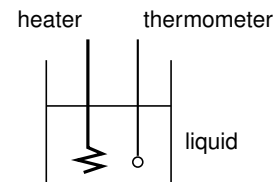


Heat, power and temperature change: practice sheet

Total: 50 marks. Calculator allowed. Write your answers in the spaces provided. Equations are not given: write them in symbols before you use numbers. Data and constants are on the last page.

Lifebuoy.  The parts marked with the lifebuoy symbol are worth 30 marks out of 50, that is 60 %: if you have completed all of them, you pass.

1. An 800 W heater is placed in 2.0 kg of oil and is switched on for 5.0 min. The temperature of the oil rises by 60 °C. Assume that no energy is lost.



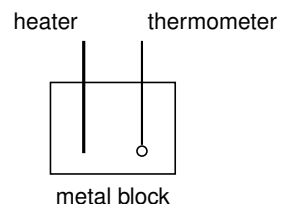
- (a) Write the given quantities with their units and name the unknown quantity.  [1]

- (b) Write, in symbols, the equation for the energy supplied by the heater and the equation for the energy gained by the oil. Rearrange the second one to make the specific heat capacity c the subject.  [2]

- (c) Calculate the energy supplied by the heater. [1]

- (d) Calculate the specific heat capacity of the oil. [1]

2. A 50 W heater is used for 10 min to heat a 0.50 kg aluminium block, initially at 20 °C. The block is not insulated.



- (a) Write the given quantities with their units and name the unknown quantity.  [1]

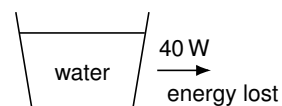
- (b) Write, in symbols, the equation for the temperature rise ΔT of the block when energy Q is supplied, and the equation for efficiency.  [2]

- (c) Calculate the temperature rise expected if no energy is lost. [1]

- (d) The final temperature is measured: 74 °C. Calculate the efficiency of the heating. [1]

- (e) Suggest one way to improve the efficiency. [1]

3. A cup contains 0.25 kg of water at 80 °C. The water loses energy to the surroundings at an average rate of 40 W.



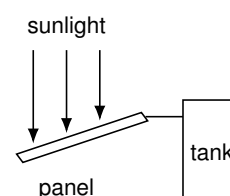
(a) Write the given quantities with their units and name the unknown quantity for the time taken to cool by 20 °C. ⚙️ [1]

(b) Write, in symbols, the equation for the energy lost and the equation linking energy, power and time. Combine them into one expression for the time t . ⚙️ [2]

(c) Calculate the energy lost when the temperature falls by 20 °C. [1]

(d) Calculate how long this takes. Give your answer in minutes. [1]

4. A solar panel of area 2.0 m² faces the Sun. Sunlight delivers 600 W to each square metre. 50 % of this power heats 100 kg of water in a tank.



(a) Write the given quantities with their units and name the unknown quantity for the rise in temperature of the water in 1.0 h. ⚙️ [1]

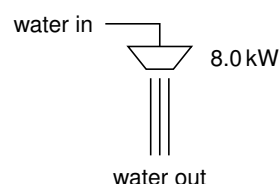
(b) Write, in symbols, the expression for the useful power and the expression for the rise in temperature ΔT after a time t . ⚙️ [2]

(c) Calculate the useful power that heats the water. [1]

(d) Calculate the energy transferred to the water in 1.0 h. [1]

(e) Calculate the rise in temperature of the water in 1.0 h. [1]

5. An electric shower has a power of 8.0 kW. Water flows through it at 0.10 kg every second and enters at 12 °C. Assume that all the energy heats the water.



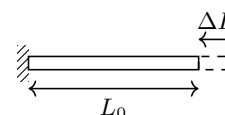
(a) Write the given quantities with their units, in SI units, and name the unknown quantity. [1]

(b) Write, in symbols, the energy supplied to the water in 1 s and the equation for the rise in temperature ΔT of that water. [2]

(c) Calculate the rise in temperature of the water. [1]

(d) Calculate the temperature of the water leaving the shower. [1]

6. A brass bar expands by 1.9 mm when its temperature rises from 20 °C to 120 °C. For brass, $\alpha = 1.9 \times 10^{-5} / ^\circ\text{C}$.

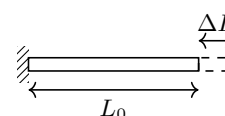


(a) Write the given quantities in SI units and name the unknown quantity. [1]

(b) Write, in symbols, the equation for linear expansion and rearrange it to make the initial length L_0 the subject. [2]

(c) Calculate the initial length of the bar, in metres. [1]

7. An aluminium rod is 1.50 m long at 18 °C. When it is heated, its length increases by 2.07 mm. For aluminium, $\alpha = 2.3 \times 10^{-5} / ^\circ\text{C}$.



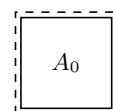
(a) Write the given quantities in SI units and name the unknown quantity. [1]

(b) Write, in symbols, the equation for linear expansion and rearrange it to make the temperature rise ΔT the subject. [2]

(c) Calculate the rise in temperature of the rod. [1]

(d) Calculate the final temperature of the rod. [1]

8. A square steel plate has sides of 0.50 m at 20 °C. It is heated to 220 °C. For steel, $\alpha = 1.2 \times 10^{-5}/^{\circ}\text{C}$, and the area expansion coefficient is $\beta = 2\alpha$.



steel plate

(a) Write the given quantities in SI units and name the unknown quantity.

⚙️ [1]

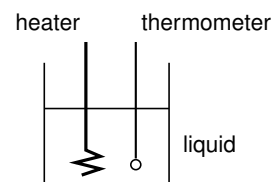
(b) Write, in symbols, the equation for the increase in area ΔA in terms of β , and the equation linking β and α .

⚙️ [2]

(c) Calculate the increase in area. Give your answer in cm^2 .

[1]

9. An electric heater heats 1.0 kg of water from 15 °C to 65 °C in 4.0 min. First assume that no energy is lost.



(a) Write the given quantities with their units and name the unknown quantity.

⚙️ [1]

(b) Write, in symbols, the equation for the energy gained by the water and the equation for power. Combine them into one expression for P .

⚙️ [2]

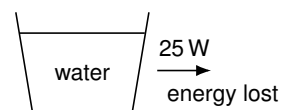
(c) Calculate the power of the heater.

[1]

(d) In practice the heater is only 80 % efficient. Calculate the electrical power it needs.

[1]

10. A mug of tea loses energy to the surroundings at an average rate of 25 W. In 8.0 min the temperature of the tea falls by 12 °C. Assume that tea has the same specific heat capacity as water.



(a) Write the given quantities in SI units and name the unknown quantity.

⚙️ [1]

(b) Write, in symbols, the equation for the energy lost and rearrange it to make the mass m of the tea the subject. Include the link between energy, power and time.

⚙️ [2]

(c) Calculate the energy lost by the tea.

[1]

(d) Calculate the mass of the tea.

[1]

Data and constants

Specific heat capacity of water 4200 J/(kg °C)

Specific heat capacity of aluminium 900 J/(kg °C)

Linear expansion coefficients α steel $1.2 \times 10^{-5}/^{\circ}\text{C}$; brass $1.9 \times 10^{-5}/^{\circ}\text{C}$; aluminium $2.3 \times 10^{-5}/^{\circ}\text{C}$

Area expansion coefficient $\beta = 2\alpha$

Conversion $T/\text{K} = \theta/^{\circ}\text{C} + 273$