insertion of the dielectric is explicitly given as $C_d = 2C$.

Substitute these specific measured values completely into the fundamental relationship formula:

$$2C = K \times C$$

Divide both sides clearly by the non-zero initial capacitance C:

$$K = \frac{2C}{C}$$

$$K = 2$$

Step 4: Final Answer:

The dielectric constant of the inserted material is definitively 2.

Quick Tip: The dielectric constant K strictly indicates the exact multiplying factor by which the total capacitance is enhanced. If it doubles, $K = 2$. If it triples, $K = 3$. Simple and direct!

---

21. $\vec{P} = x\hat{i} + 0.8\hat{j} + 0.6\hat{k}$

If magnitude of $\vec{P}$ is 2, value of x is

(A) $\sqrt{3}$

(B) 2

(C) $\sqrt{2}$

(D) 1

Correct Answer: (A) $\sqrt{3}$

Solution:

Step 1: Understanding the Concept:

A vector in three-dimensional space is represented by its components along the x, y, and z axes.

The magnitude (or length) of this vector is found by taking the square root of the sum of the squares of its individual scalar components.

Step 2: Key Formula or Approach:

For a given vector $\vec{P} = P_x\hat{i} + P_y\hat{j} + P_z\hat{k}$, the magnitude $|\vec{P}|$ is given by the formula:

$$|\vec{P}| = \sqrt{P_x^2 + P_y^2 + P_z^2}$$

Step 3: Detailed Explanation:

From the given vector equation, the components are $P_x = x$, $P_y = 0.8$, and $P_z = 0.6$.

The problem states that the magnitude of the vector is exactly 2, so $|\vec{P}| = 2$.

Substitute these given values into the magnitude formula:

$$2 = \sqrt{x^2 + (0.8)^2 + (0.6)^2}$$

Square both sides of the equation to remove the square root:

$$4 = x^2 + 0.64 + 0.36$$

Add the numerical values on the right side:

$$4 = x^2 + 1.00$$

Subtract 1 from both sides to isolate x^2:

$$x^2 = 4 - 1$$

$$x^2 = 3$$

Taking the square root gives the value of x:

$$x = \sqrt{3}$$

Step 4: Final Answer:

The value of x is $\sqrt{3}$.

Quick Tip: Recognizing common Pythagorean triplets (like $0.6, 0.8, 1.0$) can greatly speed up calculations! Since $0.8^2 + 0.6^2 = 1^2$, the equation instantly simplifies to $x^2 + 1 = 4$.

---

22. A particle moves in a circular path of radius 4 cm

Correct Answer: Data extraction statement

Solution:

Step 1: Understanding the Concept:

This statement strictly provides the geometric boundary condition for a particle undergoing circular motion.

Without additional kinematic variables like time, velocity, or frequency, it acts as a descriptive setup rather than a complete solvable question.

Step 2: Key Formula or Approach:

The foundational property of a circular path is its circumference, defined by the formula

$C = 2\pi r$.

This tells us the total path length covered in one single, complete revolution.

Step 3: Detailed Explanation:

The given radius of the circular path is strictly $r = 4$ cm.

By substituting this radius into the circumference formula, we can determine the distance for one loop:

$$C = 2\pi(4) = 8\pi \text{ cm}$$

Since no further operational data is provided in this specific line, this is the maximum extractable physical information.

Step 4: Final Answer:

The particle follows a path where one revolution equals a distance of 8π cm.

Quick Tip: In exam papers, sometimes an overarching data statement is printed as a standalone line before presenting the actual questions that depend on it.

Always look closely at the immediately following questions (like Q23) to apply this extracted data!

---

23. A particle moves in a circular path of radius 4 cm. It completes 5 revolutions in 2 minutes. Find its linear velocity.

Correct Answer: $\frac{\pi}{3}$ cm/s

Solution:

Step 1: Understanding the Concept:

Linear velocity in uniform circular motion is the continuous distance traveled along the circumference of the circle divided by the elapsed time.

It directly relates to the angular frequency, which measures how rapidly the particle cycles through revolutions.

Step 2: Key Formula or Approach:

The fundamental relationship between linear velocity v, radius r, and angular velocity ω is

given by $v = r\omega$.

The angular velocity ω can be calculated from the frequency of revolutions f using the formula $\omega = 2\pi f$.

Step 3: Detailed Explanation:

First, carefully identify the given physical values from the problem statement.

Radius $r = 4$ cm.

The particle effectively completes 5 revolutions in a total time of 2 minutes.

Convert the given time entirely into standard SI base units (seconds): 2 minutes $=$ 120 seconds.

Now, calculate the fundamental frequency f, which is the number of revolutions per second:

$$f = \frac{5 \text{ revolutions}}{120 \text{ seconds}} = \frac{1}{24} \text{ Hz}$$

Next, calculate the corresponding angular velocity ω:

$$\omega = 2\pi\left(\frac{1}{24}\right) = \frac{\pi}{12} \text{ rad/s}$$

Finally, apply the linear velocity formula using the radius and angular velocity:

$$v = 4 \times \left(\frac{\pi}{12}\right)$$

$$v = \frac{4\pi}{12} = \frac{\pi}{3} \text{ cm/s}$$

Step 4: Final Answer:

The linear velocity of the particle is exactly $\frac{\pi}{3}$ cm/s.

Quick Tip: Always convert minutes into seconds before calculating frequency to ensure your final velocity unit is consistently in cm/s or m/s.

---

24. In simple harmonic motion (SHM), the acceleration of a particle at a displacement of 3m from the mean position is 48 m/s^2 directed towards the mean position. Find the angular frequency.

Correct Answer: 4 rad/s

Solution:

Step 1: Understanding the Concept:

The defining characteristic of Simple Harmonic Motion (SHM) is that the acceleration of the oscillating particle is always strictly directly proportional to its displacement from the mean position.

Furthermore, this acceleration vector is always directed precisely opposite to the displacement vector (towards the equilibrium point).

Step 2: Key Formula or Approach:

The fundamental kinematic equation for acceleration a in SHM at any given displacement x is:

$$a = -\omega^2 x$$

Here, ω represents the angular frequency of the oscillator. Taking just the magnitude gives $|a| = \omega^2 x$.

Step 3: Detailed Explanation:

From the problem text, the specific magnitude of acceleration is explicitly given as $|a| = 48$ m/s^2.

The corresponding displacement magnitude from the mean position is explicitly $x = 3$ m.

Substitute these known values directly into the magnitude equation:

$$48 = \omega^2 \times 3$$

Rearrange the equation to isolate the unknown ω^2:

$$\omega^2 = \frac{48}{3}$$

$$\omega^2 = 16$$

Take the square root of both sides to confidently find the angular frequency:

$$\omega = \sqrt{16} = 4 \text{ rad/s}$$

Step 4: Final Answer:

The angular frequency of the particle's motion is 4 rad/s.

Quick Tip: The negative sign in $a = -\omega^2 x$ simply indicates direction (towards the mean position). When doing purely numerical calculations with magnitudes, you can safely drop the negative sign.

---

25. The force experienced by the Earth due to solar radiation is 9×10^9, N. Find the radiation pressure on Earth. (Radius of Earth R = 6.4×10^6, m)

Correct Answer: 6.99×10^{-5} N/m^2

Solution:

Step 1: Understanding the Concept:

Radiation pressure is defined exactly as the physical force exerted by electromagnetic radiation per unit area on a given target.

For a massive spherical body like the Earth absorbing radiation from a distant source (the Sun), the effective intercepting area is not the total surface area of the sphere, but rather its flat projected cross-sectional area.

Step 2: Key Formula or Approach:

The defining formula for pressure P based on applied force F and intercepting area A is $P = \frac{F}{A}$.

The effective intercepting cross-sectional area of a sphere of radius R is exactly a circle: $A = \pi R^2$.

Step 3: Detailed Explanation:

The total force exerted by the solar radiation is given directly as $F = 9 \times 10^9$ N.

The given radius of the Earth is $R = 6.4 \times 10^6$ m.

First, calculate the effective cross-sectional area intercepting the light:

$$A = \pi R^2$$

$$A = \pi (6.4 \times 10^6)^2$$

$$A = \pi (40.96 \times 10^{12}) \text{ m}^2 \approx 1.2868 \times 10^{14} \text{ m}^2$$

Now, directly substitute the force and the calculated area into the radiation pressure formula:

$$P = \frac{9 \times 10^9}{1.2868 \times 10^{14}}$$

$$P \approx 6.99 \times 10^{-5} \text{ N/m}^2$$

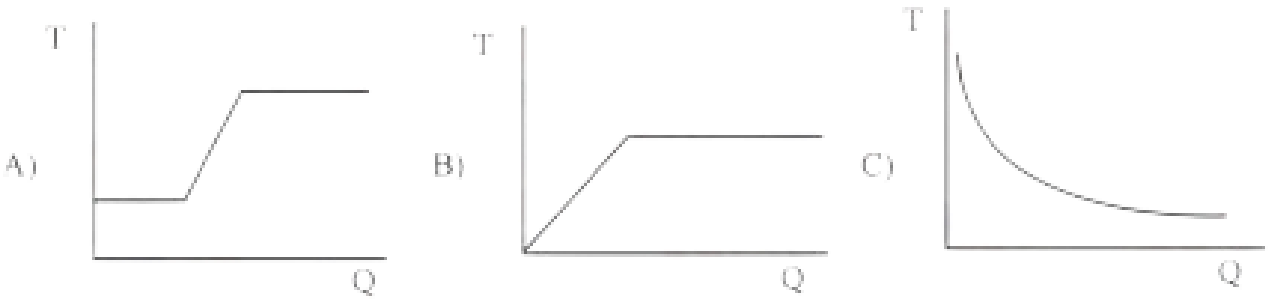
Step 4: Final Answer:

The calculated radiation pressure acting on the Earth is approximately 6.99×10^{-5} N/m^2.

Quick Tip: A highly common mistake is using the total surface area of the sphere ($4\pi R^2$). Always remember that parallel incoming light rays only ever "see" the flat circular shadow (πR^2) of a spherical object!

---

26. When ice at 0°C is heated and converted into steam at 100°C, which graph correctly represents the variation of temperature with heat supplied?



Correct Answer: (B)

Solution:

Step 1: Understanding the Concept:

The process of heating ice at 0°C all the way to steam at 100°C involves three distinct thermodynamic stages.

It involves a phase change from solid to liquid, a pure temperature increase of the liquid, and finally a phase change from liquid to gas.

Step 2: Key Formula or Approach:

During a phase change, heat is strictly supplied as latent heat ($Q = mL$), and the absolute temperature remains entirely constant, leading to a horizontal line on a Temperature vs. Heat graph.

During a single-phase temperature rise, heat goes into specific heat capacity ($Q = mc\Delta T$), causing the temperature to rise linearly with a constant positive slope.

Step 3: Detailed Explanation:

Let's trace the correct physical sequence of the heating curve:

Stage 1: Ice at 0°C melts into liquid water at 0°C. The temperature strictly remains constant at 0°C as heat is continuously supplied. This produces a horizontal line segment starting right from the origin along the heat axis.

Stage 2: The liquid water is then heated from 0°C up to 100°C. The temperature continuously rises linearly as more heat is supplied, creating a diagonal straight line moving upward.

Stage 3: The water at 100°C begins to boil and convert entirely into steam. The temperature remains completely constant at 100°C during this entire process, forming a second horizontal line segment.

Looking strictly at the provided visual options, Graph B is the only graph that perfectly depicts this exact "horizontal-diagonal-horizontal" sequence starting from the origin.

Step 4: Final Answer:

Graph B correctly represents the exact variation of temperature with the heat supplied.

Quick Tip: Remember that the length of the horizontal segments depends on the latent heats. Since the latent heat of vaporization of water is much larger than the latent heat of fusion, the boiling horizontal line is actually much longer than the melting horizontal line!

Chemistry

1. Reagent used to convert decanol to decanoic acid

(A) Tollen's reagent

(B) Jones reagent

(C) Grignard reagent

(D) Fehling's reagent

(E) DIBAC—H

Correct Answer: (B) Jones reagent

Solution:

Step 1: Understanding the Concept:

The oxidation of a primary alcohol to a carboxylic acid requires the use of a strong oxidizing agent. Mild oxidizing agents will stop at the aldehyde stage.

Step 2: Key Formula or Approach:

The approach is to identify the functional group transformation (primary alcohol to carboxylic acid) and select the corresponding strong oxidizing agent from the given options.

Step 3: Detailed Explanation:

Decanol is a primary alcohol with a 10-carbon chain.

To convert it into decanoic acid, complete oxidation must occur.

Jones reagent, which is a mixture of chromium trioxide (CrO_3) in aqueous sulfuric acid and acetone, is a strong oxidizing agent.

It oxidizes primary alcohols first to aldehydes, and then rapidly further to carboxylic acids.

Tollen's reagent and Fehling's reagent are mild oxidizing agents that only oxidize aldehydes to carboxylic acids, but do not oxidize alcohols.

Grignard reagents are used for nucleophilic addition to carbonyls, not for oxidation.

DIBAC—H is a reducing agent, typically used to reduce esters or nitriles to aldehydes.

Therefore, Jones reagent is the correct choice.

Step 4: Final Answer:

The correct reagent is Jones reagent.

Quick Tip: Remember that weak oxidizing agents like PCC or PDC will stop the oxidation of a primary alcohol at the aldehyde stage.

Only strong oxidizing agents like Jones reagent or acidified $KMnO_4$ will take it all the way to a carboxylic acid.

2. IUPAC name of $(CH_3)_3C-CH_2Br$

Correct Answer: 1-Bromo-2,2-dimethylpropane

Solution:

Step 1: Understanding the Concept:

To find the IUPAC name, identify the longest carbon chain containing the principal functional group (here, the halogen atom).

Step 2: Key Formula or Approach:

The approach is to expand the condensed structural formula, number the longest parent chain starting from the end closer to the substituent, and name the substituents alphabetically.

Step 3: Detailed Explanation:

The given compound is $(CH_3)_3C-CH_2Br$.

Expanding the structure, we see a central carbon attached to three methyl groups and one $-CH_2Br$ group.

The longest continuous carbon chain that includes the carbon attached to the bromine atom is 3 carbons long (a propane chain).

We number the chain starting from the carbon directly attached to the bromine atom to give it the lowest locant.

Carbon-1 is the $-CH_2Br$ carbon.

Carbon-2 is the central quaternary carbon, which has two remaining methyl groups attached as substituents.

Carbon-3 is one of the terminal methyl groups.

The substituents are one 'bromo' group at C-1 and two 'methyl' groups at C-2.

When writing the name, substituents are listed in alphabetical order.

Thus, 'bromo' comes before 'methyl'.

Combining these parts, the IUPAC name is 1-Bromo-2,2-dimethylpropane.

Step 4: Final Answer:

The IUPAC name is 1-Bromo-2,2-dimethylpropane.

Quick Tip: Always identify the longest continuous carbon chain first.

Do not be confused by the condensed formula; drawing out the expanded structure helps in accurately locating the parent chain and substituents.

---

3. Geometry of a molecule AB_3E_2 with 3 bond pairs and 2 lone pairs

Correct Answer: T-shaped

Solution:

Step 1: Understanding the Concept:

According to the Valence Shell Electron Pair Repulsion (VSEPR) theory, the geometry of a molecule depends on the total number of electron domains around the central atom.

Step 2: Key Formula or Approach:

The approach uses VSEPR rules where Steric Number = (Number of Bond Pairs) + (Number of Lone Pairs). Minimizing lone-pair repulsions defines the final molecular shape.

Step 3: Detailed Explanation:

The molecule has the generic formula AB_3E_2.

It possesses 3 bond pairs (B) and 2 lone pairs (E), making a total of 5 electron domains.

With 5 electron domains, the central atom undergoes sp^3d hybridization.

The basic electron domain geometry for 5 domains is trigonal bipyramidal.

To minimize repulsion (especially lone pair-lone pair and lone pair-bond pair repulsions), the lone pairs occupy the more spacious equatorial positions.

The three bond pairs occupy the remaining two axial positions and one equatorial position.

The resulting molecular geometry, observing only the atoms and ignoring the lone pairs visually, takes the shape of the letter 'T'.

Therefore, the molecular geometry is T-shaped.

Step 4: Final Answer:

The molecular geometry is T-shaped.

Quick Tip: In a trigonal bipyramidal electron geometry (sp^3d), lone pairs always occupy equatorial positions first because the bond angles are 120°, which provides more space and minimizes repulsion compared to axial positions (90°).

---

4. Which donot form carbylamine

(A) Ethanamines

(B) Benzamine

(C) Porp-2-amine

(D) Propan-1-amine

(E) N-methylethanamine

Correct Answer: (E) N-methylethanamine

Solution:

Step 1: Understanding the Concept:

The carbylamine reaction, also known as the isocyanide test, is a chemical test exclusively used to detect the presence of primary (1°) amines.

Step 2: Key Formula or Approach:

The approach is to identify the degree of amine for each option; secondary (2°) and tertiary (3°) amines do not undergo this reaction.

Step 3: Detailed Explanation:

In the carbylamine test, a primary amine is heated with chloroform and alcoholic potassium hydroxide to form a foul-smelling isocyanide (carbylamine).

Let us analyze the given options to determine their amine class.

(A) Ethanamines (e.g., $CH_3CH_2NH_2$) are aliphatic primary amines, so they give the test.

(B) Benzamine (aniline, $C_6H_5NH_2$) is an aromatic primary amine, so it gives the test.

(C) Porp-2-amine ($CH_3CH(NH_2)CH_3$) is an aliphatic primary amine, so it gives the test.

(D) Propan-1-amine ($CH_3CH_2CH_2NH_2$) is an aliphatic primary amine, so it gives the test.

(E) N-methylethanamine ($CH_3CH_2NHCH_3$) is a secondary amine.

Since it is a secondary amine, it does not form carbylamine.

Step 4: Final Answer:

N-methylethanamine does not form carbylamine.

Quick Tip: The Carbylamine test is a reliable qualitative test for both aliphatic and aromatic primary amines.
If you see any prefix like "N-methyl" or "N,N-dimethyl", it indicates a secondary or tertiary amine, which will definitely fail this test.

---

5. Which transition metal has more than one metallic structure at normal temperature?

(A) Cr
(B) Ni
(C) Mn
(D) V
(E) Cu

Correct Answer: (C) Mn

Solution:

Step 1: Understanding the Concept:
Certain transition metals exhibit polymorphism (or allotropy), meaning they can exist in more than one crystalline structure.

Step 2: Key Formula or Approach:
The approach is to recall the allotropic forms of 3d transition metals and identify which one has highly complex or multiple structures.

Step 3: Detailed Explanation:
Manganese (Mn) has a highly stable half-filled $3d^5$ electron configuration.
Due to this stability, it exhibits complex bonding characteristics and exists in four different distinct polymorphic forms (alpha, beta, gamma, and delta).
At normal (room) temperature, it primarily exists in the α-manganese form, which is a highly complex body-centered cubic structure with 58 atoms per unit cell.
Its tendency to form multiple distinct metallic structures sets it apart from typical transition

metals like Cr, Ni, V, and Cu, which generally maintain a single standard bcc or fcc structure at normal conditions.

Therefore, Manganese is known for having more than one complex metallic structural form.

Step 4: Final Answer:

Mn has more than one metallic structure.

Quick Tip: Manganese is an anomaly in the 3d series; its $3d^5$ configuration makes its metallic bonding weaker and its crystal lattice highly complex compared to neighboring metals.

---

6. An organic compound $C_5H_{10}O$ does not reduces Tollen's reagent but forms addition compound with sodium hydrogen sulphite and gives the Iodoform test. On vigorous oxidation, it gives ethanoic acid and propanoic acid.

Correct Answer: Pentan-2-one

Solution:

Step 1: Understanding the Concept:

By identifying the functional groups corresponding to specific chemical tests, the exact structure of an unknown compound can be deduced.

Step 2: Key Formula or Approach:

The approach is to interpret each qualitative test: $NaHSO_3$ test for carbonyls, Tollen's test for distinguishing aldehydes from ketones, and the Iodoform test for methyl ketones, then use Popoff's rule for oxidation cleavage.

Step 3: Detailed Explanation:

The given molecular formula is $C_5H_{10}O$, which has a degree of unsaturation of 1, pointing to either a double bond or a ring.

Since the compound forms an addition compound with sodium hydrogen sulphite ($NaHSO_3$), it must contain a carbonyl group (making it an aldehyde or a ketone).

The compound does not reduce Tollen's reagent, which confirms it is a ketone and not an aldehyde.

Furthermore, it gives a positive Iodoform test, indicating the presence of a methyl ketone group (CH_3-CO-).

A 5-carbon ketone containing a methyl ketone group must be Pentan-2-one ($CH_3-CO-CH_2-CH_2-CH_3$).

To verify, let's look at the oxidation products.

Upon vigorous oxidation of ketones, the carbon-carbon bonds break according to Popoff's rule, where the carbonyl group tends to stay with the smaller alkyl fragment.

Oxidative cleavage of Pentan-2-one between C-2 and C-3 gives a 2-carbon fragment and a 3-carbon fragment.

These fragments oxidize to ethanoic acid (CH_3COOH) and propanoic acid (CH_3CH_2COOH).

This perfectly matches the given products.

Step 4: Final Answer:

The organic compound is Pentan-2-one.

Quick Tip: Use chemical tests as "clues" to puzzle out organic structures.

$NaHSO_3$ test = Carbonyl group.

Negative Tollen's test = Ketone.

Positive Iodoform test = Terminal methyl group attached to the carbonyl.

Popoff's Rule helps in predicting the cleavage products of unsymmetrical ketones.

---

7. Which are complex reaction

(i) Oxidation of ethane

(ii) Thermal decomposition of HI on gold surface

(iii) Saponification of methyl acetate

(iv) Nitration of phenol

(v) Decomposition of NH_3 on hot Pt surface

Correct Answer: (i) and (iv)

Solution:

Step 1: Understanding the Concept:

In chemical kinetics, reactions that occur in a single step are called elementary reactions. Reactions that occur in a sequence of elementary steps (a mechanism) to give the final products are called complex reactions.

Step 2: Key Formula or Approach:

The approach is to classify reactions based on their known mechanisms; multi-step mechanisms involving intermediates are complex.

Step 3: Detailed Explanation:

According to standard Chemical Kinetics theory, complex reactions involve multiple intermediate steps or yield mixed side products.

(i) Oxidation of ethane: It passes through a series of intermediate steps (forming alcohols, aldehydes, and acids) before final conversion to CO_2 and H_2O.

This is a classic complex chain reaction.

(ii) Thermal decomposition of HI on a gold surface: This is a classic example of a zero-order reaction on a solid catalyst surface, often treated as elementary at high concentrations.

(iii) Saponification of methyl acetate: This is a bimolecular second-order elementary reaction in basic kinetics discussions.

(iv) Nitration of phenol: It occurs via electrophilic aromatic substitution, involving intermediate sigma complexes, and yields a mixture of ortho and para products.

This multi-step pathway makes it a typical complex reaction.

(v) Decomposition of NH_3 on hot Pt surface: This is another zero-order elementary-like catalytic surface reaction.

Therefore, based on standard textbook classifications, (i) and (iv) represent complex consecutive and parallel reaction mechanisms respectively.

Step 4: Final Answer:

(i) Oxidation of ethane and (iv) Nitration of phenol are complex reactions.

Quick Tip: Reactions such as complete combustion, or those that generate multiple intermediate side products like nitration, are always complex because they cannot happen via a single simultaneous molecular collision.

8. Conc. of H ions in HCl solution is 3×10^{-3}M then pH = ——-?

Correct Answer: 2.52

Solution:

Step 1: Understanding the Concept:

The pH of a solution is a measure of its acidity, mathematically defined as the negative base-10 logarithm of the hydrogen ion concentration.

Step 2: Key Formula or Approach:

The formula used is:

$$\text{pH} = -\log_{10}[\text{H}^+]$$

Step 3: Detailed Explanation:

We are given that the concentration of hydrogen ions $[\text{H}^+]$ is 3×10^{-3} M.

Substitute the given value directly into the pH formula:

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

Using the logarithmic property $\log(a \times b) = \log(a) + \log(b)$:

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

We know that $\log_{10}(10^{-3}) = -3$ and the standard accepted value for $\log_{10}(3) \approx 0.4771$.

$$\text{pH} = -(0.4771 - 3)$$

$$\text{pH} = 3 - 0.4771$$

$$\text{pH} = 2.5229$$

Rounding to two decimal places, the calculated pH is 2.52.

Step 4: Final Answer:

The pH of the solution is 2.52.

Quick Tip: A quick way to estimate pH for an ion concentration of $A \times 10^{-B}$ is to use the formula $\text{pH} = B - \log(A)$.
Memorizing basic log values like $\log(2) \approx 0.30$ and $\log(3) \approx 0.48$ will save you calculation time during the exam.

---

9. Mass of ethanoic acid required to prepare 0.5m solution containing 100g of water?

Correct Answer: 3 g

Solution:

Step 1: Understanding the Concept:

Molality (m) is a concentration term defined as the number of moles of solute dissolved per kilogram of the solvent.

Step 2: Key Formula or Approach:

The relevant formulas are:

$$\text{Molality } (m) = \frac{\text{Moles of solute } (n)}{\text{Mass of solvent in kg}}$$

$$\text{Moles of solute } (n) = \frac{\text{Mass } (W)}{\text{Molar Mass } (M)}$$

Step 3: Detailed Explanation:

The solvent here is water, and its mass is given as 100 g.

First, convert this mass into kilograms:

$$\text{Mass of solvent} = \frac{100}{1000} = 0.1 \text{ kg}$$

The target molality (m) of the solution is given as 0.5 m (mol/kg).

Now, calculate the required number of moles (n) of the solute (ethanoic acid):

$$0.5 = \frac{n}{0.1}$$

$$n = 0.5 \times 0.1 = 0.05 \text{ moles}$$

Next, calculate the molar mass of ethanoic acid (CH_3COOH).

Using the atomic masses: Carbon (C) = 12, Hydrogen (H) = 1, Oxygen (O) = 16.

$$M = 12 + (3 \times 1) + 12 + (2 \times 16) + 1$$

$$M = 12 + 3 + 12 + 32 + 1 = 60 \text{ g/mol}$$

Now, calculate the mass (W) of ethanoic acid corresponding to 0.05 moles:

$$W = n \times M$$

$$W = 0.05 \text{ mol} \times 60 \text{ g/mol}$$

$$W = 3 \text{ g}$$

Step 4: Final Answer:

The mass of ethanoic acid required is 3 g.

Quick Tip: Always double-check that your solvent mass is converted to kilograms when working with molality equations.

A common mistake is using grams directly, which offsets the final answer by a factor of 1000.

---

10. Spin only magnetic moement given not correct is

(A) Ni^{2+} (4.73)

(B) Fe^{2+} (4.90)

(C) Ti^{2+} (2.84)

(D) CO^{2+} (3.89)

(E) Mg^{2+} (5.92)

Correct Answer: (A) Ni^{2+} (4.73)

Solution:

Step 1: Understanding the Concept:

The spin-only magnetic moment (μ) is dependent on the number of unpaired electrons (n)

present in the outermost d-orbitals of the transition metal ion.

Step 2: Key Formula or Approach:

The formula for spin-only magnetic moment is:

$$\mu = \sqrt{n(n+2)} \text{ B.M.}$$

Step 3: Detailed Explanation:

Let's evaluate the number of unpaired electrons and the theoretical magnetic moment for each given ion.

For option (A), Ni^{2+}:

The electronic configuration of Ni is $[Ar]4s^2 3d^8$.

The Ni^{2+} ion has an outer configuration of $3d^8$.

According to Hund's rule, filling 8 electrons in 5 d-orbitals leaves 2 unpaired electrons ($n = 2$).

$$\mu = \sqrt{2(2+2)} = \sqrt{8} \approx 2.83 \text{ B.M.}$$

The value given in the option is 4.73, which is drastically incorrect.

For option (B), Fe^{2+}:

Configuration is $3d^6$, which has 4 unpaired electrons ($n = 4$).

$$\mu = \sqrt{4(4+2)} = \sqrt{24} \approx 4.90 \text{ B.M.}$$

(This is correct).

For option (C), Ti^{2+}:

Configuration is $3d^2$, which has 2 unpaired electrons ($n = 2$).

$$\mu = \sqrt{2(4)} = \sqrt{8} \approx 2.83 \text{ B.M.}$$

(This is correct).

For option (D), CO^{2+} (Cobalt ion Co^{2+}):

Configuration is $3d^7$, which has 3 unpaired electrons ($n = 3$).

$$\mu = \sqrt{3(5)} = \sqrt{15} \approx 3.87 \text{ B.M.}$$

(This is approximately 3.89, so it is considered correct).

For option (E), the text says Mg^{2+} (5.92). This is a clear typographical error in the paper for

Mn^{2+} (Manganese).

Mn^{2+} has a $3d^5$ configuration with 5 unpaired electrons ($n = 5$).

$$\mu = \sqrt{5(7)} = \sqrt{35} \approx 5.92 \text{ B.M.}$$

Assuming the intended ion was Mn^{2+}, this value is correct.

Thus, the unequivocally incorrect value matched to the wrong ion is in option (A).

Step 4: Final Answer:

The given magnetic moment for Ni^{2+} is not correct.

Quick Tip: To quickly estimate the spin-only magnetic moment, note that the value is always slightly greater than the number of unpaired electrons (e.g., $n = 2$ gives ~ 2.8, $n = 3$ gives ~ 3.9).

Since 4.73 starts with a 4, it corresponds to an ion with 4 unpaired electrons, not 2.

---

11. Minimum energy required to remove an atom from sodium is 3.313×10^{-19}g. Maximum wavelength of radiation that will get photoelectron

Correct Answer: 600 nm

Solution:

Step 1: Understanding the Concept:

The minimum energy required to remove an electron from a metal surface is called its work function (Φ).

The maximum wavelength (threshold wavelength, λ_0) capable of ejecting a photoelectron corresponds exactly to this minimum energy.

Step 2: Key Formula or Approach:

The energy of a photon relates to its wavelength by the Planck-Einstein relation:

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

Where h is Planck's constant (6.626×10^{-34} J s) and c is the speed of light (3×10^8 m/s).

Note: The unit in the question is mistakenly typed as "g.", but it implies Joules (J).

Step 3: Detailed Explanation:

Given the work function (minimum energy) $E = 3.313 \times 10^{-19}$ J.

We rearrange the formula to solve for the maximum wavelength λ:

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

Substitute the known constants into the equation:

$$\lambda = \frac{6.626 \times 10^{-34} \text{ J s} \times 3 \times 10^{8} \text{ m/s}}{3.313 \times 10^{-19} \text{ J}}$$

First, multiply the numerator:

$$hc \approx 19.878 \times 10^{-26} \text{ J m}$$

Now, divide by the energy:

$$\lambda = \frac{19.878 \times 10^{-26}}{3.313 \times 10^{-19}}$$

Notice that $\frac{19.878}{3.313} \approx 6.00$.

$$\lambda = 6.00 \times 10^{-7} \text{ m}$$

To convert meters to nanometers ($1 \text{ nm} = 10^{-9}$ m):

$$\lambda = 600 \times 10^{-9} \text{ m} = 600 \text{ nm}$$

Step 4: Final Answer:

The maximum wavelength of radiation is 600 nm.

Quick Tip: To save calculation time in exams, memorize the value of $hc \approx 1240 \text{ eV} \cdot \text{nm}$ or $hc \approx 19.89 \times 10^{-26} \text{ J} \cdot \text{m}$.

Also, observe that 3.313 is exactly half of 6.626, making the division trivial without a calculator!

12. Find the emf of the reaction at 298K

$\mathbf{Ni_{(s)} + 2Ag^{+}_{2\times10^{-3}M} \rightarrow Ni^{+2}_{4\times10^{-2}M} + 2Ag_{(s)}}$

$(\mathbf{E^{0}_{cell}} = 1.5$ **at** $298\mathbf{K})$

Correct Answer: 1.38 V

Solution:

Step 1: Understanding the Concept:

The electromotive force (EMF) of a cell under non-standard conditions is determined using the Nernst equation, which correlates the cell potential with the standard potential and the reaction quotient.

Step 2: Key Formula or Approach:

The Nernst equation at 298 K is:

$$E_{\text{cell}} = E^{0}_{\text{cell}} - \frac{0.0591}{n} \log_{10} Q$$

Where n is the number of moles of electrons transferred, and Q is the reaction quotient.

Step 3: Detailed Explanation:

From the given cell reaction:

$$\text{Ni}_{(s)} + 2\text{Ag}^{+}_{(aq)} \rightarrow \text{Ni}^{+2}_{(aq)} + 2\text{Ag}_{(s)}$$

The number of electrons transferred $n = 2$.

The reaction quotient Q is given by:

$$Q = \frac{[\text{Ni}^{+2}]}{[\text{Ag}^{+}]^2}$$

Substitute the given concentrations into the expression for Q:

$$Q = \frac{4 \times 10^{-2}}{(2 \times 10^{-3})^2}$$

Calculate the denominator:

$$(2 \times 10^{-3})^2 = 4 \times 10^{-6}$$

Now, calculate Q:

$$Q = \frac{4 \times 10^{-2}}{4 \times 10^{-6}} = 10^4$$

Now, substitute $E^0_{\text{cell}} = 1.5$ V, $n = 2$, and $Q = 10^4$ into the Nernst equation:

$$E_{\text{cell}} = 1.5 - \frac{0.0591}{2} \log_{10}(10^4)$$

Since $\log_{10}(10^4) = 4$:

$$E_{\text{cell}} = 1.5 - \frac{0.0591}{2} \times 4$$

$$E_{\text{cell}} = 1.5 - (0.0591 \times 2)$$

$$E_{\text{cell}} = 1.5 - 0.1182 = 1.3818 \text{ V}$$

Rounding to two decimal places, we get 1.38 V.

Step 4: Final Answer:

The emf of the cell is 1.38 V.

Quick Tip: Always remember to square the concentration of the silver ion $[Ag^+]$ in the reaction quotient Q, as its stoichiometric coefficient in the balanced equation is 2. Missing this power is the most common error in Nernst equation problems.

---

13. $X_2 + O_2 \rightleftharpoons 2XO$

Concenttration of X_2 and O_2 are 4×10^{-3} and 3×10^{-3} respectively. Equilibrium concentration of XO (Kc = 0.5)

Correct Answer: 2.45×10^{-3} M

Solution:

Step 1: Understanding the Concept:

The equilibrium constant K_c for a reversible reaction is defined as the ratio of the product of the equilibrium concentrations of the products to the product of the equilibrium concentrations of

the reactants, each raised to the power of their stoichiometric coefficients.

Step 2: Key Formula or Approach:

For the reaction $X_2 + O_2 \rightleftharpoons 2XO$, the equilibrium expression is:

$$K_c = \frac{[XO]^2}{[X_2][O_2]}$$

Step 3: Detailed Explanation:

We are given:

$K_c = 0.5$

$[X_2] = 4 \times 10^{-3}$ M

$[O_2] = 3 \times 10^{-3}$ M

We need to find the concentration of XO, let's denote it as [XO].

Substitute the given values into the K_c expression:

$$0.5 = \frac{[XO]^2}{(4 \times 10^{-3}) \times (3 \times 10^{-3})}$$

Calculate the denominator:

$$(4 \times 10^{-3}) \times (3 \times 10^{-3}) = 12 \times 10^{-6}$$

Now the equation becomes:

$$0.5 = \frac{[XO]^2}{12 \times 10^{-6}}$$

Multiply both sides by 12×10^{-6}:

$$[XO]^2 = 0.5 \times 12 \times 10^{-6}$$

$$[XO]^2 = 6 \times 10^{-6}$$

Take the square root of both sides to find [XO]:

$$[XO] = \sqrt{6 \times 10^{-6}}$$

$$[XO] = \sqrt{6} \times 10^{-3}$$

We know that $\sqrt{4} = 2$ and $\sqrt{9} = 3$, so $\sqrt{6}$ is approximately 2.45.

$$[XO] \approx 2.45 \times 10^{-3} \text{ M}$$

Step 4: Final Answer:

The equilibrium concentration of XO is 2.45×10^{-3} M.

Quick Tip: When dealing with equilibrium constant expressions, pay strict attention to the stoichiometric coefficients. The coefficient '2' for XO means its concentration must be squared in the numerator.

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14. Which pais have ability to form $p\pi - p\pi$ multiple bonds

(A) C and O

(B) B and N

(C) N and P

(D) F and Cl

(E) C and Si

Correct Answer: (A) C and O

Solution:

Step 1: Understanding the Concept:

The ability of elements to form strong $p\pi - p\pi$ multiple bonds (like double or triple bonds) depends heavily on their atomic size.

Small atomic size allows for effective lateral overlap of the p-orbitals.

Step 2: Key Formula or Approach:

The approach is to identify elements belonging to the 2nd period of the periodic table, as they possess small sizes and compact $2p$ orbitals, making $p\pi - p\pi$ overlap highly effective.

Step 3: Detailed Explanation:

Let's analyze the given pairs:

(A) C and O: Both are 2nd-period elements with small atomic radii. They effectively overlap their $2p$ orbitals to form stable $p\pi - p\pi$ double bonds, as seen in molecules like CO_2, ketones, and aldehydes.

(B) B and N: Although both are 2nd period, typical multiple bonding is less dominant compared to Carbon and Oxygen, though they do form $p\pi - p\pi$ in specific aromatic-like rings (e.g., borazine). However, C and O is the classic and most prolific pair for this.
(C) N and P: Phosphorus is a 3rd-period element. Its $3p$ orbitals are larger and more diffuse, resulting in weak $p\pi - p\pi$ overlap.
(D) F and Cl: Halogens typically form single bonds. Chlorine is a 3rd-period element and does not favor $p\pi - p\pi$ bonding.
(E) C and Si: Silicon is a 3rd-period element. Its larger size makes $p\pi - p\pi$ overlap with carbon very weak (which is why CO_2 is a gas with double bonds, while SiO_2 forms a solid network of single bonds).
Thus, Carbon and Oxygen are the best and most universally recognized pair for forming robust $p\pi - p\pi$ multiple bonds.
Step 4: Final Answer:
C and O have the ability to form $p\pi - p\pi$ multiple bonds.

Quick Tip: Elements of the second period (C, N, O) uniquely form stable $p\pi - p\pi$ multiple bonds. Elements in the third period and below generally avoid $p\pi - p\pi$ bonding due to poor lateral overlap of their larger, more diffuse orbitals.

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15. Pyridinium chlorochromate is a complex of .....

Correct Answer: Chromium trioxide (CrO_3), pyridine, and HCl

Solution:
Step 1: Understanding the Concept:
Pyridinium chlorochromate (PCC) is a common, mild oxidizing agent used extensively in organic chemistry to convert primary alcohols to aldehydes without over-oxidizing them to carboxylic acids.
Step 2: Key Formula or Approach:
The approach is to recall the preparation and chemical composition of the PCC reagent based

on its name and standard textbook definitions.

Step 3: Detailed Explanation:

The name "Pyridinium chlorochromate" hints directly at its components.

It is synthesized by dissolving chromium trioxide (CrO_3) in hydrochloric acid (HCl), and then adding pyridine (C_5H_5N).

The reaction forms a complex salt with the formula $[C_5H_5NH]^+[CrO_3Cl]^-$.

The components of this complex are therefore: Pyridine (C_5H_5N), Hydrogen chloride (HCl), and Chromium trioxide (CrO_3).

Step 4: Final Answer:

It is a complex of Pyridine, CrO_3, and HCl.

Quick Tip: To remember the composition of PCC, just break down the name: "Pyridinium" comes from Pyridine + HCl, and "chlorochromate" comes from CrO_3 + HCl.

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16. In Chemotherapy, liqannd used to remove excess of Cu

Correct Answer: D-Penicillamine

Solution:

Step 1: Understanding the Concept:

Chelation therapy is a medical procedure that involves the administration of chelating agents to remove heavy metals from the body.

Step 2: Key Formula or Approach:

The approach is to identify the specific chelating ligand structurally and medically suited to bind and safely excrete copper ions from the human body.

Step 3: Detailed Explanation:

Wilson's disease is a genetic disorder where excess copper accumulates in the body tissues, particularly in the liver and brain.

To treat this copper toxicity, specific chelating ligands are administered.

D-Penicillamine is a well-known therapeutic chelating agent (ligand) that binds tightly to

copper ions, forming a stable, water-soluble complex.

This complex is then safely filtered by the kidneys and excreted in the urine.

Other chelators like EDTA are primarily used for lead poisoning, while Desferrioxamine is used for iron overload.

For copper specifically, D-Penicillamine is the standard choice.

Step 4: Final Answer:

D-Penicillamine is the ligand used to remove excess Cu.

Quick Tip: Questions linking coordination chemistry to medicine are common. Remember these classic matches:

Copper toxicity → D-Penicillamine.

Lead toxicity → EDTA.

Iron toxicity → Desferrioxamine.

Anti-cancer → Cisplatin.

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17. IUPAC name of

$$\begin{array}{l} CH_3-CH(OH)-CH_2-CH(OH)-CH(C_2H_5) \\ | \\ CH_3-CH_2 \end{array}$$

Correct Answer: 5-Ethylheptane-2,4-diol

Solution:

Step 1: Understanding the Concept:

To name the organic compound properly, we must determine the longest continuous carbon chain containing the principal functional groups (hydroxyl groups, —OH) and assign the lowest possible numbers to these groups.

Step 2: Key Formula or Approach:

The approach involves expanding the condensed formula, tracing the longest chain containing both —OH groups, numbering it to give the —OH groups the lowest locants, and naming the

substituents alphabetically.

Step 3: Detailed Explanation:

Let's analyze the structure given:

It is a continuous chain from the left: $CH_3 - CH(OH) - CH_2 - CH(OH) - CH$ ...

Attached to this last CH carbon is a (C_2H_5) group.

The vertical line | pointing down to $CH_3 - CH_2$ indicates that there is another ethyl group attached to the same CH carbon.

Starting from the left (methyl end), we trace through the carbons:

C-1: CH_3

C-2: CH(OH)

C-3: CH_2

C-4: CH(OH)

C-5: CH

From C-5, we have two identical ethyl groups ($-CH_2CH_3$). One of these groups will form part of the main parent chain, making it C-6 and C-7.

The parent chain is therefore 7 carbons long (Heptane).

The remaining ethyl group on C-5 acts as a substituent.

Now, let's establish the numbering direction.

Numbering from left to right gives the principal functional groups (the two $-OH$ groups) positions 2 and 4.

Numbering from right to left would give the $-OH$ groups positions 4 and 6.

The lowest locant set is (2,4), so we number from left to right.

Substituent: An "ethyl" group at position 5.

Principal functional groups: Two hydroxyl groups "diol" at positions 2 and 4.

Combining these parts: 5-ethyl + heptane + 2,4-diol = 5-Ethylheptane-2,4-diol.

Step 4: Final Answer:

The IUPAC name is 5-Ethylheptane-2,4-diol.

Quick Tip: Always be careful with terminal C_2H_5 or C_3H_7 groups in condensed structures. They often hide the true longest chain. Expanding them explicitly helps avoid selecting a shorter parent chain.

18. Which are carcinogenic hydrocarbon

(i) 1,2 - Benzanthracene

(ii) pent-1-yne

(iii) 1,2 - Benpyrene

(iv) cyclohexane

(v) 3-methyl cholanthrene

Correct Answer: (i), (iii) and (v)

Solution:

Step 1: Understanding the Concept:

Carcinogenic hydrocarbons are toxic compounds capable of causing cancer in living tissues. They are typically Polynuclear Aromatic Hydrocarbons (PAHs) containing multiple fused benzene rings.

Step 2: Key Formula or Approach:

The approach is to identify which of the given compounds are complex, fused-ring aromatic structures known for their toxicity and carcinogenicity.

Step 3: Detailed Explanation:

Polynuclear aromatic hydrocarbons containing more than two benzene rings fused together are generally toxic and possess cancer-producing (carcinogenic) properties. They are formed during the incomplete combustion of organic materials like tobacco, coal, and petroleum.

Let's evaluate the options:

(i) 1,2-Benzanthracene: This is a well-known PAH consisting of four fused aromatic rings. It is highly carcinogenic.

(ii) Pent-1-yne: This is a simple aliphatic alkyne. It is not carcinogenic.

(iii) 1,2-Benpyrene (Benzopyrene): This is a five-ring PAH, famously found in coal tar and cigarette smoke, and is one of the most potent known carcinogens.

(iv) Cyclohexane: This is a simple non-aromatic cyclic alkane. It is relatively non-toxic and not carcinogenic.

(v) 3-methyl cholanthrene: This is a highly potent carcinogenic PAH widely used in laboratory research to induce tumors in study models.

Therefore, the carcinogenic hydrocarbons are (i), (iii), and (v).

Step 4: Final Answer:

(i) 1,2-Benzanthracene, (iii) 1,2-Benpyrene, and (v) 3-methyl cholanthrene are carcinogenic.

Quick Tip: As a general rule in organic environmental chemistry, hydrocarbons with 3 or more fused aromatic rings (PAHs) should immediately be flagged as potentially carcinogenic and toxic.

---

19. Metals used in preparation of dihydrogen in lab

Correct Answer: Granulated Zinc (Zn)

Solution:

Step 1: Understanding the Concept:

In the laboratory, dihydrogen (H_2) gas is typically prepared by reacting an active metal with a dilute mineral acid or an aqueous alkali.

Step 2: Key Formula or Approach:

The approach is to identify the standard metal utilized in school and research laboratories for safely and efficiently generating hydrogen gas.

Step 3: Detailed Explanation:

The most common and standard method for preparing dihydrogen in the laboratory involves the reaction of granulated zinc with dilute hydrochloric acid (HCl) or dilute sulfuric acid (H_2SO_4).

The chemical reaction is:

$$Zn_{(s)} + 2H^+_{(aq)} \rightarrow Zn^{2+}_{(aq)} + H_{2(g)}$$

Granulated zinc is preferred over pure block zinc because the impurities present in it act as a local catalyst (forming micro-galvanic cells) which speeds up the reaction.

Alternatively, zinc can also react with aqueous alkali (like NaOH) to produce hydrogen and sodium zincate, though acid is more commonly used.

Highly reactive metals like Sodium or Potassium are not used in the lab because their reaction with acids or water is violently explosive.

Step 4: Final Answer:

Granulated Zinc is the metal used.

Quick Tip: Always specify "granulated" zinc rather than just "zinc", as the granular form provides a larger surface area and its inherent impurities facilitate a steady, manageable rate of hydrogen evolution.

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20. Volume ofmethanol to make 2L of 0.4M solution

(**density** $= 0.64 \mathbf{KgL^{-1}}$, **MM** $= 32$ **g mol**$^{-1}$)

Correct Answer: 40 mL (or 0.04 L)

Solution:

Step 1: Understanding the Concept:

To find the required volume of a pure liquid solute to prepare a solution, we must first calculate the required mass of the solute using the molarity equation, and then convert that mass to volume using the given density.

Step 2: Key Formula or Approach:

The required formulas are:

$$\text{Moles of solute } (n) = \text{Molarity } (M) \times \text{Volume of solution in L } (V)$$

$$\text{Mass } (W) = n \times \text{Molar Mass (MM)}$$

$$\text{Volume of pure liquid} = \frac{\text{Mass}}{\text{Density}}$$

Step 3: Detailed Explanation:

Given:

Molarity $(M) = 0.4$ M (mol/L)

Volume of solution $(V) = 2$ L

Molar Mass (MM) $= 32$ g/mol

Density $= 0.64$ Kg/L $= 640$ g/L (since 1 Kg $= 1000$ g).

First, calculate the required number of moles (n) of methanol:

$$n = M \times V = 0.4 \text{ mol/L} \times 2 \text{ L} = 0.8 \text{ moles}$$

Next, calculate the mass (W) of methanol required:

$$W = n \times \text{MM} = 0.8 \text{ moles} \times 32 \text{ g/mol} = 25.6 \text{ g}$$

Now, use the density to find the volume of pure methanol needed:

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

$$\text{Volume} = \frac{25.6 \text{ g}}{640 \text{ g/L}}$$

$$\text{Volume} = 0.04 \text{ L}$$

Convert the volume into milliliters (mL):

$$0.04 \text{ L} \times 1000 \text{ mL/L} = 40 \text{ mL}$$

Step 4: Final Answer:

The required volume of methanol is 40 mL.

Quick Tip: Always ensure unit consistency. The density is given in Kg/L, but molar mass is usually in g/mol. Convert density to g/L (0.64 Kg/L = 640 g/L) before dividing the mass in grams to prevent major magnitude errors.

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21. Enthalpy of combustion of benzene, graphite, dihydrogen are -3260, -390 and -290 kJ/mol. Find the enthalpy of formation of benzene

Correct Answer: 50 kJ/mol

Solution:

Step 1: Understanding the Concept:

Hess's Law states that the total enthalpy change for a chemical reaction is independent of the pathway. The enthalpy of formation can be calculated using the enthalpies of combustion of the reactants and products.

Step 2: Key Formula or Approach:

The mathematical relationship is:

$$\Delta H_f^\circ(\text{compound}) = \sum \Delta H_c^\circ(\text{reactants}) - \sum \Delta H_c^\circ(\text{products})$$

Alternatively, construct the formation reaction and use the constituent combustion equations.

Step 3: Detailed Explanation:

The target reaction is the formation of benzene (C_6H_6) from its standard state elements:

$$6C_{(graphite)} + 3H_{2(g)} \rightarrow C_6H_{6(l)}$$

We are given the standard enthalpies of combustion (ΔH_c):

1) $\Delta H_c(C_{graphite}) = -390$ kJ/mol

2) $\Delta H_c(H_2) = -290$ kJ/mol

3) $\Delta H_c(C_6H_6) = -3260$ kJ/mol

Using the formula derived from Hess's Law for formation from combustion data:

$$\Delta H_f(C_6H_6) = [6 \times \Delta H_c(C) + 3 \times \Delta H_c(H_2)] - [\Delta H_c(C_6H_6)]$$

Substitute the given values into the equation:

$$\Delta H_f(C_6H_6) = [6(-390) + 3(-290)] - (-3260)$$

Perform the multiplications:

$$6 \times (-390) = -2340 \text{ kJ}$$

$$3 \times (-290) = -870 \text{ kJ}$$

Add the reactant combustion enthalpies:

$$-2340 + (-870) = -3210 \text{ kJ}$$

Now, subtract the combustion enthalpy of the product (benzene):

$$\Delta H_f(C_6H_6) = -3210 - (-3260)$$

$$\Delta H_f(C_6H_6) = -3210 + 3260$$

$$\Delta H_f(C_6H_6) = +50 \text{ kJ/mol}$$

Step 4: Final Answer:

The enthalpy of formation of benzene is +50 kJ/mol.

Quick Tip: A common trap is forgetting to multiply the combustion enthalpies of the elements by their stoichiometric coefficients from the balanced formation equation (6 for Carbon, 3 for Hydrogen). Always write out the balanced formation equation first!
