Mechanics 2

CORE questions

Core 1

(a) Complete the following sentence.

"The temperature of a body rises when the .... energy of its molecules is increased." [1]

(b) Fig. 1 gives details about an empty beaker and the same beaker with different substances in it.

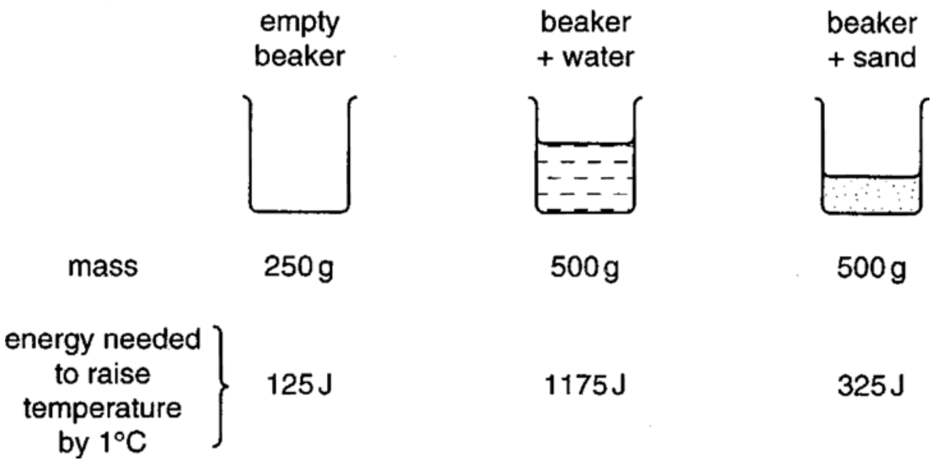

Fig. 1

(i) Which of the arrangements has the highest thermal capacity?

....

(ii) 1. What is the mass of the water? .... g

2. What is the mass of the sand? .... g

3. How much energy is needed to raise the temperature of the water by 1 °C?

.... J

4. How much energy is needed to raise the temperature of the sand by 1 °C?

.... J

5. Use your answers above to suggest why, on a sunny day, the temperature of the sand on a beach rises faster than the temperature of the sea.

....

....

....[6]

Core 2

(a) Some students are asked to write down what they know about evaporation of a liquid. Here are their statements, some of which are correct and some incorrect.

Put a tick alongside those statements which are correct.

A "Evaporation occurs at any temperature." ☐

B "Evaporation only occurs at the boiling point." ☐

C "Evaporation occurs where the liquid touches the bottom of the container." ☐

D "Evaporation occurs at the surface of the liquid." ☐

E "It is the higher energy molecules which escape" ☐

F "The molecules gain energy as they escape." ☐

G "The liquid temperature **always** rises when evaporation occurs." ☐

H "Rapid evaporation produces cooling." ☐

[4]

(b) Sometimes after shaving, men splash a liquid, called an aftershave, over their faces. This makes their faces feel fresher as the aftershave evaporates.

(i) Which of the statements in part **(a)** explains why the aftershave, even though it is at room temperature, cools the skin.

statement ....

(ii) Suggest why the aftershave cools the skin better than water at room temperature.

....

....
[2]

Core 3

Some smoke is mixed with the air in a glass box. The box is lit brightly from the side and its contents studied from above through a microscope.

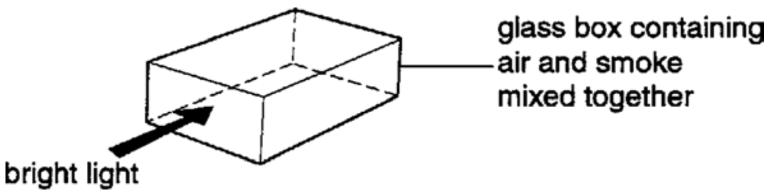

Fig. 2

(a) Bright specks are seen moving in continuous and jerky random movement.

(i) What are the bright specks? Tick **one** box.

air molecules ☐

smoke molecules ☐

smoke particles ☐

Core 3

(ii) What is the explanation for the jerky random movement? Tick **one** box.

The air molecules bombard each other. ☐

The smoke particles bombard each other. ☐

The air molecules bombard the smoke particles. ☐

The air molecules bombard the glass. ☐

The smoke particles bombard the glass. ☐

(b) The contents of the glass box exert a pressure on the glass walls.
Tick **any** of the following sentences which might help explain this pressure.

The air molecules bombard each other. ☐

The smoke particles bombard each other. ☐

The air molecules bombard the smoke particles. ☐

The air molecules bombard the glass. ☐

The smoke particles bombard the glass. ☐

ALTERNATIVE TO PRACTICAL questions

Alternative to Practical 1

The apparatus shown in Fig. 3 is used in a heat experiment.

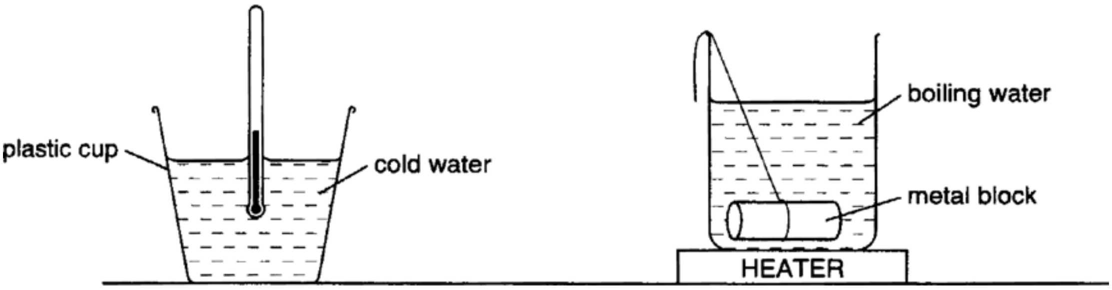

Fig. 3

A piece of metal at the boiling temperature of water is transferred to a mass of cold water. Initially, the cold water is at a temperature of T_C. The hot metal raises the temperature of this water to T_H. The rise in temperature, θ, is determined from the relation $\theta = T_H - T_C$. The experiment is repeated so as to obtain five sets of readings for different masses of cold water.

(a) Draw up a table, for use in your laboratory notebook, in which you can record

m, the mass of cold water used,

T_C, the temperature of the cold water,

T_H, the maximum temperature reached by the cold water,

θ, the rise in temperature of the cold water.

[3]

(b) Fig. 4 on page 6 is a graph showing how θ varies with m, the mass of cold water used.

(i) Why has a smooth line been drawn through the points?

....

....

....

Alternative to Practical 1

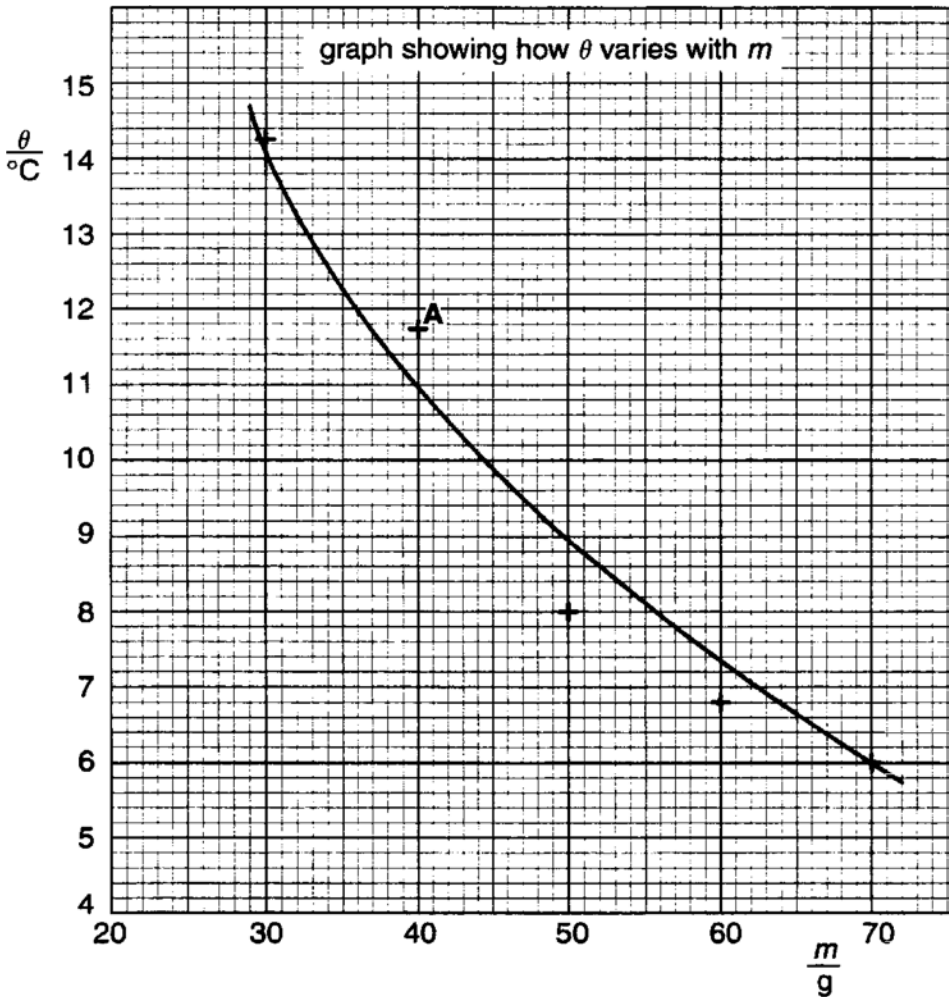

Fig. 4

(ii) The graph point that is labelled A does not lie on the graph line. (You can assume that the graph line is correctly drawn.) Complete the following statements about the value of θ and of m at the point A.

1. If the value of θ were .... °C smaller, the point A would lie on the line.

2. If the value of m were .... g smaller, the point A would lie on the line.

(iii) In **(ii)** above which is the most likely reason, 1 or 2, for the point A not being on the line? Give a reason for your choice.

choice: Tick **one** box.

☐ 1.

☐ 2.

reason:

....

....[4]

EXTENSION questions

Extension 1

Fig. 5 shows a student's design for a thermometer. The student stated that the material labelled M could be a copper rod, alcohol or nitrogen gas.

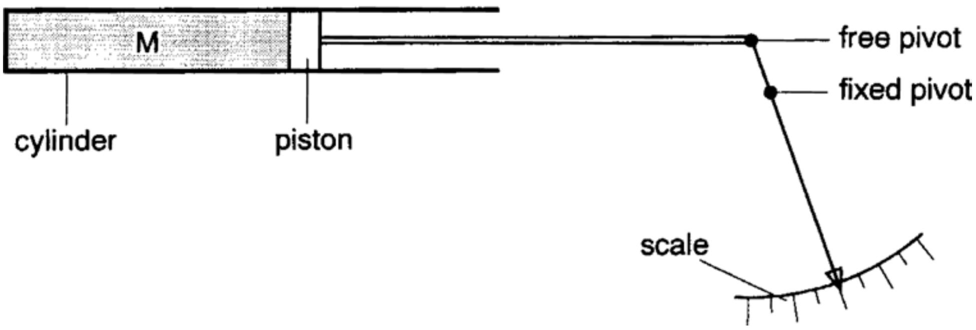

Fig. 5

(a) Explain what is meant by the term *sensitivity of the thermometer*.

....

....[1]

(b) **(i)** State which of the three suggested materials would give a thermometer of greatest sensitivity.

....

(ii) Explain your answer.

....

....
[2]

(c) **(i)** State which of the three materials would allow the thermometer to measure the largest range of temperature.

....

(ii) Explain your answer.

....

....
[2]

(d) The student found that the temperature scale of this thermometer was *non-linear*. Explain what this means.

....

....[2]

Extension 2

Fig. 6 shows a sealed box containing only dry air. At a particular instant, one of the air molecules in the box is situated at P and it is moving towards face ABCD along the direction shown by the arrow.

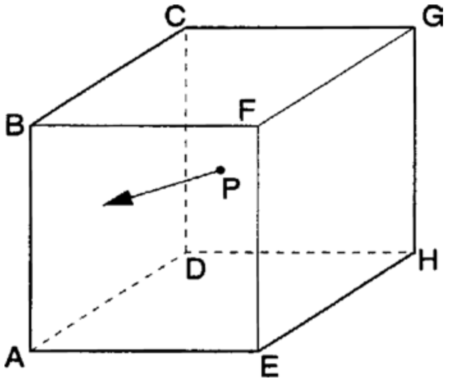

Fig. 6

(a) Describe and explain a possible path of the molecule within the box.

....

....

....

....

....[2]

(b) Explain how this molecule

(i) helps to cause a pressure on the side ABCD,

....

....

....

(ii) helps to cause an equal pressure on all the sides.

....

....

....[2]

Extension 2

(c) The box is squashed but no air leaks out. By calculation, complete the table below.

	volume of box / m^3	pressure / Pa	temperature / °C
before squashing	0.09	1.0×10^5	20
after squashing	0.04		20

[2]

Extension 3

In an experiment to find the specific latent heat of fusion of ice, an electric heater, of power 200 W, is used.

The following readings are taken.

mass of ice at 0 °C, before heating started, 0.54 kg
mass of ice at 0 °C, after 300 s of heating, 0.36 kg

(a) Calculate a value of the specific latent heat of fusion of ice.

specific latent heat of fusion of ice = ... [4]

(b) Explain, in molecular terms, how heat is transferred from the surface of a block of ice to its centre.

....

....

....

....

....[2]

Mechanics 2 – answers

Core 1

(a) internal / thermal / kinetic / heat / motion / movement

b **(i)** the beaker and water

(ii) 1 250 g

2 250 g

3 1050 J

4 200 J

5 sand requires less energy to raise its temperature

or the temperature of sand rises more for the same energy input
or the reverse argument for water
or water has a bigger specific heat capacity

Core 2

(a) correct answers A D E H

(b) **(i)** either E or H

(ii) evaporates more rapidly / easily

Core 3

(a) **(i)** correct answer smoke particles

(ii) correct answer air molecules bombard the smoke particles

(b) correct answer air molecules bombard the glass
smoke particles bombard the glass

Alternative to Practical 1

(a) a suitable table showing units for both mass and temperature

(b) **(i)** it is a way of taking an average
it is a way of showing up unexpected results

(ii) 1 0.8 °C

2 3 g

(iii) correct answer box 1
reason difficult to measure temperature to 1 °C
or heat losses involved
or easy to measure mass to better than 1 g

Extension 1

(a) change in property / length / volume per degree

(b) **(i)** nitrogen

(ii) gases expand more / most

(c) **(i)** copper

(ii) a small increase in length per degree / high melting point etc.

(d) the pointer movement is not the same for all degrees
or the effect is different at different parts of the scale

Extension 2

(a) any two from
random path lengths
collides with or bounces off sides
hits or bounces off other molecules

(b) **(i)** it hits / bounces off ABCD at some time

(ii) it hits / bounces off all sides at some time / the chance of hitting all sides is equal

(c) pressure $\times$ volume = constant
pressure $= 0.09 / 0.04 \times 10^5$
$= 2.3 \times 10^5$ Pa

Extension3

(a) specific latent heat of fusion of ice = heat supplied / mass melted
= 60 000 / 0.18 J / kg
= 330 000 J / kg

(b) any two from
molecules vibrate
pass energy from molecule to molecule
process is conduction