Solutions for Topic 3 – Thermal physics

1. **a)** specific heat capacity depends on mass of object; objects of the same specific heat capacity will require more energy to heat a larger mass to the same temperature

b) area of contact will only affect the rate of transfer, not the direction

c) higher specific heat capacity means heat is transferred more readily

d) energy will be transferred from the object with the higher temperature to that of lower temperature

2. If the objects are at the same temperature, there is no transfer of energy between them, so their internal energy must be the same.

3. **a)** internal energy is the sum of the potential energy of the particles (arising from intermolecular forces) and the random kinetic energy of the particles

b) $c = \frac{Q}{m\Delta T} = \frac{1.2 \times 10^3}{0.25 \times 20} = 240 \text{ J kg}^{-1} \text{ K}^{-1}$

4. $Q = 3.0 \times (120 - 20) \times 490 = 1.47 \times 10^5 \text{ J}$

5. $\Delta T = 8K$; $Q = (0.07 \times 8 \times 4200) + (0.08 \times 8 \times 390) = 2.6 \text{ kJ}$

6. rate of flow of air $= \frac{7 \times 10^3}{1.01 \times 10^3 \times 30} = 0.23 \text{ kg s}^{-1}$

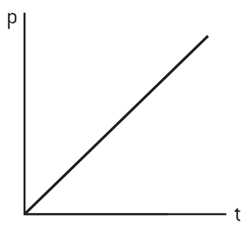
7. **a)** $Q = mL = 2 \times 3.34 \times 10^5 = 6.7 \times 10^5 \text{ J}$

b) $Q = mL = 2 \times 2.26 \times 10^6 = 4.5 \times 10^6 \text{ J}$

c) Freezing requires bonds to be formed; boiling requires breaking of intermolecular bonds which requires more energy

8. 20 g of neon = 1 mole; 8 g of helium = 2 moles; ratio of Ne to He $= \frac{1}{2}$

9.



10. high temperature and low pressure

11. **a)** **(i)** Ideal gases ignore intermolecular forces between molecules in between collisions. In real gases, there is a short-range repulsive force and a long-range attractive force between molecules.

(ii) potential energy is ignored as it is assumed there are no intermolecular forces between molecules

b) p, n and R all constant

using ideal gas law and converting temperature to Kelvin,

$V_2 = \frac{T_2}{T_2} \times V_1 = 873 \text{ cm}^3$

$\Delta V = V_2 - V_1 = 3 \text{ cm}^3$

12. **a)** **(i)** $p \propto V^{-1}$

(ii) $V \propto T$

b) **(i)** $\frac{p_1}{T_1} = \frac{p_2}{T'}$

(ii) $\frac{V_1}{T'} = \frac{V_2}{T_2}$

c) $T' = \frac{p_2}{p_1}T_1 = \frac{V_1}{V_2}T_2$ constant K

so $pV = KT$

13. a) $V_2 = \frac{263 \times 1.01 \times 10^5 \times 0.25}{303 \times 0.65 \times 10^5} = 0.34\ m^3$

b) no gas molecules enter or leave the balloon; helium behaves as an ideal gas (intermolecular forces are negligible)

c) number of moles $n = \frac{1.01 \times 10^5 \times 0.25}{303 \times 8.31} = 10.0$ mol