AP EAPCET 2026 May 14 Shift 2

Question Paper (Memory-Based) with Solutions

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General Instructions

(i) The test is of 3 hours duration.

(ii) This test paper consists of 160 questions. The maximum marks are 160.

(iii) Physics and Chemistry contains 40 questions each and Mathematics contains 80 questions.

(iv) Each question carries +1 marks for correct answer and there is no negative marking for wrong answer.

1. The value of the integral $\int_0^{\pi} \frac{x \sin x}{1+\cos^2 x}\, dx$ is:

(A) $\frac{\pi^2}{4}$

(B) $\frac{\pi}{2}$

(C) $\frac{\pi^2}{2}$

(D) $\frac{\pi}{4}$

Correct Answer: (A) $\frac{\pi^2}{4}$

Solution:

Concept: To solve this integral, we use the definite integral property $\int_0^a f(x)\, dx = \int_0^a f(a-x)\, dx$.

This allows us to eliminate the x term in the numerator, which is a common technique for integrands involving $x \sin x$ or $x \cos x$.

Step 1: Apply the integral property.

Let $I = \int_0^{\pi} \frac{x \sin x}{1+\cos^2 x}\, dx$.

Replacing x with $(\pi - x)$:

$$I = \int_0^{\pi} \frac{(\pi - x)\sin(\pi - x)}{1+\cos^2(\pi - x)}\, dx$$

Since $\sin(\pi - x) = \sin x$ and $\cos(\pi - x) = -\cos x$ (so $\cos^2(\pi - x) = \cos^2 x$):

$$I = \int_0^{\pi} \frac{(\pi - x)\sin x}{1 + \cos^2 x}\, dx$$

Step 2: Sum the two forms of the integral.

Adding the original I and the modified I:

$$2I = \int_0^{\pi} \frac{x\sin x + (\pi - x)\sin x}{1 + \cos^2 x}\, dx$$

$$2I = \int_0^{\pi} \frac{\pi \sin x}{1 + \cos^2 x}\, dx \implies I = \frac{\pi}{2}\int_0^{\pi} \frac{\sin x}{1 + \cos^2 x}\, dx$$

Step 3: Integrate using substitution.

Let $u = \cos x$, then $du = -\sin x\, dx$. When $x = 0, u = 1$; when $x = \pi, u = -1$.

$$I = \frac{\pi}{2}\int_1^{-1} \frac{-du}{1 + u^2} = \frac{\pi}{2}\int_{-1}^{1} \frac{du}{1 + u^2}$$

$$I = \frac{\pi}{2}\left[\tan^{-1} u\right]_{-1}^{1} = \frac{\pi}{2}\left(\frac{\pi}{4} - \left(-\frac{\pi}{4}\right)\right)$$

$$I = \frac{\pi}{2}\left(\frac{\pi}{2}\right) = \frac{\pi^2}{4}$$

Quick Tip: For any integral of the form $\int_0^{\pi} x f(\sin x)\, dx$, you can use the shortcut:

$$\int_0^{\pi} x f(\sin x)\, dx = \frac{\pi}{2}\int_0^{\pi} f(\sin x)\, dx$$

This immediately simplifies the problem by removing the x multiplier.

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2. The value of the integral $\int_0^{\pi} \frac{x \sin x}{\sin^2 x + 2\cos^2 x}\, dx$ is:

(A) $\frac{\pi}{2}$

(B) $\frac{\pi^2}{2}$

(C) $\frac{\pi^2}{4}$

(D) $\frac{\pi}{4}$

Correct Answer: (c) $\frac{\pi^2}{4}$

Solution:

Concept: To solve this integral, we apply the definite integral property $\int_0^a f(x)\,dx = \int_0^a f(a-x)\,dx$. This technique is effective for removing the x factor from the numerator.

Step 1: Apply the property.

Let $I = \int_0^{\pi} \frac{x\sin x}{\sin^2 x + 2\cos^2 x}\,dx$. Replacing x with $(\pi - x)$:

$$I = \int_0^{\pi} \frac{(\pi - x)\sin(\pi - x)}{\sin^2(\pi - x) + 2\cos^2(\pi - x)}\,dx$$

Using the identities $\sin(\pi - x) = \sin x$ and $\cos^2(\pi - x) = \cos^2 x$:

$$I = \int_0^{\pi} \frac{(\pi - x)\sin x}{\sin^2 x + 2\cos^2 x}\,dx$$

Step 2: Combine the integrals.

Adding the two expressions for I:

$$2I = \int_0^{\pi} \frac{(x + \pi - x)\sin x}{\sin^2 x + 2\cos^2 x}\,dx = \int_0^{\pi} \frac{\pi\sin x}{\sin^2 x + 2\cos^2 x}\,dx$$

Using $\sin^2 x = 1 - \cos^2 x$:

$$2I = \pi\int_0^{\pi} \frac{\sin x}{1 - \cos^2 x + 2\cos^2 x}\,dx = \pi\int_0^{\pi} \frac{\sin x}{1 + \cos^2 x}\,dx$$

$$I = \frac{\pi}{2}\int_0^{\pi} \frac{\sin x}{1 + \cos^2 x}\,dx$$

Step 3: Evaluate using substitution.

Let $u = \cos x$, then $du = -\sin x\,dx$. For $x = 0, u = 1$; for $x = \pi, u = -1$.

$$I = \frac{\pi}{2}\int_1^{-1} \frac{-du}{1 + u^2} = \frac{\pi}{2}\int_{-1}^{1} \frac{du}{1 + u^2}$$

$$I = \frac{\pi}{2}\left[\tan^{-1} u\right]_{-1}^{1} = \frac{\pi}{2}\left(\frac{\pi}{4} - \left(-\frac{\pi}{4}\right)\right)$$

$$I = \frac{\pi}{2}\left(\frac{\pi}{2}\right) = \frac{\pi^2}{4}$$

Quick Tip: For integrals of the form $\int_0^\pi x f(\sin x)\,dx$, the x can always be replaced by $\frac{\pi}{2}$ outside the integral. This problem simplifies directly to $\frac{\pi}{2}\int_0^\pi \frac{\sin x}{1+\cos^2 x}\,dx$.

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3. The value of the integral $\int_5^9 \frac{\log 3x^2}{\log 3x^2+\log(588-84x+3x^2)}\,dx$ is equal to:

(A) 2

(B) 1

(C) $\frac{1}{2}$

(D) 4

Correct Answer: (A) 2

Solution:

Concept: To solve the problem, we use King's Property of definite integrals:

$$\int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$$

This property is particularly useful when the denominator remains unchanged or symmetrically transforms under the substitution $x \to (a+b-x)$.

Step 1: Analyze the integrand.

Let $I = \int_5^9 \frac{\log 3x^2}{\log 3x^2+\log(588-84x+3x^2)}\,dx$.

Notice the term $588-84x+3x^2$. We can factor out 3: $3(196-28x+x^2) = 3(14-x)^2$.

So the integral is $I = \int_5^9 \frac{\log 3x^2}{\log 3x^2+\log 3(14-x)^2}\,dx$.

Step 2: Apply King's Property.

Substitute x with $(5+9-x) = (14-x)$:

$$I = \int_5^9 \frac{\log 3(14-x)^2}{\log 3(14-x)^2+\log 3(14-(14-x))^2}\,dx$$

$$I = \int_5^9 \frac{\log 3(14-x)^2}{\log 3(14-x)^2+\log 3x^2}\,dx$$

Step 3: Sum the integrals.

Adding the two forms of I:

$$2I = \int_5^9 \frac{\log 3x^2 + \log 3(14-x)^2}{\log 3x^2 + \log 3(14-x)^2}\,dx$$

$$2I = \int_5^9 1\,dx$$

$$2I = [x]_5^9 = 9-5 = 4$$

$$I = \frac{4}{2} = 2$$

Quick Tip: For integrals of the form $\int_a^b \frac{f(x)}{f(x)+f(a+b-x)}\,dx$, the result is always $\frac{b-a}{2}$. In this case: $\frac{9-5}{2} = \frac{4}{2} = 2$.

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4. The value of the integral $\int_0^{\pi/2} \frac{\sin^{3/2} x}{\sin^{3/2} x + \cos^{3/2} x}\,dx$ is equal to:

(A) π

(B) $\pi/2$

(C) $\pi/4$

(D) 0

Correct Answer: (C) $\pi/4$

Solution:

Concept: This problem can be solved using the property of definite integrals:

$$\int_0^a f(x)\,dx = \int_0^a f(a-x)\,dx$$

Step 1: Define the integral and apply the property.

Let $I = \int_0^{\pi/2} \frac{\sin^{3/2} x}{\sin^{3/2} x + \cos^{3/2} x}\,dx \quad —(1)$

Applying the property $x \to \frac{\pi}{2} - x$:

$$I = \int_0^{\pi/2} \frac{\sin^{3/2}(\frac{\pi}{2}-x)}{\sin^{3/2}(\frac{\pi}{2}-x) + \cos^{3/2}(\frac{\pi}{2}-x)}\,dx$$

Since $\sin(\frac{\pi}{2}-x)=\cos x$ and $\cos(\frac{\pi}{2}-x)=\sin x$, the integral becomes:

$$I=\int_0^{\pi/2}\frac{\cos^{3/2}x}{\cos^{3/2}x+\sin^{3/2}x}\,dx \quad —(2)$$

Step 2: Combine the two expressions.

Adding equations (1) and (2):

$$2I=\int_0^{\pi/2}\left(\frac{\sin^{3/2}x+\cos^{3/2}x}{\sin^{3/2}x+\cos^{3/2}x}\right)dx$$

$$2I=\int_0^{\pi/2}1\,dx$$

Step 3: Final integration.

$$2I=[x]_0^{\pi/2}$$

$$2I=\frac{\pi}{2}-0$$

$$I=\frac{\pi}{4}$$

Quick Tip: For any integral of the form $\int_0^{\pi/2}\frac{\sin^n x}{\sin^n x+\cos^n x}\,dx$ or $\int_0^{\pi/2}\frac{\cos^n x}{\sin^n x+\cos^n x}\,dx$, the answer is always $\frac{\pi}{4}$, regardless of the value of n.

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5. The value of the integral $\int_0^{3\pi/2}\frac{\cos^3 x}{\cos^3 x+\sin^3 x}\,dx$ is:

(A) 0

(B) 1

(C) $\frac{\pi}{4}$

(D) $\frac{3\pi}{4}$

Correct Answer: (D) $\frac{3\pi}{4}$

Solution:

Concept: This integral can be solved efficiently using the "King's Property" of definite integrals:

$$\int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$$

Step 1: Apply the property.

Let $I = \int_0^{3\pi/2} \frac{\cos^3 x}{\cos^3 x+\sin^3 x}\,dx$

Replacing x with $(\frac{3\pi}{2}-x)$:

$$I = \int_0^{3\pi/2} \frac{\cos^3(\frac{3\pi}{2}-x)}{\cos^3(\frac{3\pi}{2}-x)+\sin^3(\frac{3\pi}{2}-x)}\,dx$$

Using the trigonometric identities $\cos(\frac{3\pi}{2}-x) = -\sin x$ and $\sin(\frac{3\pi}{2}-x) = -\cos x$:

$$I = \int_0^{3\pi/2} \frac{(-\sin x)^3}{(-\sin x)^3+(-\cos x)^3}\,dx$$

$$I = \int_0^{3\pi/2} \frac{-\sin^3 x}{-(\sin^3 x+\cos^3 x)}\,dx = \int_0^{3\pi/2} \frac{\sin^3 x}{\sin^3 x+\cos^3 x}\,dx$$

Step 2: Combine the integrals.

Adding the two expressions for I:

$$2I = \int_0^{3\pi/2} \left(\frac{\cos^3 x+\sin^3 x}{\cos^3 x+\sin^3 x}\right)dx$$

$$2I = \int_0^{3\pi/2} 1\,dx$$

Step 3: Final Calculation.

$$2I = [x]_0^{3\pi/2}$$

$$2I = \frac{3\pi}{2} - 0 \implies I = \frac{3\pi}{4}$$

The correct choice is (d).

Quick Tip: For any integral of the form $\int_0^a \frac{f(x)}{f(x)+f(a-x)}\,dx$, the result is simply half of the upper limit: $\frac{a}{2}$. In this problem, $\frac{3\pi/2}{2} = \frac{3\pi}{4}$.

6. A liquid flows with velocity 2 m/s through a pipe of diameter 0.01 m. Density = 1000 kg/m^3, viscosity = 0.5 kg/m·s. Reynolds number is:

(A) 20

(B) 40

(C) 100

(D) 200

Correct Answer: (B) 40

Solution:

Concept: The Reynolds number (Re) is a dimensionless quantity used in fluid mechanics to help predict flow patterns. It represents the ratio of inertial forces to viscous forces within a fluid.

Step 1: Identify the given values

- Velocity (v) $= 2$ m/s
- Diameter (D) $= 0.01$ m
- Density (ρ) $= 1000$ kg/m^3
- Viscosity (μ) $= 0.5$ kg/m·s

Step 2: Apply the Reynolds number formula.

The formula for flow through a pipe is:

$$Re = \frac{\rho v D}{\mu}$$

Substituting the values:

$$Re = \frac{1000 \times 2 \times 0.01}{0.5}$$

Step 3: Perform the calculation.

$$Re = \frac{20}{0.5}$$

$$Re = 40$$

Quick Tip: For flow in a pipe, $Re < 2000$ generally indicates laminar flow, while $Re > 4000$ indicates turbulent flow. In this specific problem, a Reynolds number of 40 confirms that the flow is highly laminar.

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7. A 100 g metal at 80°C is placed in 100 g water at 20°C. Final temperature is 40°C. Find specific heat of metal.

(A) 420 J/kgK

(B) 840 J/kgK

(C) 1680 J/kgK

(D) 2100 J/kgK

Correct Answer: (D) 2100 J/kgK

Solution:

Concept: According to the Principle of Calorimetry, when two bodies at different temperatures are placed in contact, the heat lost by the hot body is equal to the heat gained by the cold body, provided no heat is lost to the surroundings.

Step 1: Identify the parameters

- **For Metal (Hot body):**
  - Mass $(m_m) = 100 \text{ g} = 0.1 \text{ kg}$
  - Initial Temperature $(T_m) = 80°\text{C}$
  - Final Temperature $(T_f) = 40°\text{C}$
  - Specific heat $(s_m) = ?$
- **For Water (Cold body):**
  - Mass $(m_w) = 100 \text{ g} = 0.1 \text{ kg}$
  - Initial Temperature $(T_w) = 20°\text{C}$
  - Final Temperature $(T_f) = 40°\text{C}$
  - Specific heat of water $(s_w) = 4200$ J/kgK (Standard value)

Step 2: Apply the heat balance equation.

$$\text{Heat Lost by Metal} = \text{Heat Gained by Water}$$

$$m_m \cdot s_m \cdot (T_m - T_f) = m_w \cdot s_w \cdot (T_f - T_w)$$

Substituting the values:

$$0.1 \cdot s_m \cdot (80 - 40) = 0.1 \cdot 4200 \cdot (40 - 20)$$

$$s_m \cdot 40 = 4200 \cdot 20$$

Step 3: Solve for s_m.

$$s_m = \frac{4200 \cdot 20}{40}$$
$$s_m = \frac{4200}{2}$$
$$s_m = 2100 \text{ J/kgK}$$

Quick Tip: Since the masses of the two substances are equal (100 g each), you can simplify the calculation by canceling them out from both sides immediately. The ratio of the specific heats will be inversely proportional to the ratio of their temperature changes.

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8. A rod of length 1 m expands by 1 mm when temperature increases by 100°C. Coefficient of linear expansion is:

(A) 10^{-5}

(B) 10^{-4}

(C) 10^{-3}

(D) 10^{-6}

Correct Answer: (A) 10^{-5}

Solution:

Concept: Thermal expansion is the tendency of matter to change its shape, area, and volume in response to a change in temperature. For solid materials, the change in length (ΔL) is directly proportional to the original length (L_0) and the change in temperature (ΔT).

Step 1: Identify the given values.

- Original length (L_0) $= 1$ m
- Change in length (ΔL) $= 1$ mm $= 10^{-3}$ m
- Change in temperature (ΔT) $= 100°$C

Step 2: Apply the formula for linear expansion.

The coefficient of linear expansion (α) is given by:

$$\Delta L = L_0 \alpha \Delta T$$

Rearranging for α:

$$\alpha = \frac{\Delta L}{L_0 \Delta T}$$

Step 3: Calculate the final value.

Substituting the values:

$$\alpha = \frac{10^{-3}}{1 \times 100}$$

$$\alpha = \frac{10^{-3}}{10^2}$$

$$\alpha = 10^{-5}/°\text{C}$$

Quick Tip: Always ensure your units are consistent before plugging them into the formula. Converting 1 mm to 10^{-3} m is the crucial first step to avoid order-of-magnitude errors.

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9. Heat required to raise temperature of 2 kg substance by 5°C is 1000 J. Specific heat is:

(A) 50

(B) 100

(C) 200

(D) 500

Correct Answer: (B) 100

Solution:

Concept: Specific heat capacity (c) is the amount of heat energy required to raise the temperature of a unit mass of a substance by one degree Celsius (or one Kelvin). The relationship between heat energy (Q), mass (m), specific heat (c), and change in temperature (ΔT) is given by the formula:

$$Q = mc\Delta T$$

Step 1: Identify the given values.

- Heat energy (Q) $= 1000$ J
- Mass (m) $= 2$ kg
- Change in temperature (ΔT) $= 5°$C

Step 2: Rearrange the formula to solve for specific heat (c).

$$c = \frac{Q}{m\Delta T}$$

Step 3: Substitute the values and calculate.

$$c = \frac{1000}{2 \times 5}$$
$$c = \frac{1000}{10}$$
$$c = 100 \text{ J/kg°C}$$

Quick Tip: To remember the formula, think of "MCAT" ($Q = m \cdot c \cdot \Delta T$).

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10. Heat flows through a rod of length 1 m and area 1 m^2. Temperature difference = 10 K. If thermal conductivity = 5 W/mK, heat flow per second is:

(A) 10 W

(B) 25 W

(C) 50 W

(D) 100 W

Correct Answer: (C) 50 W

Solution:

Concept: The rate of heat flow through a material by conduction is governed by Fourier's Law. It states that the heat flow per second (H or Q/t) is directly proportional to the thermal conductivity of the material, the cross-sectional area, and the temperature gradient.

Step 1: Identify the given values.

- Length $(L) = 1$ m
- Area $(A) = 1\ \text{m}^2$
- Temperature difference $(\Delta T) = 10$ K
- Thermal conductivity $(k) = 5$ W/mK

Step 2: Apply the formula for heat flow.

The formula for the rate of heat flow (H) is:

$$H = \frac{kA\Delta T}{L}$$

Substituting the values into the equation:

$$H = \frac{5 \times 1 \times 10}{1}$$

Step 3: Calculate the result.

$$H = 50 \text{ Watts (W)}$$

Since "heat flow per second" is equivalent to Power, the unit is Watts.

Quick Tip: Thermal conductivity is an intrinsic property. In problems like this where length and area are both 1, the heat flow per second numerically equals the product of the thermal conductivity and the temperature difference ($k \times \Delta T$).

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11. The number of extensive and intensive properties in the list given below is respectively: Density, enthalpy, mass, temperature, volume, pressure

(A) 4, 2

(B) 1, 5

(C) 2, 4

(D) 3, 3

Correct Answer: (D) 3, 3

Solution:

Concept: Thermodynamic properties are classified into two categories based on their dependence on the size or amount of matter in a system:

- **Extensive Properties:** Properties that depend on the amount of matter present (e.g., if you double the system, the property value doubles).
- **Intensive Properties:** Properties that are independent of the amount of matter present (e.g., they remain the same regardless of system size).

Step 1: Identify Extensive Properties.

The properties that change with the amount of substance are:

1. **Enthalpy:** Total heat content depends on the mass.
2. **Mass:** Directly represents the amount of matter.
3. **Volume:** Space occupied increases with more matter.

Total Extensive = 3

Step 2: Identify Intensive Properties.

The properties that do not change based on the quantity of matter are:

1. **Density:** The ratio of mass to volume remains constant for a substance.

2. **Temperature:** A small part of a system has the same temperature as the whole.

3. **Pressure:** Does not depend on the total mass of the system.

Total Intensive = 3

Step 3: Conclusion.

The number of extensive properties is 3 and intensive properties is 3. Therefore, the respective count is (3, 3).

Quick Tip: A simple test: Divide the system into two equal halves. If the property value also divides by two (like mass or volume), it is Extensive. If the property value remains the same in both halves (like temperature or density), it is Intensive.

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12. Consider the equilibrium reactions:

$$H_3PO_4 \rightleftharpoons K_1 H^+ + H_2PO_4^-$$
$$H_2PO_4^- \rightleftharpoons K_2 H^+ + HPO_4^{-2}$$
$$HPO_4^{-2} \rightleftharpoons K_3 H^+ + PO_4^{-3}$$

The equilibrium constant, K_c for the following dissociation $H_3PO_4 \rightleftharpoons 3H^+ + PO_4^{-3}$ is:

A) $\frac{K_1}{K_2 K_3}$

B) $K_1 K_2 K_3$

C) $\frac{K_2}{K_1 K_3}$

D) $K_1 + K_2 + K_3$

Correct Answer: B) $K_1 K_2 K_3$

Solution:

Concept: When a chemical reaction can be expressed as the sum of two or more individual reactions, the equilibrium constant for the net reaction is the product of the equilibrium constants of the individual steps.

Step 1: Identify the relationship between the reactions.

The three stepwise dissociation reactions of phosphoric acid are:

1. $H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^-$ (Equilibrium constant $= K_1$)

2. $H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{-2}$ (Equilibrium constant $= K_2$)

3. $HPO_4^{-2} \rightleftharpoons H^+ + PO_4^{-3}$ (Equilibrium constant $= K_3$)

Step 2: Add the reactions together.

Summing the three equations:

$$(H_3PO_4) + (H_2PO_4^-) + (HPO_4^{-2}) \rightleftharpoons (H^+ + H_2PO_4^-) + (H^+ + HPO_4^{-2}) + (H^+ + PO_4^{-3})$$
$$H_3PO_4 \rightleftharpoons 3H^+ + PO_4^{-3} \quad \text{(Net reaction)}$$

Intermediate species ($H_2PO_4^-$ and HPO_4^{-2}) cancel out from both sides.

Step 3: Calculate the net equilibrium constant (K_c).

According to the rules of chemical equilibrium:

$$K_c = K_1 \times K_2 \times K_3$$

Quick Tip: Remember the three fundamental rules for manipulating equilibrium constants: 1. If you add reactions, multiply their K values. 2. If you reverse a reaction, take the reciprocal $(1/K)$. 3. If you multiply a reaction by a factor n, raise K to the power n (K^n).

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13. The conjugate acid of NH_2^- is:

(A) NH_3

(B) NH_2OH

(C) NH_4^+

(D) N_2H_4

Correct Answer: (A) NH_3

Solution:

Concept: According to the Brønsted-Lowry theory, an acid is a proton (H^+) donor and a base is a proton acceptor. A conjugate acid is formed when a base accepts a proton.

Step 1: Understand the relationship.

To find the conjugate acid of a given species, you must add one proton (H^+) to it. The formula relationship is:

$$\text{Base} + H^+ \rightarrow \text{Conjugate Acid}$$

Step 2: Apply the rule to NH_2^-.

Starting with the amide ion (NH_2^-):

- Add one Hydrogen atom (H).
- Increase the net charge by +1 (from −1 to 0).

$$NH_2^- + H^+ \rightarrow NH_3$$

Step 3: Conclusion.

Ammonia (NH_3) is the conjugate acid of the amide ion (NH_2^-).

Quick Tip: To remember the difference:

- **Conjugate Acid:** Base + H^+ (Add an H, increase charge by 1).
- **Conjugate Base:** Acid - H^+ (Remove an H, decrease charge by 1).

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14. Which one of the pairs will form a buffer solution?

(A) CH_3COONa & $NaOH$

(B) CH_3COONH_4 & NH_4Cl

(C) NH_4Cl & NH_4OH

(D) CH_3COONa & HCl

Correct Answer: (C) NH_4Cl & NH_4OH

Solution:

Concept: A buffer solution is a solution that resists changes in pH when small amounts of an acid or a base are added to it. There are two primary types:

- **Acidic Buffer:** A weak acid and its salt with a strong base (e.g., CH_3COOH + CH_3COONa).

- **Basic Buffer:** A weak base and its salt with a strong acid (e.g., $NH_4OH + NH_4Cl$).

Step 1: Evaluate each option.

- **Option A:** CH_3COONa (Salt) & $NaOH$ (Strong Base). This is not a buffer because $NaOH$ is a strong base.
- **Option B:** CH_3COONH_4 (Salt of weak acid/weak base) & NH_4Cl (Salt). This pair does not contain a weak acid or weak base component.
- **Option C:** NH_4OH (Weak Base) & NH_4Cl (Salt of weak base with strong acid HCl). This matches the definition of a **Basic Buffer**.
- **Option D:** CH_3COONa (Salt) & HCl (Strong Acid). While they can react to form a buffer if CH_3COONa is in excess, as a simple pair, they do not constitute the standard buffer components.

Step 2: Conclusion.
The pair in Option C consists of a weak base (NH_4OH) and its conjugate salt (NH_4Cl), which perfectly forms a basic buffer solution.

Quick Tip: To identify a buffer quickly, look for "Weak" + "Salt." If you see a "Strong" component (like $NaOH$, HCl, or HNO_3) paired only with a salt, it is usually a distractor unless a chemical reaction is specified with specific molar ratios.

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15. The solubility of $Mg_3(PO_4)_2$ is 'S' mol L^{-1}. The solubility product is given by the relation:

(A) S^5

(B) $36S^6$

(C) $6S^5$

(D) $108S^5$

Correct Answer: (D) $108S^5$

Solution:

Concept: The solubility product constant (K_{sp}) is the equilibrium constant for a solid substance dissolving in an aqueous solution. For a salt that dissociates into multiple ions, the K_{sp} is calculated by raising the concentration of each ion to the power of its stoichiometric coefficient.

Step 1: Write the dissociation equation.

Magnesium phosphate ($Mg_3(PO_4)_2$) dissociates in water as follows:

$$Mg_3(PO_4)_2(s)3Mg^{2+}(aq) + 2PO_4^{3-}(aq)$$

Step 2: Express ion concentrations in terms of solubility (S).

If the solubility of the salt is S mol/L, then according to the stoichiometry :

- $[Mg^{2+}] = 3S$
- $[PO_4^{3-}] = 2S$

Step 3: Calculate K_{sp}.

The expression for the solubility product is:

$$K_{sp} = [Mg^{2+}]^3[PO_4^{3-}]^2$$

Substituting the concentration values:

$$K_{sp} = (3S)^3(2S)^2$$

$$K_{sp} = (27S^3)(4S^2)$$

$$K_{sp} = 108S^5$$

Quick Tip: For a general salt of type A_xB_y, the shortcut formula for the solubility product in terms of solubility S is:

$$K_{sp} = x^x y^y S^{(x+y)}$$

For $Mg_3(PO_4)_2$, $x = 3$ and $y = 2$. Thus, $3^3 \cdot 2^2 \cdot S^{(3+2)} = 27 \cdot 4 \cdot S^5 = 108S^5$.