

Calculation errors -1~-2.5point, depends on the situation

10%

1. For 2mol of an ideal gas $P_{ext}=P=3.5\text{bar}$

The temperature is changed from 408K to 298K

If $C_{v,m}=3R/2$ Calculate $q, w, \Delta H, \Delta U$

$$\Delta U = 2C_v(298 - 408) = -2.743\text{KJ} \quad 2.5$$

$$\Delta H = 2C_p(298 - 408) = -4.5757\text{KJ} \quad (\text{or } \Delta H = \Delta U + nR(298-408)) \quad 2.5$$

$$Q_p = \Delta H = -4.5757\text{KJ} \quad 2.5$$

$$W = 1.83\text{KJ} = -2.743\text{KJ} + 4.5757\text{KJ} \quad 2.5$$

Some student will write:

$$V_2 = 2 \cdot 298 \cdot R / 3.5\text{bar} \quad V_1 = 2 \cdot 408 \cdot R / 3.5\text{bar} \quad \text{and } w = -P\Delta V$$

Then $dQ = dU - dW$

$$R = 8.314 / 100 \text{ bar} \cdot \text{L} \cdot \text{K}^{-1} \cdot \text{mol}^{-1} \quad \text{and } \text{bar} \cdot \text{L} = 100\text{J}$$

Using incorrect unit leads to incorrect answers:

-2 point

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2. An ideal gas undergoes an expansion from the initial state described by P_i, V_i, T And the final state is P_f, V_f, T . Please derive expressions for largest mass that can be lifted through a height h in the surroundings for the following processes:

(a) against **constant** external pressure P_f

(b) in a **reversible** process

$$W_{\text{sys}} = -W_{\text{object}} \text{ and } W_{\text{object}} = mgh$$

$$\Rightarrow mgh = \int P_{\text{ext}} dv \quad \text{or using absolute value}$$

(a)

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$$P_{\text{ext}} = P_f = \text{constant}$$

$$\int P_{\text{ext}} dv = P_f(V_f - V_i)$$

$$M = P_f(V_f - V_i) / gh \quad \text{incorrect sign} \quad -2.5$$

(b) in constant Temperature

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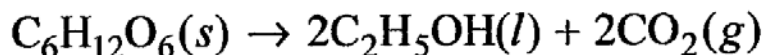
$$\int P_{\text{ext}} dv = nRT \int dv/V$$

when $n=1$

$$M = RT \ln(V_f/V_i) / gh \quad \text{incorrect sign} \quad -2.5$$

10%

3. For the reaction:



Calculate the mass of glucose required to produce **2.46L** of CO_2 measured at

$P=1.00\text{atm}$ and $T=300\text{K}$

$$n_{\text{CO}_2} = 1 \times 2.46 / (0.08205 \times 300) = 0.1 \text{ mole } n_{\text{C}_6\text{H}_{12}\text{O}_6} = 0.05 \text{ mole} \quad \text{incorrect ratio} \quad -5$$

$$R = 0.08205 \text{ atm} \cdot \text{L} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$$

$$\text{Mass} = 0.05 \text{ mole} \times 180 \text{ g/mole} = 9 \text{ g} \quad \text{incorrect molar mass} \quad -2.5$$

A: 9g

10%

4. In the reversible adiabatic expansion of **1.75mol** of an ideal gas from an initial temperature of **300K**, the work **done on** the surroundings is **1300J**. If $C_{v,m} = 3R/2$

Calculate $q, w, \Delta H$ and ΔU

$$\text{Done on the surrounding} \quad W_{\text{sys}} = -1300 \text{ J} \quad 2.5$$

$$\Delta U = -1300 \text{ J (adiabatic)} \quad 2.5$$

$$Q = 0 \quad 2.5$$

$$\Delta H = -2170 \text{ J} = 5/3 \Delta U \quad (C_p = 5/3 C_v) \quad 2.5$$

Some student will try to find the ΔT

$$1.75 C_{v,m} (\Delta T) = -1300 \quad \Delta T \sim -59.6 \text{ K} \quad \text{incorrect unit or relation} \quad -2.5$$

$$\text{Then } \Delta H = 1.75 C_p \Delta T \quad \text{or} \quad \Delta U = 1.75 R T$$

$$R = 8.314 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$$

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5. CO (Carbon monoxide) can be poisonous if inhaled in large quantities.

When the CO level increases to **800ppm**, dizziness, nausea, and unconsciousness occur, followed by death.

The partial pressure of oxygen at sea level is **0.2atm**, what proportion of CO to O_2 is fatal?

Definition of ppm for gas: $\mu\text{L/L}$

---> 800ppm: 800 μL Carbon monoxide 0.2atm: 0.2L Oxygen per 1L air

We have Amagat's law

$$V_{\text{CO}} : V_{\text{O}_2} = X_{\text{CO}} : X_{\text{O}_2}$$

$$X_{\text{CO}} / X_{\text{O}_2} = 0.004$$

Incorrect definition of ppm -2.5

20%

6. A 3 mole sample of Nitrogen in a state defined by $T_i=300\text{K}$ $V_i=35.5\text{L}$ undergoes an **isothermal reversible** expansion until $V_f=3.55\text{L}$. Calculate W assuming

(a) Nitrogen is ideal gas 10%

(b) Nitrogen is Van der Waals gas 10%

($a=1.370\text{barL}^2\text{mol}^{-2}$ $b=0.0265\text{Lmol}^{-1}$ and $L=\text{dm}^3$)

(a) $W = -\int P_{\text{ext}} dv$ reversible: $P = P_{\text{ext}}$ incorrect R or sign -5
 $= -3 \times 8.314 \times 300 \times \ln(3.55/35.5)$
 $= 17.23\text{KJ}$

(c) $P = nRT/V - nb - n^2a/V^2$

$W = -nRT \ln(3.55 - 3b/35.5 - 3b) + 9 \times 0.0625 \times 100(\text{barL} = 100\text{J}) \times (1/3.55 - 1/35.5)$
 $17.382\text{KJ} - 0.3\text{KJ} \cong 17\text{KJ}$ incorrect equation -2.5
Incorrect unit -2.5
Treat as P_{ideal} -5
Treat as P_{ext} -7.5

20%

7. Use the van der Waals equations to calculate the pressure

when **2.25 mol** H_2 are confined to a volume of **1.65L** at **298K**.

Is the gas in the repulsive or attractive region of the molecule-molecule potential?

($a=0.2452\text{barL}^2\text{mol}^{-2}$ $b=0.0265\text{Lmol}^{-1}$ and $L=\text{dm}^3$)

Show $P_{\text{real}} < P_{\text{ideal}}$

$P_{\text{ideal}} = 2.25 \times 0.08314 \times 298 / 1.65 = 33.785\text{bar}$

$P_{\text{real}} = 2.25 \times 0.08314 \times 298 / (1.65 - 2.25 \times 0.0265) - 2.25 \times 2.25 \times 0.2452 / (1.65)^2$

$34.6 > 33.8\text{bar}$ repulsive region

Incorrect unit -5
Incorrect equation -5
Didn't show the $P_{\text{real}} > P_{\text{ideal}}$ -5
"Repulsive" --> attractive -2.5