MIX TEST-3 (JEE) — Solutions
Some Basic Concepts + Thermodynamics-1 + Thermochemistry

Q1. The percentage (by weight) of NaOH in a 1.25 molal NaOH solution.

Approach (Hinglish): Molality $m = \dfrac{n_{\text{solute}}}{\text{kg solvent}}$. Assume 1 kg water $\Rightarrow n_{\text{NaOH}} = 1.25$ mol.
Mass NaOH $= 1.25 \times 40 = 50$ g; total mass solution $= 1000 + 50 = 1050$ g.
Weight % $= \dfrac{50}{1050} \times 100 = 4.7619\%$.

Final Answer: (1) 4.76%

Q2. 4 g hydrocarbon (C_xH_y) gives 12 g CO_2 on complete combustion. Empirical formula?

Approach (Hinglish): $n(CO_2) = 12/44 = 0.2727$ mol $\Rightarrow m_C = 0.2727 \times 12 = 3.2727$ g.
$m_H = 4 - 3.2727 = 0.7273$ g $\Rightarrow n_H = 0.7273$ mol.
Atom ratio H:C $= 0.7273 : 0.2727 \approx 2.667 : 1 = 8 : 3 \Rightarrow$ empirical $\boxed{C_3H_8}$.

Note: C_3H_8 is not listed in options; this is the correct empirical formula from given data. If compelled to choose, closest ratio is (1) CH_3. **Final Answer: Correct: C_3H_8 (not in options)**

Q3. 20 mL acetic acid reacts with 20 mL ethyl alcohol → ethyl acetate. Densities: acid = 1, alcohol = 0.7 g mL^{-1}. Limiting reagent?

Approach (Hinglish): $m_{\text{acid}} = 20 \times 1 = 20$ g $\Rightarrow n = 20/60 = 0.333$ mol.
$m_{\text{EtOH}} = 20 \times 0.7 = 14$ g $\Rightarrow n = 14/46 = 0.304$ mol.
Stoichiometry $1 : 1 \Rightarrow$ limiting = smaller moles = ethanol.

Final Answer: (2) Ethyl alcohol

Q4. CO_2 volume at STP when 2.12 g Na_2CO_3 (M = 106) treated with excess HCl.

Approach (Hinglish): $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$. $n(Na_2CO_3) = 2.12/106 = 0.020$ mol.
$n(CO_2) = 0.020$ mol $\Rightarrow V = 0.020 \times 22.4 = 0.448$ L.

Final Answer: (2) 0.448 L

Q5. Number of molecules in 3.5 g CO at 0°C, 760 mm.

Approach (Hinglish): $n = 3.5/28 = 0.125$ mol $\Rightarrow N = 0.125 \times N_A = 0.125 \times 6.02 \times 10^{23}$.

Final Answer: (3) $0.125 \times 6.02 \times 10^{23}$

Q6. Given: $Mg + 2HCl \rightarrow MgCl_2 + H_2$, $\Delta H = -467$ **kJ;** $MgO + 2HCl \rightarrow MgCl_2 + H_2O$, $\Delta H = -151$ **kJ;** $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$, $\Delta H_f^\circ = -286$ **kJ. Find ΔH_f° of MgO(s).**

Approach (Hinglish): Target: $Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$.
Use Hess: $(Mg+2HCl \rightarrow MgCl_2+H_2) + (H_2+\frac{1}{2}O_2 \rightarrow H_2O) - (MgO+2HCl \rightarrow MgCl_2+H_2O)$.
$\Delta H = (-467) + (-286) - (-151) = -602$ kJ mol^{-1}.

Final Answer: (2) -602 kJ mol^{-1}

Q7. Ideal gas expands reversibly from (P_i, V_i) to same V_f either isothermally or adiabatically. Which statements are true?

Approach (Hinglish): For the **same** V_f: $P_f(\text{ad}) < P_f(\text{iso})$; $|W|_{\text{iso}} > |W|_{\text{ad}}$; $T_f(\text{ad}) < T_i = T_f(\text{iso})$; $|q|_{\text{iso}} > |q|_{\text{ad}} (= 0)$.

Final Answer: (4) All

Q8. Formation of NH_3(g) from elements at constant T, P: correct option.

Approach (Hinglish): $\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow NH_3$; $\Delta n_g = 1 - (0.5 + 1.5) = -1$.
$\Delta H = \Delta U + \Delta n_g RT = \Delta U - RT \Rightarrow \Delta U > \Delta H$.

Final Answer: (3) $\Delta U > \Delta H$

Q9. $C_p(H_2O) = 75$ J K^{-1} mol^{-1}. Rise in T of 100 g water when 1 kJ is supplied.

Approach (Hinglish): $n = 100/18 = 5.556$ mol. $\Delta T = \dfrac{q}{nC_p} = \dfrac{1000}{5.556 \times 75} = 2.4$ K.

Final Answer: (1) 2.4

Q10. Which plot-combinations do *not* represent isothermal expansion of an ideal gas?

Approach (Hinglish): Selection rule (for checking your figure):
Isothermal expansion obeys $PV =$ constant, $T =$ constant.
$\Rightarrow$ (i) P–V: rectangular hyperbola; (ii) T–V: horizontal line; (iii) P–T: straight line through origin (since $P \propto T$ at fixed V is *not* relevant here; during expansion V changes, so a single P–T curve is *not* a straight line).
Mark the options whose pair violates these together for the shown paths.

Final Answer: 1 (B and D) .

Section – B: Integer Type Questions (+4, –1)

(Answers from 0 to 99 are possible)

Q11. Combustion of 0.30 g organic compound gives 0.20 g CO_2 and 0.10 g H_2O. %C (nearest integer).

Approach (Hinglish): $n(CO_2) = 0.20/44 = 0.004545$ mol $\Rightarrow m_C = 0.004545 \times 12 = 0.054545$ g.
%C $= 0.054545/0.30 \times 100 = 18.18\% \approx \boxed{18}$.

Final Answer: 18

Q12. A 60 W heater for 100 s in a rigid, adiabatic vessel raises gas T by 5°C. Gas heat capacity $= 100x$ J K^{-1}. Find x.

Approach (Hinglish): Energy input $q = 60 \times 100 = 6000$ J $= \Delta U$ (constant V, adiabatic wall).
$C = \dfrac{\Delta U}{\Delta T} = \dfrac{6000}{5} = 1200$ J K$^{-1} = 100x \Rightarrow x = 12$.

Final Answer: 12

Q13. An organic compound with C, H, S has 4% S by mass. Minimum molecular weight $= 100\,a$. Find a.

Approach (Hinglish): Minimum occurs when there is one S atom: $\frac{32}{M} = 0.04 \Rightarrow M = 800$ g mol$^{-1} = 100a$.
$\Rightarrow a = 8$.

Final Answer: 8
