

Name _____

Date _____

Score: _____ / 36

61 minutes · 36 marks · calculator and data booklet allowed

- Answer all the questions in the spaces provided.
- Show all your working. Marks are given for correct method.
- The marks for each part are shown in brackets [].

1. Boiling water on a balance [9 marks]

A beaker of water stands on an electronic balance. An immersion heater of power 60 W keeps the water boiling. In 10.0 minutes the reading of the balance falls from 0.512 kg to 0.497 kg.

(a) State what is meant by the specific latent heat of vaporization. **[1]**

(b) Calculate the specific latent heat of vaporization of water from these data. **[2]**

(c) The accepted value is $2.26 \times 10^6 \text{ J kg}^{-1}$. **Suggest** why the value in (b) is larger. **[2]**

(d) Explain, in terms of molecules, why the temperature of the water stays constant while it boils. **[2]**

(e) Outline why the specific latent heat of vaporization of water is much larger than its specific latent heat of fusion. **[2]**

2. Cooling a drink [10 marks]

Ice cubes of total mass 0.050 kg at $-15\text{ }^{\circ}\text{C}$ are added to 0.35 kg of juice at $24\text{ }^{\circ}\text{C}$ in an insulated cup. Specific heat capacity: juice $4000\text{ J kg}^{-1}\text{ K}^{-1}$, ice $2100\text{ J kg}^{-1}\text{ K}^{-1}$, water $4200\text{ J kg}^{-1}\text{ K}^{-1}$. Specific latent heat of fusion of ice = 334 kJ kg^{-1} . Ignore the cup.

(a) **Define** internal energy. [2]

(b) **Calculate** the energy needed to warm the ice to $0\text{ }^{\circ}\text{C}$ and then melt it. [2]

(c) **Show** that all the ice melts. [1]

(d) **Determine** the final temperature of the drink. [3]

(e) While the ice melts, its temperature stays at $0\text{ }^{\circ}\text{C}$. **State** what happens to the internal energy of the ice during melting. **Explain** your answer. [2]

3. A window in winter [8 marks]

A single window pane of glass has an area of 1.6 m^2 and a thickness of 5.0 mm. The thermal conductivity of the glass is $0.80\text{ W m}^{-1}\text{ K}^{-1}$. The inside surface of the glass is at $15\text{ }^{\circ}\text{C}$ and the outside surface is at $5.0\text{ }^{\circ}\text{C}$.

(a) **Calculate** the rate of thermal energy transfer through the glass. [2]

- (b) **Explain**, in terms of particles, how thermal energy is conducted through the glass. [2]

- (c) The pane is replaced by double glazing: two panes with a layer of air 12 mm thick between them. The thermal conductivity of air is $0.025 \text{ W m}^{-1} \text{ K}^{-1}$. The temperature difference across the air layer is 9.7 K. **Calculate** the rate of thermal energy transfer through the air layer. [2]

- (d) **Explain** why the air close to a cold window moves downwards. [2]

4. Two stars [9 marks]

The spectrum of star A has its peak at a wavelength of 480 nm. The radius of star A is $9.0 \times 10^8 \text{ m}$ and its distance from Earth is $3.0 \times 10^{17} \text{ m}$. Assume that the stars radiate as black bodies.

- (a) **Calculate** the surface temperature of star A. [1]

- (b) **Calculate** the luminosity of star A. [2]

- (c) **Calculate** the apparent brightness of star A at Earth. [2]

- (d) Star B has the same apparent brightness as star A. It is twice as far from Earth and its surface temperature is half that of star A. **Determine** the ratio (radius of B)/(radius of A). [3]

(e) **State** how the colour of star B differs from the colour of star A. **[1]**
