

1. How much heat is released when 8.0 g of methane gas is burned, according to the following equation:



$$\frac{8\text{g}}{16\text{g/mol}} = 0.5 \text{ mol}$$

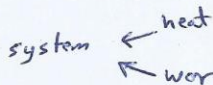
$$1 \text{ mol} \rightarrow -890$$

$$0.5 \rightarrow ?$$

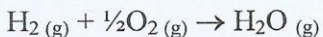
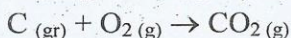
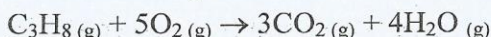
- A) 1050 kJ (B) 445 kJ C) 256 kJ D) 625 kJ $\Delta H = 0.5 \times -890 = -445\text{kJ}$

2. The internal energy ΔE (ΔU) of the system is a **positive** value if the system:

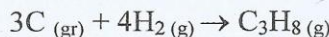
- (A) Absorbs heat and work done on it.
 (B) Absorbs heat and does work.
 (C) Release heat and does work.
 (D) Release heat and work done on it.



3. Given the following reactions:



Find ΔH_{rxn} (in kJ) for:



$$\begin{aligned} & 4\text{H}_2\text{O} + 3\text{CO}_2 \rightarrow 5\text{O}_2 + \text{C}_3\text{H}_8 \quad \Delta H = -1(-2043) \\ & 3\text{C} + 3\text{O}_2 \rightarrow 3\text{CO}_2 \quad \Delta H = 3(-394) \\ & 4\text{H}_2 + 2\text{O}_2 \rightarrow 4\text{H}_2\text{O} \quad \Delta H = 4(-242) \\ \hline & 3\text{C} + 4\text{H}_2 \rightarrow \text{C}_3\text{H}_8 \end{aligned}$$

- A) -99 B) -132 C) -118 (D) -107

4. The amount of heat (in J) required to increase the temperature of 350.0 g of copper from 25°C to 85°C is: (the specific heat of copper is 0.385 J/g °C)

$$q = C * m * \Delta T$$

$$0.385 * 350 * 60 = 8085 \text{ J}$$

- A) 6485 (B) 8085 C) 7676 D) 6806

5. A gas absorbs 1900 J as heat and its change in the internal energy is 1100 J. The amount of work (in J) in this process, is:

$$\Delta H = \Delta E - W$$

$$1900 = 1100 - W$$

$$-W = 800 \text{ J}$$

$$W = -800 \text{ J}$$

- A) -3000 B) +3000 (C) -800 D) +800

6. What is the vant Hoff factor of a solution, contained 10.0 g of CaCl₂ (an electrolyte) in 100.0 g of water, and the solution freeze at -4.1 °C? (K_f of water = 1.86 °C/m)

$$m_{\text{wt CaCl}_2} = \frac{10}{100} = 0.1 \text{ m}$$

$$m = \frac{\Delta T_f}{K_f} = \frac{4.1}{1.86} = 2.19 \text{ m}$$

$$i = \frac{2.19}{0.1} = 2.19 \approx 2.24$$

- (A) 2.44 B) 2.85 C) 2.68 D) 2.59

7. If 20.0 g of non-electrolyte substance ($M_{\text{wt}} = 6.8 \times 10^4 \text{ g/mol}$) dissolved in water to make 200 mL of solution. What is the osmotic pressure (in torr) at 30 °C?

$$n = \frac{20}{6.8 \times 10^4} = 2.94 \times 10^{-4} \text{ mol}$$

$$M = \frac{n}{V} = \frac{2.94 \times 10^{-4}}{0.2} = 0.00147 \text{ M}$$

$$\pi = MRT = 0.00147 * 0.082 * 303 = 0.0365 \text{ atm}$$

$$1 \text{ atm} \rightarrow 760 \text{ torr}$$

$$0.0365 * 760 = 27.8 \text{ torr}$$

- A) 15.0 B) 9.0 (C) 28.0 D) 31.0

8. What is the vapor pressure (in torr) of a solution prepared from 200.0 g of "CO(NH₂)₂" and 350.0 g of water at 32.0 °C. (The vapor pressure of pure water at 32.0 °C is 35.7 torr)

$$M_{\text{wt CO(NH}_2)_2} = 12 + 16 + (14 * 2) + 4 = 60 \text{ g/mol}$$

$$n_{\text{H}_2\text{O}} = \frac{350}{18} = 19.44$$

$$n_{\text{CO(NH}_2)_2} = \frac{200}{60} = 3.33$$

$$X_{\text{H}_2\text{O}} = \frac{19.44}{19.44 + 3.33} = 0.854$$

$$P = X_{\text{H}_2\text{O}} P_{\text{H}_2\text{O}}^\circ = 0.854 * 35.7 = 30.5 \text{ torr}$$

- A) 28.6 (B) 30.5 C) 29.4 D) 27.3

9. The solubility of nitrogen gas "N₂" in water at 20 °C and 520 torr is 5.0×10⁻⁴ mol/L. The Henry's law constant (in mol/L.atm) at 20 °C, is: $\frac{520}{760} = 0.68 \text{ atm}$ $S_g = k P_g$ $\frac{5 \times 10^{-4}}{0.68} = P_g$ $P_g = 7.3 \times 10^{-4} \text{ mol/L atm}$
- (A) 7.3×10⁻⁴ B) 6.7×10⁻⁴ C) 6.9×10⁻⁴ D) 7.1×10⁻⁴

10. What is the freezing point of an aqueous solution, containing a nonvolatile nonelectrolyte solute. The solution has a boiling point of 103.8 °C? (K_f of water = 1.86 °C/m and K_b of water = 0.52 °C/m) $\Delta T_b = k_b m$ $\Delta T_f = k_f m$ $\Delta T_b = 103.8 - 100 = 3.8$ $\Rightarrow \Delta T_f = 1.86 \times 7.31 = 13.6$ $0 - T_f = 13.6$ $T_f = -13.6$ °C
- A) -7.7 °C (B) -13.6 °C C) -11.2 °C D) -9.8 °C

11. The rate law of a reaction is: rate = k[A]^{1/2}[B]. The unit of k (rate constant) is: $\frac{M}{s} = k M^{1/2} M$ $k = \frac{1}{M^{1/2} s}$ $k = M^{-1/2} s^{-1}$
- (A) M^{-1/2} · s⁻¹ B) M^{3/2} · s C) M^{3/2} · s⁻¹ D) M^{1/2} · s

12. A → B is a first order reaction has a rate constant of 7.5×10⁻³ s⁻¹. The time (in seconds) required for the reaction to be 60% complete is: $A_0 = 100$ $A_t = 40$ $\ln \frac{A_0}{A_t} = kt$ $\ln \frac{100}{40} = 7.5 \times 10^{-3} t$ $t = \frac{0.916}{7.5 \times 10^{-3}} = 122 \text{ s}$
- A) 112 B) 118 (C) 122 D) 115

13. For the reaction: 3A → 2B The average rate of appearance of B may be expressed as: $-\frac{\Delta A}{3 \Delta t} = \frac{\Delta B}{2 \Delta t}$ $\frac{\Delta B}{\Delta t} = -\frac{2}{3} \frac{\Delta A}{\Delta t}$
- A) $-\frac{3}{2} \frac{\Delta A}{\Delta t}$ (B) $-\frac{2}{3} \frac{\Delta A}{\Delta t}$ C) $+\frac{2}{3} \frac{\Delta A}{\Delta t}$ D) $+\frac{3}{2} \frac{\Delta A}{\Delta t}$

14. The rate constant for first order reaction at 700 K is 6.2×10⁻⁴ and at 760 K is 2.4×10⁻². The activation energy (in kJ/mol) for this reaction is: $\ln \left(\frac{k_2}{k_1} \right) = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$ $\Rightarrow \ln \left(\frac{2.4 \times 10^{-2}}{6.2 \times 10^{-4}} \right) = \frac{E_a}{8.3} \left(\frac{1}{700} - \frac{1}{760} \right)$ $E_a = 269500 \text{ J/mol} = 269.5 \text{ kJ/mol}$
- (A) 269.5 B) 465.8 C) 325.6 D) 312.7

15. For the following reaction:



The table shows the initial rates of the reaction that measured for three experiments:

Exp.	[NO] ₀ mol/L	[Cl ₂] ₀ mol/L	Initial rate (mol L ⁻¹ hr ⁻¹)
1	0.50	0.50	1.19
2	1.0	0.50	4.76
3	1.0	1	9.52

$$R = k [\text{NO}]^x [\text{Cl}_2]^y$$

The rate law for the reaction is:

A) rate = k [Cl₂]²

(B) rate = k [NO]²[Cl₂]

C) rate = k [NO][Cl₂]²

D) rate = k

$$R_1 \Rightarrow 1.19 = (0.5)^x (0.5)^y k$$

$$R_2 \Rightarrow 4.76 = (1)^x (0.5)^y k$$

$$\frac{R_2}{R_1} \Rightarrow 4 = (2)^x \quad [x=2]$$

$$R_2 \Rightarrow 4.76 = k (1)^x (0.5)^y$$

$$R_3 \Rightarrow 9.52 = k (1)^x (1)^y$$

$$\frac{R_3}{R_2} \Rightarrow 2 = (2)^y \quad [y=1]$$

$$\text{so } R = k [\text{NO}]^2 [\text{Cl}_2]$$