Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

STEM | Exam Builder

Thermal properties of matter

Time allowed: 1 hour 10 minutes

Subject code **0625**

Physics

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 72

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 72 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

STEM | Exam Builder

Print at 100% (Actual size) so diagrams keep their real measurements.

1 A metal tyre for a wooden wheel is made from an iron ring. This is shown in Fig. 4.1.

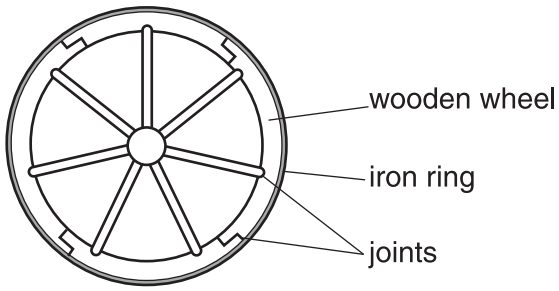


Fig. 4.1

The iron ring is made slightly too small to fit on the wheel.

(a) Explain why heating the iron ring will help it fit on the wheel.

.....

.....[1]

(b) Explain your answer to **(a)** in terms of the particles in the iron ring.

.....

.....[2]

(c) Explain what will happen to the iron ring after it has been fitted on the wheel and left to cool.

.....

.....[1]

(d) Suggest what happens to the joints in the wooden wheel after fitting the iron ring.

.....

.....[1]

[Total: 5]

Thermal expansion Click for more variations

STEM | Exam Builder

1 **(a)** idea of expansion / gets bigger B1

(b) particles have more energy / vibrate faster B1
ignore move quickly or move faster

particles move apart / space between particles increases B1
NOT particles expand

(c) contracts / gets smaller / shrinks B1
IGNORE fits tightly

(d) idea of being pushed together B1
accept move / stick together / compressed
accept pulled tight/together

[Total: 5]

STEM | Exam Builder

2 Fig. 6.1 shows workers pouring liquid metal.

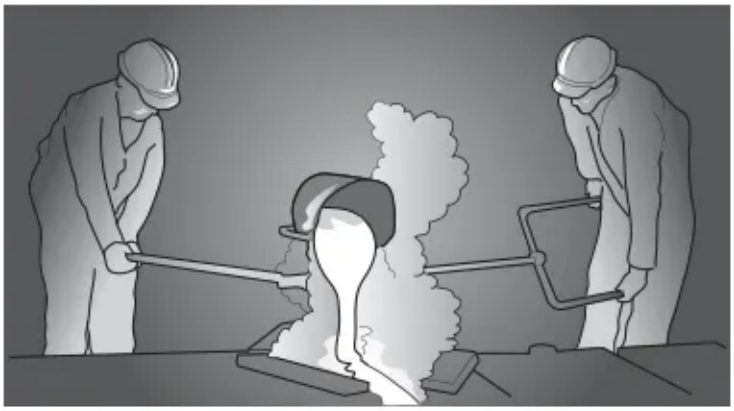


Fig. 6.1

(a) The metal changes from hot liquid to cool solid.

Describe what happens to the arrangement, separation and motion of the atoms as the metal changes from hot liquid to cool solid.

.....

.....

.....

.....

.....

.....

..... [3]

(b) The workers cool their tools in water. They spill some water onto the floor but later the floor is dry.

Explain what happens to the water. State the name of the process.

explanation .....

.....

.....

.....

.....

process .....

[3]

[Total: 6]

Melting, boiling and evaporation Click for more variations

2(a)	more regular/uniform arrangement/fixed position owtte	**B1**
	separation between atoms decreases/move closer/tightly packed	**B1**
	slower moving atoms/atoms vibrate (more slowly)	**B1**
2(b)	(water) molecules gain energy (from surroundings)	**B1**
	molecules escape from a liquid (surface)	**B1**
	evaporation	**B1**
	Total:	**6**

STEM | Exam Builder

3 **(a)** The arrows on Fig. 5.1 represent changes of state.

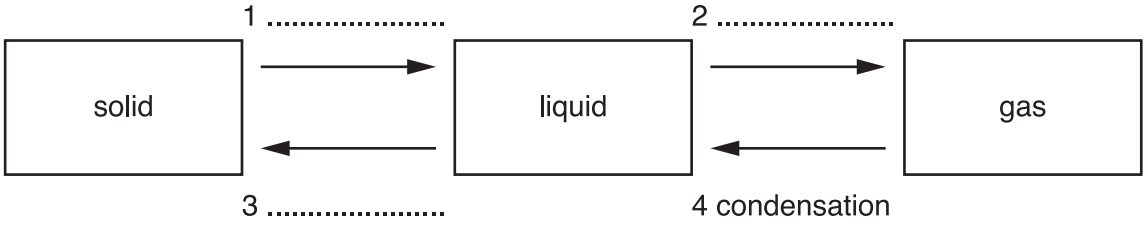


Fig. 5.1

One of the arrows is labelled. Label each of the other arrows with the correct change of state. Write the change of state on the dotted lines next to each arrow. [3]

(b) A beaker contains some liquid with a low boiling point. The beaker is placed onto a small amount of water, as shown in Fig. 5.2.

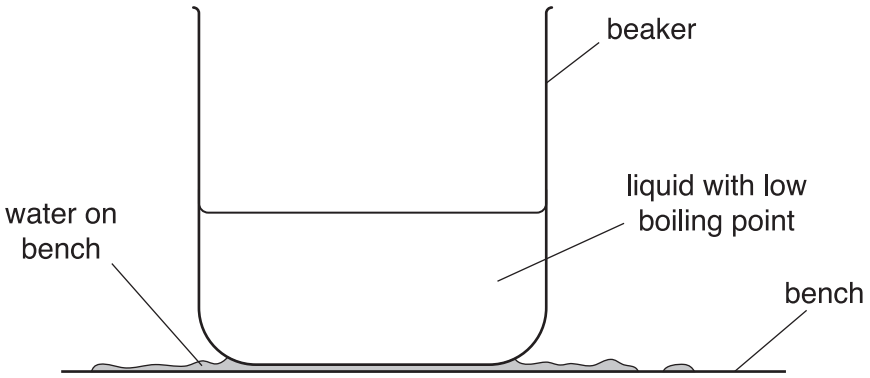


Fig. 5.2

The liquid in the beaker evaporates quickly. The water on the bench cools and turns to ice.

Explain why the water cools.

.....

.....

.....

.....

..... [3]

[Total: 6]

States of matter and the particle model Click for more variations

STEM | Exam Builder

Reduced to 78% to fit the page (wider than A4).

3(a)	1. melting 2. boiling / evaporation 3. freezing / solidification	**B1** **B1** **B1**
3(b)	Any **three** from: (evaporation –) most energetic molecules escape from surface of liquid average KE of molecules remaining in liquid decreases temperature of liquid decreases energy transfers from water (on bench) to liquid (so water cools / freezes)	**B3**

4 **(a)** The molecules of most liquids are, on average, slightly further apart than the molecules of a solid.

State **one** other difference between the molecular structures of a solid and a liquid.

.....

.....[1]

(b) A glass tube passes through a stopper and into a glass flask. Fig. 4.1 shows that the flask is completely full of a liquid and that there is also some liquid in the tube.

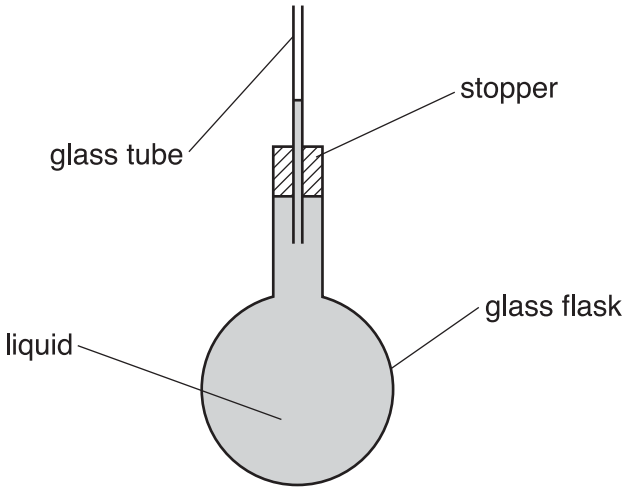


Fig. 4.1

The flask is immersed in a large beaker of very hot water. At first, the level of the liquid in the tube falls, but after a short time it rises.

(i) Explain why, at first, the level of the liquid in the tube falls.

.....

.....

.....

.....[3]

(ii) Explain why the liquid level in the tube stops falling and starts to rise.

.....

.....

.....[2]

[Total: 6]

STEM | Exam Builder

Thermal expansion Click for more variations

Reduced to 77% to fit the page (wider than A4).

4(a)	molecules of solid arranged in lattice / in organised pattern / without gaps / orderly / fixed structure	**B1**
4(b)(i)	glass heated first **or** at first liquid not heated / does not expand / takes time (to heat up) **or** glass poor conductor	**B1**
	glass expands	**B1**
	capacity / volume of flask increases	**B1**
4(b)(ii)	liquid (starts to) warms up	**B1**
	liquid expands more than the solid / glass	**B1**

5 During both boiling and evaporation, liquid water is converted into water vapour.

The rate at which the mass of **boiling** water decreases depends only on the rate at which the water is gaining thermal energy.

(a) The specific latent heat of vaporisation of water is 2.3×10^6 J / kg. Thermal energy is supplied to boiling water in a kettle at a rate of 460 W.

Calculate the mass of water that is boiled away in 180 s.

mass = ... [2]

(b) The rate at which the mass of **evaporating** water decreases depends on other factors.

(i) State two of these factors.

1. .....

2. .....

[2]

(ii) State two other ways in which evaporation is different from boiling.

1. .....

2. .....

[2]

[Total: 6]

Melting, boiling and evaporation Click for more variations

STEM | Exam Builder

5 **(a)** (m =) Pt / l **OR** $460 \times 180 / 2.3 \times 10^6$ **OR** $82\,800 / 2.3 \times 10^6$ C1

0.036 kg **OR** 36 g A1

(b) **(i)** any two from:
(surface) area
draught
temperature (of water / room)
humidity of air B2

(ii) any two from:
evaporation at any temperature / below boiling point
evaporation (only) at the surface
evaporation influenced by surface area / draught / temperature / humidity (not if given in **(b)(i)**) B2

[Total: 6]

STEM | Exam Builder

6 A silver spoon has a thermal capacity of 7.2 J / °C.

(a) Explain what is meant by *thermal capacity*.

.....

.....

.....[2]

(b) The silver spoon is dropped into a saucepan of boiling water. The internal energy of the spoon increases as its temperature increases from 22 °C to 100 °C.

(i) Calculate the increase in the internal energy of the spoon.

increase in internal energy = ...[1]

(ii) State, in terms of the atoms, what is meant by *internal energy*.

.....

.....

.....[2]

(c) The spoon is removed from the boiling water and immediately it begins to transfer energy to the surroundings. The temperature of the surroundings is 22 °C.

On Fig. 5.1, sketch a graph to show how the temperature of the spoon changes with time from the instant that it is removed from the water. [3]

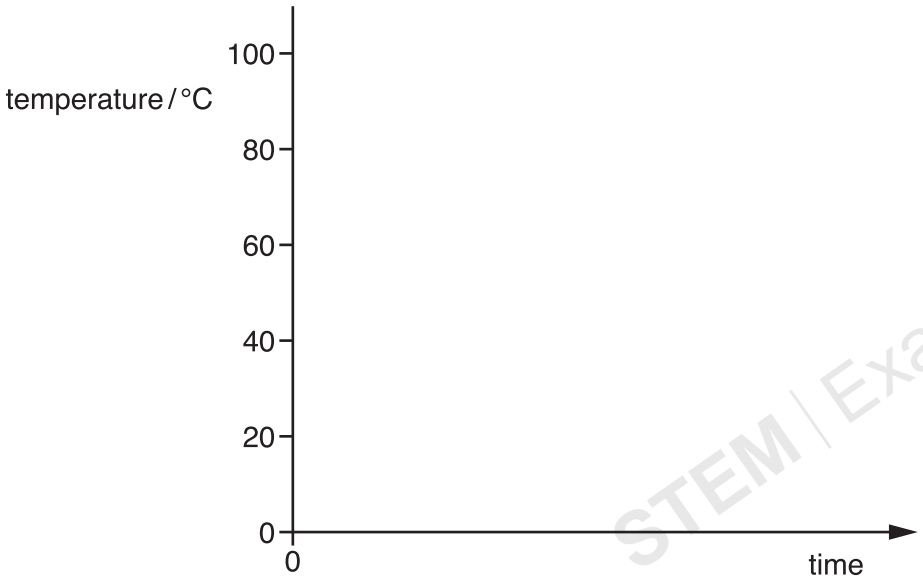


Fig. 5.1

[Total: 8]

Specific heat capacity Click for more variations

STEM | Exam Builder

6(a)	(quantity of internal) energy that raises temperature	**M1**
	per degree Celsius / per unit temperature change	**A1**
6(b)(i)	560 / 562 / 561.6 J	**B1**
6(b)(ii)	kinetic energy / potential energy / total energy (of atoms / molecules / particles)	**B1**
	kinetic added to potential energy (of atoms / molecules / particles)	**B1**
6(c)	line from 100 °C **and** falling	**B1**
	falls at decreasing rate	**B1**
	levels off at labelled / approximate 22 °C	**B1**

STEM | Exam Builder

7 **(a)** State what is meant by the *specific heat capacity* of a substance.

.....

.....

..... [2]

(b) A student carries out an experiment to find the specific heat capacity of aluminium. He uses an electric heater and a thermometer, inserted into separate holes in an aluminium block.

The following data are obtained.

mass of aluminium block = 2.0 kg
power of heating element = 420 W
time of heating = 95 s
initial temperature of block = 19.5 °C
final temperature of block = 40.5 °C

Calculate the value of the specific heat capacity of aluminium given by this experiment.

specific heat capacity = ... [4]

(c) In the experiment in **(b)**, no attempt is made to prevent loss of thermal energy from the surfaces of the block.

Suggest two actions the student could take to reduce the loss of thermal energy from the surfaces of the block.

1. .....

2. .....

[2]

[Total: 8]

Specific heat capacity Click for more variations

STEM | Exam Builder

7 **(a)** energy/heat required to increase temperature
- of 1 kg / 1 g / unit mass (of the substance) B1
- by 1 °C / 1 K / unit temperature B1

(b) $E = mc\Delta\theta$ in any form OR (c =) $E \div m\Delta\theta$ C1
$E = Pt$ in any form OR 420 × 95 (= 39 900) C1
$\Delta\theta$ = [40.5 – 19.5] OR 21 C1
(c = 39 900÷42 =) 950 J/(kg °C) A1

(c) any two separate points from: max. B2
- lagging / insulation (around block) OR insulate (the block)
- raise temperature of block by a smaller amount OR heat for a shorter time OR use lower power heater <u>for same time</u> OR higher power <u>for same temperature rise / shorter time</u>
- polish the surface of the block OR wrap the block in shiny material OR paint (shiny) white
- reduce initial temperature of block (to below room temperature) OR raise temperature of room
- reduce draughts

[Total: 8]

STEM | Exam Builder

8 **(a)** Define *specific heat capacity*.

.....

..... [2]

(b) Solar energy is striking the steel deck of a ship.

(i) Describe how the colour of the deck affects the absorption of the solar energy.

.....

..... [1]

(ii) The solar energy strikes the deck at the rate of 1400 W on every square metre.

The steel plate of the deck is 0.010 m thick.

Steel has a density of 7800 kg / m^3 and a specific heat capacity of 450 J / (kg °C).

13% of the solar energy striking the deck is absorbed and the rest is reflected.

Using these figures, calculate

1. how many joules of solar energy are absorbed by 1.0 m^2 of the deck in 1.0 s,

number of joules = ... [1]

2. the mass of 1.0 m^2 of deck,

mass = ... [2]

3. the rate of rise in temperature of the deck, stating the equation you use.

rate of rise = ... °C / s [3]

[Total: 9]

Specific heat capacity Click for more variations

STEM | Exam Builder

8 **(a)** heat/energy to raise/change temperature M1
of 1 kg/g/unit mass through 1°C/1K/unit temperature A1

(b) **(i)** darker colours absorb more OR lighter/shiny colours absorb less B1

(ii) **1.** 182 B1
2. (mass of $1m^2$ =) volume × density OR $D = M/V$ OR (1 ×) 0.01 × 7800 C1
78 kg A1
3. $Q = mc\theta$ B1
182 = 78 × 450 × θ (e.c.f. from **1**,**2**) C1
0.00519 °C/s OR 5.19×10^{-3} °C/s (e.c.f. from **1**,**2**) A1

[Total: 9]

STEM | Exam Builder

9 **(a)** Define specific heat capacity.

.....

..... [2]

(b) A bowl contains 500 cm^3 of water at a temperature of 5.0 °C. The bowl of water is placed in a freezer for several hours. When the bowl is removed from the freezer, it contains ice at a temperature of –18.0 °C. The density of water is 1000 kg/m^3.

(i) Calculate the mass of water in the bowl when it is placed in the freezer.

mass = ... [2]

(ii) The specific heat capacity of water is 4200 J/(kg °C). The specific heat capacity of ice is 2100 J/(kg °C). The specific latent heat of fusion of water is 3.3×10^5 J/kg.

Calculate the energy given out as the water cools from 5.0 °C to ice at –18.0 °C.

energy = ... [5]

[Total: 9]

Specific heat capacity Click for more variations

STEM | Exam Builder

9(a)	energy required to raise the temperature of 1 kg / 1 g / unit mass of a substance by 1 °C / unit temperature	**A2**
	energy required to raise the temperature of a substance by 1 °C	C1
9(b)(i)	0.50 kg	**A2**
	$\rho = m/V$ in any form	C1
9(b)(ii)	190 000J / 1.9×10^5 J / 190 kJ	**A5**
	(E=) $mc\Delta T$ in any form	C1
	(E=) mL in any form	C1
	Use of c = 4200 (J / kg °C) AND ΔT = 5	C1
	Use of c = 2100 AND ΔT = 18	C1

10 **(a)** Three identical dishes, A, B and C, contain an equal volume of water.

Dish A is outside in sunlight and experiences no wind during the day. Dish B is outside in sunlight and experiences a strong wind during the day. Dish C is in a dark room.

Water evaporates from each dish. After 12 hours, a student measures the volume of water in each dish. Dish C contains the largest volume of water and dish B contains the smallest volume of water.

Explain, in terms of particles, why the three dishes have different volumes of water.

.....

.....

.....

.....

.....

.....

..... [4]

(b) Define specific latent heat of vaporisation.

.....

.....

..... [2]

STEM | Exam Builder

(c) Fig. 5.1 shows an insulating beaker, crushed ice, an immersion heater and a thermometer.

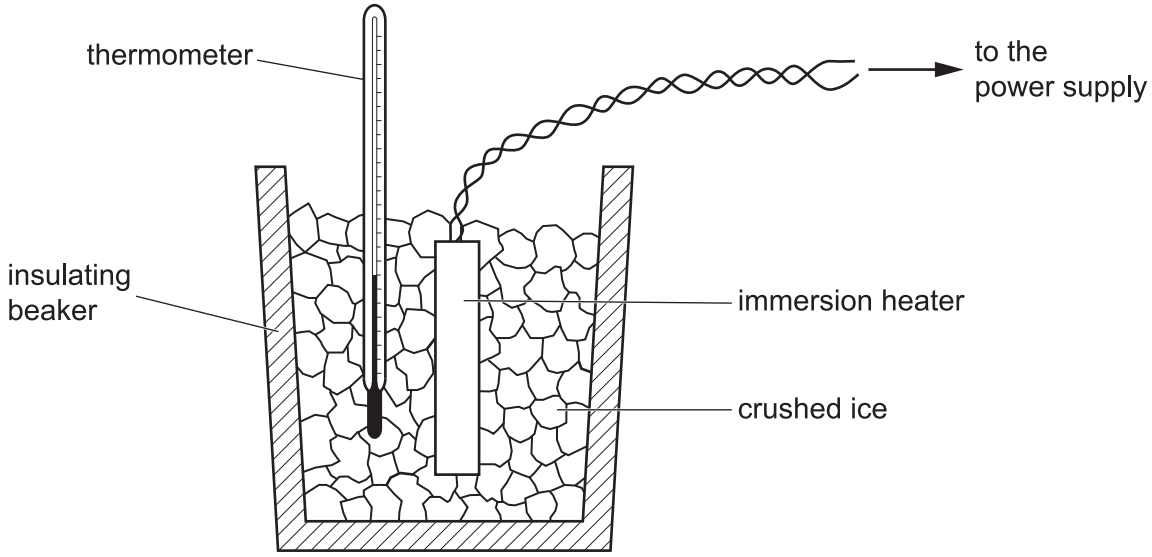


Fig. 5.1

The initial temperature of the ice is –60 °C.
The immersion heater is switched on and the temperature is recorded at equal intervals of time.
Fig. 5.2 shows the temperature–time graph.

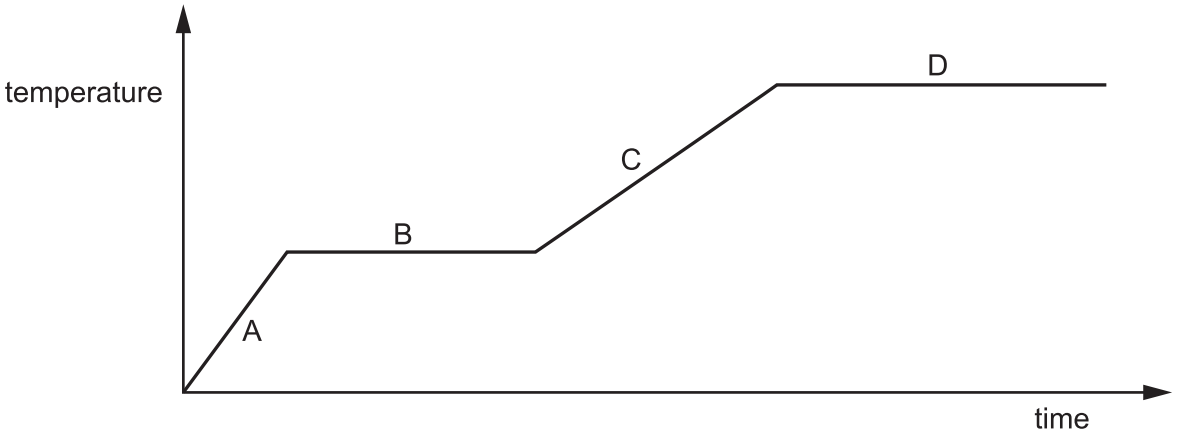


Fig. 5.2

Describe what occurs in each of the sections A, B, C and D.

A .....

B .....

C .....

D .....

[3]

[Total: 9]

Melting, boiling and evaporation Click for more variations

STEM Exam Builder

10(a)	energy from the Sun transfers to / is absorbed by (water) molecules, (so KE of (water) molecules increases)	**B1**
	molecules with high(er) energy / KE / fast(er) moving molecules escape (from the surface)	**B1**
	wind removes molecules when they have left the surface (so they do not re-enter the liquid)	**B1**
	any **one** from: • wind increases the rate of evaporation • (absorption of) energy from the Sun increases the rate of evaporation • least / less water evaporates / lower rate of evaporation from dish C • most / more water evaporates / higher rate of evaporation from dish B	**B1**
10(b)	energy to change 1 kg / unit mass from liquid to gas / gas to liquid (without changing its temperature)	**A2**
	energy to change from liquid to gas / gas to liquid **OR** energy to change state of 1 kg	C1
10(c)	A: temperature (of solid / ice) increases **AND** C: temperature (of liquid / water) increases	**B1**
	B: solid / ice changes to liquid / water **OR** solid / ice melts (at constant temperature)	**B1**
	D: liquid / water changes to gas / steam **OR** liquid / water boils (at constant temperature)	**B1**

STEM | Exam Builder