

Chap. 2  
Feb 5

REPEAT / REVIEW: Slides #60-61  
Perfect Gas Expansions/Compression

$C_{p,m} = C_{v,m} + R = 27.3 + 8.31 = 35.6$   
 $n = \frac{32}{16} = 2 \text{ mol}$

A sample of 32 g of  $\text{CH}_4(\text{g})$  is initially at a pressure of 500 kPa and volume of 20 L.

$M = 16$   
 $C_{v,m} = 27.3 \text{ J/mol-K}$

$T = 601 \text{ K}$

Calculate  $q$ ,  $w$ ,  $\Delta U$  and  $\Delta H$  for each of the following processes:

$P_2 = \frac{P_1 V_1}{n R} = \frac{500 (20)}{2 (8.31)}$

1. The gas is expanded reversibly and isothermally to a volume of 40 L.

$\Delta T = 0$   
 $V_1 = 20$   
 $V_2 = 40$

$0 = \Delta U = q + w$

$w = -n R T \ln \left( \frac{V_2}{V_1} \right)$   
 $= -2 (8.31) (601) \ln \left( \frac{40}{20} \right) = -6935 \text{ J}$   
 $\Delta U = n C_{v,m} \Delta T = 0$   
 $\Delta H = 0$

2. The gas is expanded reversibly and adiabatically to a pressure of 200 kPa and a volume of 40 L.

$P_2 = \frac{P_1 V_1^\gamma}{V_2^\gamma}$   
 $= \frac{500 (20)^\gamma}{2 (8.31)}$   
 $= 481 \text{ kPa}$

$q = 0$   
 $\Delta U = q + w = 0 + w$   
 $w = -6935 \text{ J} = n C_{v,m} \Delta T = 2 (27.3) (481 - 601)$   
 $\Delta H = n C_{p,m} \Delta T = 2 (35.6) (481 - 601)$   
 $= -8540 \text{ J}$

$\Delta U = q + w$

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REPEAT / REVIEW: Slides #60-61 (CONT'D)  
Perfect Gas Expansions/Compression

A sample of 32 g of  $\text{CH}_4(\text{g})$  is initially at a pressure of 500 kPa and volume of 20 L.

Calculate  $q$ ,  $w$ ,  $\Delta U$  and  $\Delta H$  for each of the following processes:

3. The gas is cooled at a constant pressure of 500 kPa to a volume of 12 L.

$$w = -P\Delta V$$

$$q = \Delta H$$

$$\Delta U = n C_{V,m} \Delta T = 2(27.3)(361 - 601)$$

$$= -13,100 \text{ J}$$

$$P_2 = \frac{500(12)}{2(8.31)}$$

$$= 361 \text{ K}$$

$$q = \Delta H = n C_{P,m} \Delta T = 2(35.6)(361 - 601)$$

$$= -17,100 \text{ J}$$

$$\Delta U = q + w \rightarrow w = \Delta U - q$$

$$= -13,100 - (-17,100)$$

$$= 4,000 \text{ J}$$

4. The gas is heated at a constant volume of 20 L until the pressure reaches 700 kPa.

$$P_2 = \frac{700(20)}{2(8.31)} = 842 \text{ K}$$

$$q = \Delta U = n C_{V,m} \Delta T = 13,200 \text{ J}$$

$$\Delta H = n C_{P,m} \Delta T = 17,200$$

$$w = 0$$

$$w = -P\Delta V$$

$$= -500(12 - 20)$$

$$= 4000 \text{ J}$$