Physics Y11

Chapter Review Q1 to Q20

1 A. The kinetic theory states that particles are in constant motion.

2 Temperature—the average kinetic energy of particles in a substance.

3 Heat refers to the energy that is transferred between objects, whereas temperature is a measure of the average kinetic energy of the particles within a substance.

4 **a** $5 + 273 = 278\,K$

b $200 - 273 = -73°C$

5 The fixed points must be reproducible under any conditions. The starting point of the scale must be zero, with no negative values.

6 0°C is not the lowest value on the Celsius scale—negative values are possible. The freezing and boiling points of water are not fixed but vary with changing pressure.

7 As thermal equilibrium is reached, the balls must be at the same temperature.

8 B

9 The substance is changing state—in this case, it is melting. The heat energy is used to increase the potential energy of the particles in the solid instead of increasing their kinetic energy, so the temperature does not change. The energy needed to change from solid to liquid is the latent heat of fusion.

10 Both have the same kinetic energy as their temperatures are the same; however, the steam has more potential energy due to its change in state. Therefore the steam has greater internal energy.

11 The higher energy particles are escaping, leaving behind the lower energy particles. The result is that the average kinetic energy of the remaining particles decreases, thus the temperature drops.

12 $Q = mc\Delta T$

$$c = \frac{Q}{m\Delta T}$$

$$= \frac{5020}{2.00 \times 20}$$

$$= 125.5\,J\,kg^{-1}\,K^{-1}$$

$$= 126\,J\,kg^{-1}\,K^{-1}$$

13 $Q = mL$

$= 0.08 \times 0.88 \times 10^5$

$= 7.0\,\text{kJ}$

14 $c_{copper} = 390\,\text{J kg}^{-1}\text{K}^{-1}$, $c_{iron} = 440\,\text{J kg}^{-1}\text{K}^{-1}$. Copper requires less thermal energy to heat it than iron so will cool the water travelling through it less than iron. However, it is also a better conductor of heat so will require additional insulation to avoid transferring more heat to the surrounds.

15 $\Delta U = Q - W$

$= +14\,600 - (-2.65 \times 10^6)$

$= 2\,664\,600\,\text{J}$

$Q = mL_{fusion} + mc\Delta T$

$2\,664\,600 = 4.55 \times 3.34 \times 10^5 + 4.55 \times 4180 \times (T - 0)$

$T = 60^\circ\text{C}$

16 Note that both the cup and the water must be cooled since there will be heat transfer between the two materials in contact.

$$Q_{\text{melting ice}} + Q_{\text{heating ice}} = Q_{\text{cooling water}} + Q_{\text{cooling cup}}$$

$$m_{ice}L_f + m_{ice}c_{water}\Delta T = m_{water}c_{water}\Delta T + m_{copper}c_{copper}\Delta T$$

$$m_{ice} \times 3.34 \times 10^5 + m_{ice} \times 4180 \times (20 - 0) = 0.100 \times 4180 \times (60 - 20) + 0.200 \times 390 \times (60 - 20)$$

$$3.34 \times 10^5 m_{ice} + 8.36 \times 10^4 m_{ice} = 1.672 \times 10^4 + 3120$$

$$4.176 \times 10^5 m_{ice} = 1.984 \times 10^4$$

$$m_{ice} = \frac{1.984 \times 10^4}{4.176 \times 10^5}$$

$= 4.75 \times 10^{-2}$ kg

17 $Q_{milk} = Q_{steam} + Q_{water}$

$$m_m c\Delta T = m_s L_f + m_w c_w \Delta T$$

$$0.425 \times 3930 \times (70.0 - 4.00) = 2.25 \times 10^6 m + m \times 4180 \times (100 - 70.0)$$

$$1.10 \times 10^5 = 2.25 \times 10^6 m + 1.254 \times 10^5 m$$

$$2.375 \times 10^6 m = 1.10 \times 10^5$$

$$m = \frac{1.10 \times 10^5}{2.375 \times 10^6}$$

$$= 4.63 \times 10^{-2} \text{ kg}$$

18

$$Q_{lemon} = Q_{ice} + Q_{water}$$

$$m_l c\Delta T = m_i L_f + m_w c_w \Delta T$$

$$0.468 \times 3850 \times (20.0 - 3.00) = 3.34 \times 10^5 m + m \times 4180 \times (3.00 - 0.00)$$

$$3.063 \times 10^4 = 3.34 \times 10^5 m + 1.254 \times 10^4 m$$

$$3.063 \times 10^4 = 3.465 \times 10^5 m$$

$$m = \frac{3.063 \times 10^4}{3.465 \times 10^5}$$

$$= 8.84 \times 10^{-2} \text{ kg}$$

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$$Q_{\text{steam}} = Q_{\text{ice}}$$

$$m_s c_s \Delta T + m_s L_v + m_s c_w \Delta T = m_i c_i \Delta T + m_i L_f + m_i c_w \Delta T$$

$$m_s \times 2000 \times (115 - 100) + 2.25 \times 10^6 m_s + m_s \times 4180 \times (100 - 55.0) = 2.50 \times 2100 \times (0 - (-12.5)) + 2.50 \times 3.34 \times 10^5 + 2.50 \times 4180 \times (55.0 - 0)$$

$$3.00 \times 10^4 m_s + 2.25 \times 10^6 m_s + 1.881 \times 10^5 m_s = 6.56 \times 10^4 + 8.35 \times 10^5 + 5.7475 \times 10^5$$

$$2.4681 \times 10^6 m_s = 1.4754 \times 10^6$$

$$m_s = \frac{1.4754 \times 10^6}{2.4681 \times 10^6}$$

$$= 0.598 \text{ kg}$$

20

$$Q_{\text{iron}} = Q_{\text{water}}$$

$$m_i c_i \Delta T = m_w c_w \Delta T + m_w L_v$$

$$18.0 \times 440 \times (545 - T) = 1.50 \times 4180 \times (100 - 22.0) + 1.50 \times 2.25 \times 1$$

$$4.316 \times 10^6 - 7.920 \times 10^3 T = 4.8906 \times 10^5 + 3.375 \times 10^6$$

$$7.920 \times 10^3 T = 4.316 \times 10^6 - 3.8641 \times 10^6$$

$$T = \frac{4.519 \times 10^5}{7.920 \times 10^3}$$

$$= 57.1°\text{C}$$