Solve the following questions with these given information

- Specific heat capacity of ice (C_{ice}) = 2.01J/g°C
- Specific heat capacity of steam (C_{steam}) = 2.06J/g°C
- Molar heat of fusion for water (ΔH_f) = 6.02kJ/mol
- Molar heat of vaporization for water(ΔH_v) = 40.6kJ/mol

1. How much energy is required to heat 190.0g of water from 25.0°C to 95°.0C?

q= mcΔT = (190.0g)(4.184J g°C)(95.0°C-25.0°C) = 55647J = 55.6kJ

2. How much energy is needed to evaporate 190.0g of water at 100.0°C?

$$\boldsymbol{q = mol \times \Delta H_v = \ 190.0g \times \frac{1mol}{18.01528g} \times \frac{40.6kJ}{mol} = \ 428.19kJ = 4.28{\times}10^2 kJ}$$

3. How much energy is required to heat 300.0g of water from 45.0°C to 120.0°C?

q= mcΔT = (300.0g)(4.184J g°C)(100.0°C-45.0°C) = 69036J = 69.0kJ

$\boldsymbol{q = mol \times \Delta H_v = \ 300.0g \times \frac{1mol}{18.01528g} \times \frac{40.6kJ}{mol}}$ **= 676.09kJ = 676kJ**

q= mcΔT = (300.0g)(2.06J g°C)(120.0°C-100.0°C) = 12360J = 12.4kJ

q_{total} = 69.0kJ + 676kJ + 12.4kJ = 757.4kJ

4. How many joules are given off when cooling 25.0g water from 10.0°C to -25.0°C?

q= mcΔT = (25.0g)(4.184J g°C)(0°C-10.0°C) = -1046J = -1.05kJ

$\boldsymbol{q = mol \times \Delta H_f = \ 25.0g \times \frac{1mol}{18.01528g} \times \frac{-6.02kJ}{mol}}$ **= -8.3540kJ = -8.35kJ**

q= mcΔT = (25.0g)(2.01J g°C)(-25.0°C-0°C) = -1256.25J = -1.26kJ

q_{total} = -1.05kJ + -8.35kJ + -1.26kJ = -10.66kJ

5. How much energy is needed to heat up 55.0g of ice from -15.0°C into steam at 115.0°C?

q_1= mcΔT = (55.0g)(2.01J g°C)(0°C - (-15.0°C)) = 1658.25J = 1.66kJ

$$q_2 = mol \times \Delta H_f = 55.0g \times \frac{1mol}{18.01528g} \times \frac{6.02kJ}{mol} = 18.38kJ = 18.4kJ$$

q_3= mcΔT = (55.0g)(4.184J g°C)(100.0°C-0.0°C) = 23012J = 23.0kJ

$$q_4 = mol \times \Delta H_v = 55.0g \times \frac{1mol}{18.01528g} \times \frac{40.6kJ}{mol} = 123.95kJ = 124kJ$$

q_5= mcΔT = (55.0g)(2.06J g°C)(115.0°C-100.0°C) = 1699.5J = 1.70kJ

q_{total} = 1.66kJ + 18.4kJ + 23.0kJ + 124kJ + 1.70kJ = 168.76kJ

6. What is the final temperature when 37.8kJ is added to 55.0g of water at -15.0°C?

Based on result in question 5, $q_1 + q_2$ = 20.1kJ and $q_1 + q_2 + q_3$ = 43.1kJ. Since 37.8kJ is larger than $q_1 + q_2$, we can calculate how much heat is left over.

$q_{left\ over}$ = 37.8 kJ – 20.1kJ = 17.7kJ or 17700J

q = mcΔT => 17700J = 55.0g(4.184)(T_f - 0.0°C)

$$T_f = T_i + \frac{q}{mc_l} = 0.0°C + \frac{17700J}{55.0g(4.184J/g°C)} = 76.9°C$$