

Thermal-practice-1-extended

[14 marks]

1. This question is about internal energy. [4 marks]

(i) Mathilde raises the temperature of water in an electric kettle to boiling point. Once the water is boiling steadily, she measures the change in the mass of the kettle and its contents over a period of time.

The following data are available.

Initial mass of kettle and water = 1.880 kg

Final mass of kettle and water = 1.580 kg

Time between mass measurements = 300 s

Power dissipation in the kettle = 2.5 kW

Determine the specific latent heat of vaporization of water.

(ii) Outline why your answer to (b)(i) is an overestimate of the specific latent heat of vaporization of water.

Part 2 Melting of the Pobeda ice island

2a. The Pobeda ice island forms regularly when icebergs run aground near the Antarctic ice shelf. The “island”, which consists of a slab of pure ice, breaks apart and melts over a period of decades. The following data are available. [8 marks]

Typical dimensions of surface of island = 70 km × 35 km

Typical height of island = 240 m

Average temperature of the island = -35°C

Density of sea ice = 920 kg m^{-3}

Specific latent heat of fusion of ice = $3.3 \times 10^5\text{ J kg}^{-1}$

Specific heat capacity of ice = $2.1 \times 10^3\text{ J kg}^{-1}\text{K}^{-1}$

(i) Distinguish, with reference to molecular motion and energy, between solid ice and liquid water.

(ii) Show that the energy required to melt the island to form water at 0°C is about $2 \times 10^{20}\text{ J}$. Assume that the top and bottom surfaces of the island are flat and that it has vertical sides.

(iii) The Sun supplies thermal energy at an average rate of 450 W m^{-2} to the surface of the island. The albedo of melting ice is 0.80. Determine an estimate of the time taken to melt the island assuming that the melted water is removed immediately and that no heat is lost to the surroundings.

2b. Suggest the likely effect on the average albedo of the region in which the island was floating as a result of the melting of the Pobeda ice island. [2 marks]

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