Multiple-Choice Questions of Chapter 15

3.19×10^{5} Pa $0.25 \times 10^{-3}\ m^3$ $0.78 \times 10^{-3}\ m^3$

Question 1

An ideal gas expands at a constant pressure of $\underbrace{240cmHg}$ from $\underbrace{250\ cm^3}$ to $\underbrace{780\ cm^3}$. It is then allowed to cool at constant volume to its original temperature. What is the net amount of heat that flows into the gas during the entire process?

- A) 170 cal
- B) 4.04 cal
- [✓ C) 40.4 cal]
- D) 59.6 cal

$\Delta U = Q + W$ but $\Delta U = 0$ (returning to the Same T)

$\Rightarrow Q = -W$

$Q = -(-P\Delta V) = (3.19 \times 10^{5})(0.78 \times 10^{-3} - 0.25 \times 10^{-3}) = 169\ J = 40.4\ cal$

Question 2

As 3.0 liters of ideal gas at 27° C is heated, it expands at a constant pressure of 2.0 atm. How much work is done by the gas as its temperature is changed from 27° C to 227° C?

- A) 0.37 kJ
- B) 1.09 kJ
- C) 405 kJ
- [✓ D) 0.40 kJ]

$W = P\Delta V = 2 \times 1.013 \times 10^{5} (V_2 - V_1)$

but $\frac{V_2}{V_1} = \frac{T_2}{T_1} \rightarrow \frac{V_2}{3} = \frac{227+273}{27+273} \rightarrow \boxed{V_2 = 5\ L}$

$\rightarrow W = 2 \times 1.013 \times 10^{5} (5-3) \times 10^{-3} = 405\ J = \boxed{0.40\ kJ}$

Question 3

How much external work is done by an ideal gas in expanding from a volume of 3.0 liters to a volume of 30.0 liters against a constant pressure of 2.0 atm?

- [✓ A) 5.5 kJ]
- B) 5500 kJ
- C) 6.1 kJ
- D) 54 kJ

$P = 2 \times 1.013 \times 10^{5}$ Pa

$W = P\Delta V = \cdots$ (similar to last part of 2)

Question 4

A 2.0 kg metal block (c=0.137 cal/g·° C) is heated from 15° C to 90° C. By how much does its internal energy change?

- A) 21 kJ
- B) 86 J
- C) 103 kJ
- [✓ D) 86 kJ]

$\Delta U = Q = mc\Delta T$

$= (2)(0.137\ \frac{kcal}{kg \cdot {}^\circ C})(90-15) = 20.55\ kcal$

$= \boxed{86\ kJ}$

Question 5

If a certain mass of water falls a distance of 854 m and all the energy is effective in heating the water, what will be the temperature rise of water?

- A) 8.38° C
- [✓ B) 2.00° C]
- C) 2000° C
- D) 35.1° C

$\cancel{m} g \Delta Y = Q = \cancel{m} c \Delta T$

$\Delta T = \frac{g \Delta Y}{c} = \frac{(9.8)(854)}{4.186 \times 10^{3}\ J/kg \cdot {}^\circ C} = \boxed{2\ {}^\circ C}$

Question 6

How many joules of heat per hour are produced in a motor that is 75.0 percent efficient and requires 0.250 hp to run it?

- [✓ A) 168 kJ]

$e = 0.75,\ Q_H/\text{Second} = 0.25\ hp = (0.25 \times 746) = 186.5\ \text{Joule/s}$

$e = \frac{W}{Q_H} \rightarrow 0.75 = \frac{W}{186.5} \rightarrow W = 139.9 \rightarrow Q_c = 186.5 - W = 46.7\ J/s$

$= 168\ kJ/hr$

B) 503 kJ
C) 1.2 kJ
D) 0.25 kJ

Question 7

Compute the entropy change of 5.00 g of water at 100°C as it changes to steam at 100°C under standard pressure.

A) 27.0 cal/K = 113 J/K
B) 1.07 cal/K = 4.49 J/K
[✓ C)] 7.24 cal/K = 30.3 J/K
D) 1.45 cal/K 6.06 J/K

Question 8

An ideal gas was slowly expanded from 2.00 m3 to 3.00 m3 at a constant temperature of 30° C. The entropy change of the gas was +47 J/K during the process. (a) How much heat was added to the gas during the process? (b) How much work did the gas do during the process?

A) (a) 14.2 kcal, (b) 3.4 kJ
B) (a) 0.337 kcal, (b) 1.40 kJ
[✓ C)] (a) 3.4 kcal, (b) 14 kJ
D) (a) 59.7 kcal, (b) 250 kJ

Question 9

A household refrigerator has a coefficient of performance of 5.2. If the room temperature outside the refrigerator is 28° C, what is the lowest temperature that can be obtained inside the refrigerator?

A) -10.8° C
B) -15.7° C
C) -18.2° C
[✓ D)] -20.5° C .

$$K_r = 5.2 = \frac{Q_c}{W} = \frac{Q_c}{Q_H - Q_c} = \frac{1}{\frac{Q_H}{Q_c} - 1}$$

but $\frac{Q_H}{Q_c} = \frac{T_H}{T_c} = \frac{28+273}{T_c} \Rightarrow 5.2 = \frac{1}{\frac{301}{T_c} - 1} \rightarrow T_c \simeq 253\,k = -20^0C$

Question 10

The Carnot efficiency for a heat engine operating between the temperatures of 300° C and 15° C is

A) 5%
[✓ B)] 50%
C) 74%
D) 93%

$$e = 1 - \frac{T_c}{T_H} = 1 - \frac{15+273}{300+273} = 0.5$$

$$= 50\%$$