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

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Conduction, convection and radiation

Time allowed: 1 hour 10 minutes

Subject code **0625**

Physics

Questions from Paper 3, Paper 4 and Paper 6

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

Total marks

/ 69

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 69 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

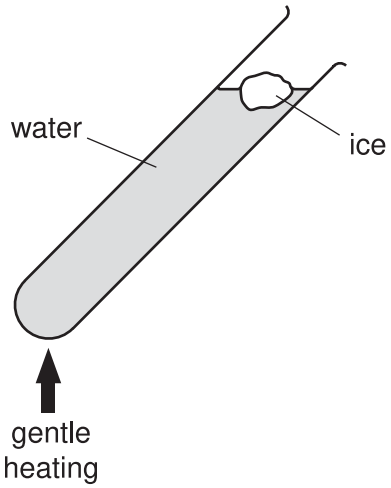
Advice

- 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.

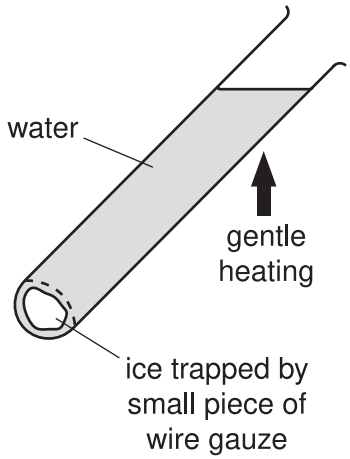
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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Fig. 6.1 shows two experiments to investigate energy transfer in water.



Experiment 1
Cold water is gently heated at the bottom. The ice at the top melts before the water boils.



Experiment 2
Cold water is gently heated at the top. The ice trapped at the bottom remains solid, even when the water at the top begins to boil.

Fig. 6.1

(a) Name the process by which thermal (heat) energy travels through the glass.

..... [1]

(b) **(i)** Name the principal process in Experiment 1 which takes the energy from the water at the bottom to the ice at the top.

..... [1]

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(ii) Describe how the process in **(b)(i)** occurs.

.....

.....

.....

.....

..... [2]

(c) Suggest two reasons why the ice in Experiment 2 does not melt, even when the water at the top begins to boil.

1. .....

.....

2. .....

..... [2]

[Total: 6]

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1 **(a)** conduction B1

(b) **(i)** convection B1

(ii) hot water expands OR hot water less dense B1
hot water rises (ignore anything about cold water falling) B1

(c) convection cannot occur B1
water is a poor conductor B1

[Total: 6]

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2 **(a)** Fig. 4.1 shows a pan on a hotplate. The hotplate heats the pan and the water.

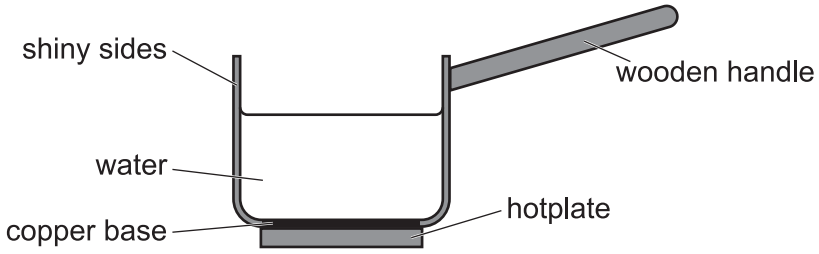


Fig. 4.1

Use your ideas about thermal energy transfer to explain why the pan has:

(i) a wooden handle

..... [1]

(ii) shiny sides

.....

..... [2]

(iii) a copper base.

..... [1]

(b) Fig. 4.2 shows a heater for warming a room. When there is hot water in the heater, thermal energy transfers from the water to the room.

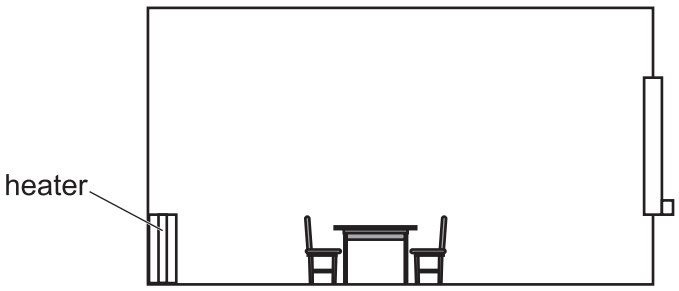


Fig. 4.2

Explain how thermal energy from the heater warms the entire room. Use your ideas about the density of air. You may draw on Fig. 4.2.

.....

.....

.....

..... [4]

[Total: 8]

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2(a)(i)	reduces heat transfer (to handle) OR wood is an insulator	**B1**
2(a)(ii)	poor / worst emitter (of heat)	**B1**
	(of) infrared / radiation	**B1**
2(a)(iii)	allows heat transfer (to water) OR (good) conductor (of heat)	**B1**
2(b)	any **four** from**:** conduction (through metal of heater) air particles gain kinetic energy / KE air particles move further apart hot air becomes less dense hot / less dense air rises OR cold / denser air falls idea of convection current	**B4**

3 **(a)** Fig. 6.1 shows an electric kettle containing cold water.

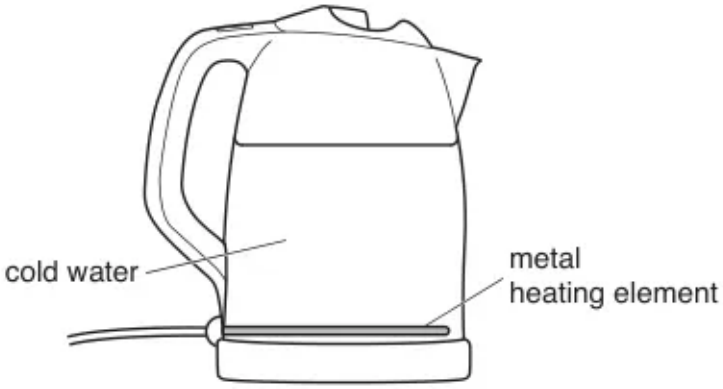


Fig. 6.1

The metal heating element heats the water.

Explain how thermal energy from the heating element is transferred to all the water in the kettle.

.....

.....

.....

.....

.....

..... [4]

(b) Fig. 6.2 shows two similar metal cans. The only difference is the surface. Can A has a dull black surface and can B has a shiny white surface.

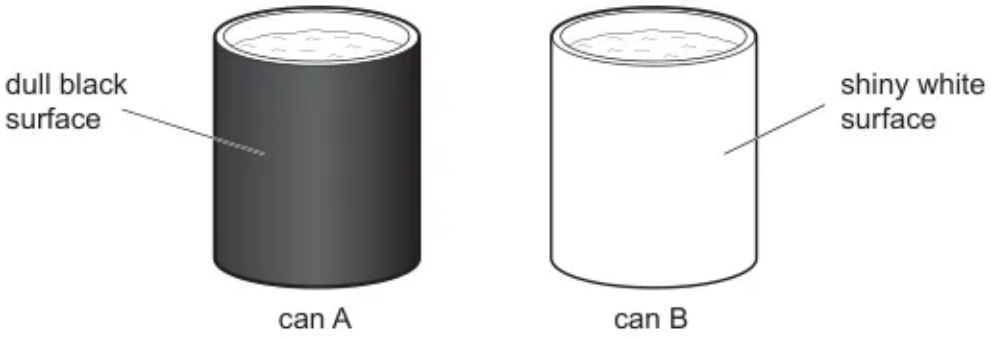


Fig. 6.2

(i) A student fills each can with hot water. The initial temperature of the water is 85 °C.

The student records the temperature of the water in each can every 30 seconds for 10 minutes.

Suggest which can of water will cool more quickly. Give a reason for your answer.

suggestion .....

reason .....

.....

[2]

(ii) Suggest and explain **two** changes to can B that reduce thermal energy loss to the surroundings.

change 1 .....

.....

.....

change 2 .....

.....

.....

[4]

[Total: 10]

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3(a)	conduction from the element to the water	**B1**
	convection	**B1**
	warmer water less dense (than colder water) or ra	**B1**
	warm water rises / cool water falls	**B1**
3(b)(i)	dull black / can A	**M1**
	(dull black) better radiator / good radiator better emitter / gives out more radiant heat / emits more infra-red / loses more energy by radiation	**A1**
3(b)(ii)	Any **two** of following pairs: lag / wrap in (named) insulator / cotton wool / polystyrene reduces heat lost by conduction cover in foil reduces heat lost by radiation add lid reduces heat loss by convection / evaporation	**B4**

4 On a sunny day, the temperatures of a black tarmac road and the air above the road increase.

(a) Explain why the surface temperature of the tarmac increases.

.....

.....

..... [2]

(b) State the method of thermal energy transfer from the tarmac to the air **immediately** above the road.

..... [1]

(c) State the main method of thermal energy transfer from the air immediately above the road to the rest of the air.

..... [1]

(d) Explain why the surface temperature of the tarmac is higher than the surrounding air temperature.

.....

.....

..... [2]

[Total: 6]

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4(a)	(tarmac / it) absorbs infrared radiation (emitted from the Sun)	**A2**
	(tarmac / it) absorbs radiation / infrared (emitted from the Sun)	C1
4(b)	conduction	**B1**
4(c)	convection	**B1**
4(d)	*any **two** from:* 1 black / tarmac is a better absorber (of radiation) than air 2 tarmac is a poor emitter (at low / this temperature) 3 thin layer of tarmac / very large volume / column of air above road	**B2**

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5 Fig. 5.1 shows two containers, each filled with hot water.

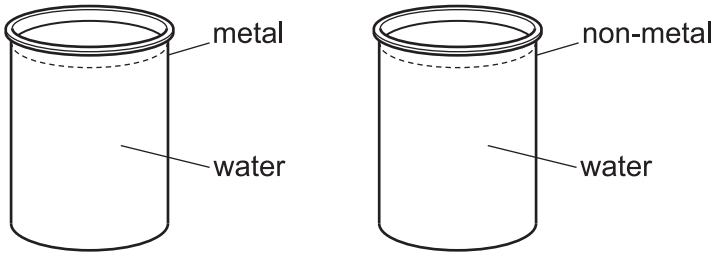


Fig. 5.1

The outer surface of the metal container is hot.

(a) Explain how electrons transfer thermal energy through the metal of the container.

.....

.....

.....

..... [3]

(b) The outer surface of the non-metal container is much cooler than the outer surface of the metal container.

Explain why a non-metal conducts thermal energy less well than a metal.

.....

..... [1]

(c) Explain, in terms of particles, why gases are poor thermal conductors compared to non-metal solids.

.....

.....

..... [2]

[Total: 6]

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

5(a)	any **three** from: • (metals contain) delocalised / free / mobile electrons • (delocalised electrons) gain energy (from lattice vibrations of the atoms nearest to the hot water) • (delocalised) electrons move through the metal (lattice) • collisions between the (delocalised) electrons and (remote) ions / atoms (transfers thermal energy to all parts of the metal container)	**B3**
5(b)	no delocalised / free electrons	**B1**
5(c)	particles are further / far apart	**B1**
	fewer particle collisions (to transfer energy) **OR** no lattice vibrations (to transfer energy)	**B1**

6 Fig. 5.1 shows a cross-section of the inside of a vacuum flask containing a cold liquid. The walls of the vacuum flask are made of glass.

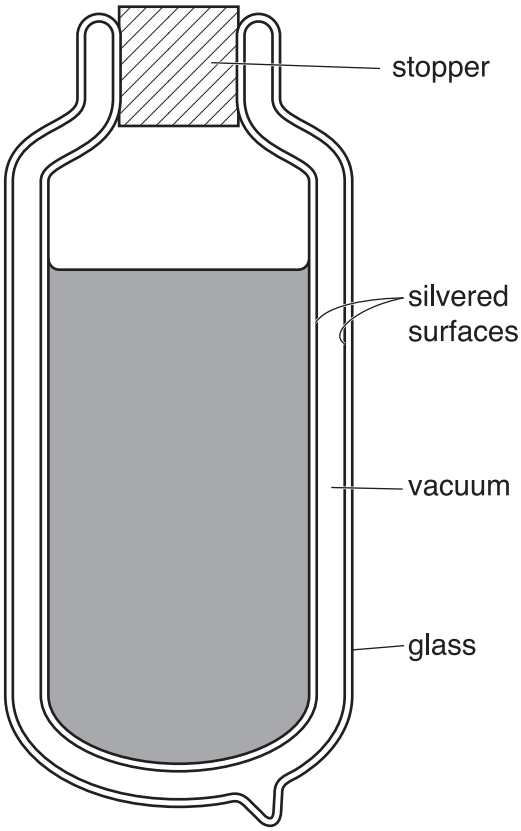


Fig. 5.1

(a) The vacuum flask is being used to keep a liquid cool on a hot day.

Explain how the labelled features of the vacuum flask keep the liquid cool by reducing thermal energy transfer. Include the names of the processes involved.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Suggest a suitable material for the stopper.

..... [1]

[Total: 6]

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6(a)	any mention of radiation/infra-red radiation wrt silvered surfaces	**B1**
	silvered surfaces are poor emitters / poor absorbers / (good) reflectors	**B1**
	glass is a poor conductor OR glass reduces thermal energy / heat gain by conduction	**B1**
	vacuum prevents thermal energy / heat gain by conduction OR convection	**B1**
	stopper reduces thermal energy / heat gain by convection	**B1**
6(b)	any suitable insulator e.g. cork, plastic, rubber	**B1**

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7 **(a)** A machine delivers a hot drink in a plastic cup, which is uncomfortably hot to hold.

Fig. 5.1 shows the cup with the hot drink.

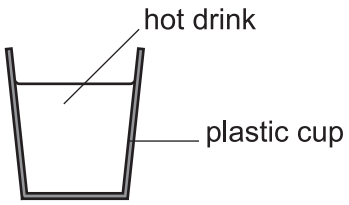


Fig. 5.1

Fig. 5.2a shows the cup with the hot drink and a holder for the sides of the cup.

Fig. 5.2b shows a cross-section through the holder. The holder is made from two strong paper cylinders separated by a wavy piece of strong paper to make air gaps.

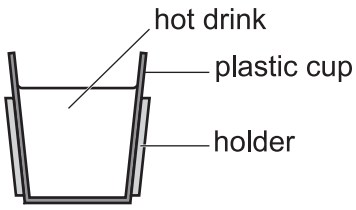


Fig. 5.2a

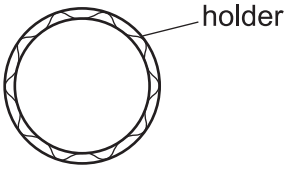


Fig. 5.2b

Explain how using the holder makes it more comfortable to hold the cup.

.....

.....

..... [3]

(b) A student carries out experiments on the cooling of the hot drink described in **(a)**, with and without the holder in place. He finds that the holder only reduces the rate of cooling slightly.

Suggest and explain another action that reduces the rate of cooling more effectively.

suggestion .....

explanation .....

.....

..... [3]

(c) State the method of thermal energy transfer from a star through the vacuum of space.

..... [1]

[Total: 7]

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7(a)	air good insulator / poor conductor	**B1**
	holder / it stops / reduces conduction OR no / less thermal energy conducted (to hand)	**B1**
	temperature (of outside of holder) lower (than cup) OR less energy to skin / hand / person	**B1**
7(b)	(put a) lid / cover (on cup)	**B1**
	mention of convection	**B1**
	less / no convection (from surface)	**B1**
	alternative route for last 2 m.p.s	
	mention of evaporation	**(B1)**
	less / no evaporation (from surface / container)	**(B1)**
7(c)	radiation	**B1**

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8 The Sun is a large sphere of high temperature gas. An extremely large quantity of energy radiates from the Sun into space every second.

(a) A process releases energy inside the Sun and its temperature stays high.

State the name of this process.

..... [1]

(b) A gardener stores water in a large, cylindrical metal drum. The drum is painted black and has no lid. On a bright, sunny day, the water evaporates quickly and the water level in the drum falls.

(i) Suggest how, by using a drum of a different shape, the gardener can reduce the quantity of water lost by evaporation.

.....

..... [1]

(ii) The gardener is told that, by painting the drum white, he can reduce the quantity of radiation absorbed and so reduce the rate of evaporation.

Describe an experiment to show that black surfaces are better absorbers of radiation than white surfaces. You may include a diagram.

.....

.....

.....

.....

..... [4]

[Total: 6]

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8	**(a)**	(nuclear) fusion	B1	[1]
	(b)	**(i)** smaller (surface) area (accept thinner, narrower(at top), ignore reference to lid)	B1	[1]
		(ii) apparatus: black object, white object, thermometer(s)/ball-bearing with wax/level of water in vessel	B1	
		source of heat e.g. Sun/radiant heater (condone light bulb/Bunsen burner)	B1	
		action: (fill cans with water and) measure temperature rise **or** wax melts **or** compare volumes of water	B1	
		observation: water in black can (better absorber) has greater temperature increase / wax melts first / less water note: emission experiment gains max. 2	B1	[4]
				[Total: 6]

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9 A metal container is used to cook food. The metal container has thick walls. Hot cooking oil at a temperature of 120 °C is poured into the container.

(a) The outside surface of the container gets hot. Some thermal energy passes through the metal because vibrating atoms in the metal collide with neighbouring atoms and transfer energy to them.

Explain how the rest of the thermal energy is conducted through the metal container to the outside surface by another process.

.....

.....

.....

..... [3]

(b) The outside surface of the container is brightly polished and shiny.

Explain how this reduces the power that needs to be supplied to keep the oil at the correct temperature.

.....

.....

.....

.....

..... [3]

(c) The metal container is spherical. The spherical container has a smaller surface area than a long, thin container of the same volume.

Explain the advantage of using a spherical container.

.....

.....

..... [1]

[Total: 7]

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9(a)	electrons mentioned	**B1**
	electrons travel (a great distance) through the metal **or** (vibrating) atoms hit (free) electrons	**B1**
	electrons hit (distant) particles **or** transfer energy (to distant atoms)	**B1**
9(b)	shiny surfaces are poor emitters (of radiation)	**B1**
	infrared / radiation / mentioned	**B1**
	less energy lost **or** lost energy does not need to be supplied	**B1**
9(c)	less thermal energy emitted **or** less space for energy to be lost	**B1**

10 A student investigates the effect of insulation on the cooling of a liquid.

Plan an experiment which will enable her to investigate how changing the thickness of insulation surrounding a beaker affects the rate of cooling of hot water in the beaker.

The apparatus available includes:

- a glass beaker
- a supply of hot water
- a lid to fit the beaker
- strips of insulation which can be cut to size.

In your plan:

- list any additional apparatus needed
- explain briefly how to do the experiment, including the measurements to take so that the rate of cooling can be determined
- state the key variables to keep constant
- draw a table, or tables, with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

You may draw a diagram if it helps to explain your plan.

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[7]

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10	**MP1**	**apparatus:** thermometer and stopwatch	**1**
	MP2	**method:** measure independent variable measure initial and final temperatures measure time	**1**
	MP3	repeat for new value of independent variable	**1**
	MP4	**control variable:** one (explicitly stated) from: volume of water, initial temperature	**1**
	MP5	**table:** MUST be appropriate for method with: columns, with correct units, for independent and dependent variables any other quantity mentioned must have correct units	**1**
	MP6	**analysis:** compare readings in the table to see if change in insulation thickness produces change in (rate of) temperature change (owtte), plot line graph (with axes specified)	**1**
	MP7	**additional point** (one from)**:** at least 5 sets of data taken, repeat for each value of independent variable and take average correct description of how to calculate rate of cooling from results	**1**

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