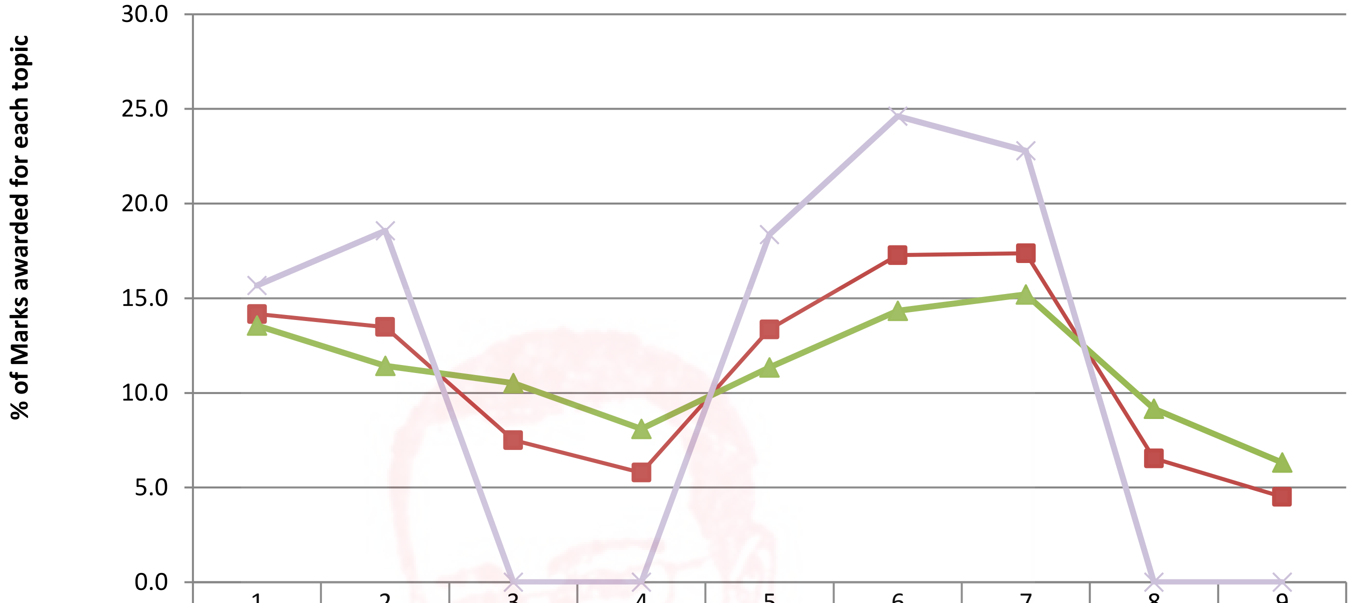
Name

iG Phx 5 EQ 14w to 02w P3 4Students 235marks

For these stats only papers 3 (which after 2016 became paper 4) and paper 6 were used to examine the topics.

iG Phx CIE 0625 PAPERS 3 and 6

Percentage of all WEIGHTED marks awarded for P3 & 6 each topic from s2002 to w2014 (red squares) and % of Paper 3 marks (green triangles) and paper 6 (purple crosses)

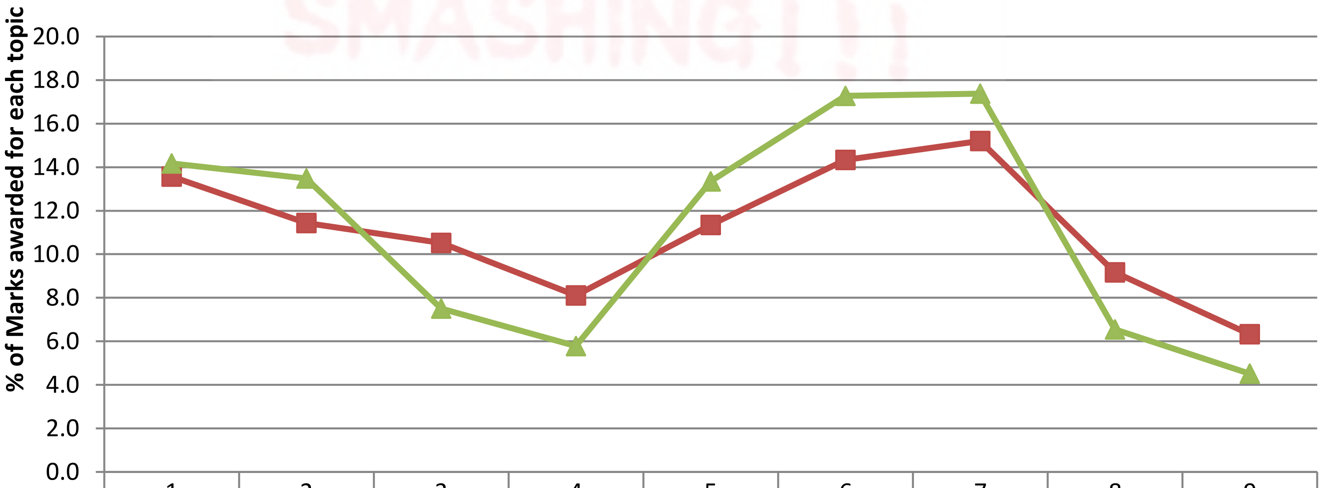


	1	2	3	4	5	6	7	8	9
PhxBoth P3&6	14.2	13.5	7.5	5.8	13.4	17.3	17.4	6.5	4.5
PhxP3	13.6	11.4	10.5	8.1	11.3	14.3	15.2	9.2	6.3
PhxP6	15.7	18.6	0.0	0.0	18.4	24.6	22.8	0.0	0.0

Papers 3 and 6 Topic Number

PAPER 3

Percentage of all marks awarded for each topic from s2002 to w2014 in Paper 3 (red squares) and marks per topic for papers 3 and 6 (green triangles)



	1	2	3	4	5	6	7	8	9
ALL P3 %	13.6	11.4	10.5	8.1	11.3	14.3	15.2	9.2	6.3
P3 & 6	14.2	13.5	7.5	5.8	13.4	17.3	17.4	6.5	4.5

Paper 3 Topic Number

Papers covered in this sample

	1st Paper	Last Paper	Marks/ paper	Theor. All Papers	Actual All Marks	Difference	Difference %	Weight per paper	Weight per mark
Paper 3	2002w	2014w	80	2000	2072	72	3.6	50	0.63
Paper 6	2002s	2015w	40	1120	1040	-80	-7.1	20	0.50

There are a few missing:

Got all Paper 31s (except 2014w Paper 31), and got 2014w 33

So papers in time zones 2 and 3 are not covered.

All topics ranked by frequency of marks in exams (P3 and 6 only)

Topic	PhxBoth P3&6	PhxP3	PhxP6
7	17.4	15.2	22.8
6	17.3	14.3	24.6
1	14.2	13.6	15.7
2	13.5	11.4	18.6
5	13.4	11.3	18.4
3	7.5	10.5	0.0
8	6.5	9.2	0.0
4	5.8	8.1	0.0
9	4.5	6.3	0.0

Other statistics that might be of interest:

	Topics:	1	2	3	4	5	6	7	8	9
P3/4 marks	2072	281	237	218	168	235	297	315	190	131
P3/4 %		13.6	11.4	10.5	8.1	11.3	14.3	15.2	9.2	6.3
P6	1040	163	193	0	0	191	256	237	0	0
P6 %		15.7	18.6	0.0	0.0	18.4	24.6	22.8	0.0	0.0
Total Marks (WIEGHTED)	1815	257	245	136	105	242	314	315	119	82
% of Marks (Weighted)	1815	14.2	13.5	7.5	5.8	13.4	17.3	17.4	6.5	4.5
# of Questions		63	64	35	16	63	74	70	26	20
Average marks per Q		**4.1**	**3.8**	**3.9**	**6.6**	**3.8**	**4.2**	**4.5**	**4.6**	**4.1**

Final note:

My iG and IB chemistry papers were broken down more carefully than these were, so there may be a mark or two in the wrong topic especially in topics 3 to 5, but if you learnt or taught these topics in sequence than you shouldn't have a problem with seeing material from an earlier topic.

Defining the Topics: Why not use the units given in the syllabus?

Artificial topics have been created for the physics syllabus by me so that each topic is roughly the same size. Topics go in syllabus order. I have decided to use the number of marks allocated in previous exams to each syllabus point to determine how many go into each topic.

1. General physics

Topic 1

1.1 Length and time
1.2 Motion
1.3 Mass and weight
1.4 Density

Topic 2

1.5 Forces
1.6 Momentum (Extended candidates only)

Topic 3

1.7 Energy, work and power
1.8 Pressure

2. Thermal physics

Topic 4

2.1 Simple kinetic molecular model of matter

Topic 5

2.2 Thermal properties and temperature
2.3 Thermal processes

3. Properties of waves, including light and sound

Topic 6

3.1 General wave properties
3.2 Light
3.3 Electromagnetic spectrum
3.4 Sound

4. Electricity and magnetism

Topic 7

4.1 Simple phenomena of magnetism
4.2 Electrical quantities
4.3 Electric circuits
4.4 Digital electronics (Extended candidates only)
4.5 Dangers of electricity

Topic 8

4.6 Electromagnetic effects

5. Atomic physics

Topic 9

5.1 The nuclear atom
5.2 Radioactivity

1 **(a)** Fig. 1.1 shows a liquid-in-glass thermometer.

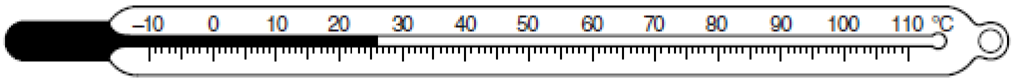


Fig. 1.1

(i) In the process of making the thermometer, the scale divisions were spaced equally.

What assumption was made about the liquid?

....

.... [1]

(ii) Suggest **two** changes to the thermometer that would require the spacing of the scale divisions to be larger.

1. ....

2. ....

[2]

(iii) As a result of the changes in **(ii)**, what other change is needed to enable the thermometer to be used for the same temperature range?

.... [1]

(b) The expansion of a liquid is an example of a physical property that may be used to measure temperature.

State **two** other physical properties that may also be used to measure temperature.

1. the .... of ....

2. the .... of ....

[2]

[Total: 6]

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Q# 2/ iG Phx/2014/s/Paper 31/ www.SmashingScience.org

7 **(a)** The following are three statements about boiling.

- A liquid boils at a fixed temperature.
- During boiling, vapour can form at any point within the liquid.
- Without a supply of thermal energy, boiling stops.

Complete the following equivalent statements about evaporation.

- A liquid evaporates at ....

  ....

- During evaporation ....

  ....

- Without a supply of thermal energy, evaporation ....

[3]

(b) A pan containing water boiling at 100 °C is standing on an electrically heated hot-plate. In 20 minutes, 0.075 kg of water is lost as steam. The specific latent heat of vaporisation of water is 2.25×10^6 J/kg.

(i) Calculate the energy used in converting 0.075 kg of boiling water to steam.

energy = ... [2]

Q# 3/ iG Phx/2013/w/Paper 31/ Q4 NOT with Q4b(i)
A car is moving with a kinetic energy of 1.2x10^05/J

4 **(a)** State the energy changes that take place when

(i) a cyclist rides down a hill without pedalling,

....

....

(ii) a cyclist pedals up a hill at a constant speed.

....

....
[3]

(b) A car of mass 940 kg is travelling at 16 m/s.

(i) Calculate the kinetic energy of the car.

kinetic energy = ... [2]

(ii) The car is brought to rest by applying the brakes.

The total mass of the brakes is 4.5 kg. The average specific heat capacity of the brake material is 520 J/(kg °C).

Calculate the rise in temperature of the brakes. Assume there is no loss of thermal energy from the brakes.

rise in temperature = ... [3]

[Total: 8]

5 One side of a copper sheet is highly polished and the other side is painted matt black.

The copper sheet is very hot and placed in a vertical position, as shown as in Fig. 5.1.

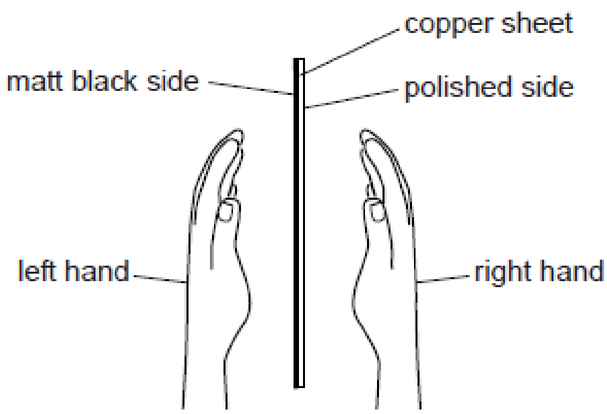

Fig. 5.1

A student places her hands at equal distances from the sheet, as shown in Fig. 5.1.

(a) Explain

(i) why her hands are not heated by **convection**,

....

.... [1]

(ii) why her hands are not heated by **conduction**.

....

.... [1]

(b) State and explain which hand gets hotter.

....

....

.... [2]

(c) It is suggested that one side of the copper sheet cools to a lower temperature than the other side.

Explain why this does not happen.

....

....

.... [2]

[Total: 6]

5 **(a)** On a hot day, sweat forms on the surface of a person's body and the sweat evaporates.

(b) The temperature of a person of mass 60 kg falls from 37.2 °C to 36.7 °C.

(i) Calculate the thermal energy lost from the body. The average specific heat capacity of the body is 4000 J / (kg °C).

thermal energy lost = ... [2]

(ii) The cooling of the body was entirely due to the evaporation of sweat.

Calculate the mass of sweat which evaporated. The specific latent heat of vaporisation of sweat is 2.4×10^6 J / kg.

mass = ... [2]

[Total: 7]

4 Fig. 4.1 shows a cross-section of a double-walled glass vacuum flask, containing a hot liquid. The surfaces of the two glass walls of the flask have shiny silvered coatings.

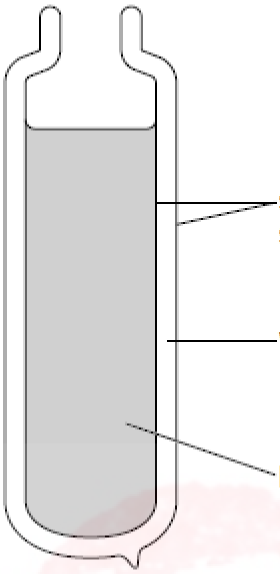

Fig. 4.1

(a) Explain

(i) why the rate of loss of thermal energy through the walls of the flask **by conduction** is very low,

....

....

....

....

(ii) why the rate of loss of thermal energy through the walls of the flask **by radiation** is very low.

....

....

....

....

[3]

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(b) Suggest, with reasons, what must be added to the flask shown in Fig. 4.1 in order to keep the liquid hot.

....

....

....

....

....[3]

[Total: 6]

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(b) Fig. 7.1 shows five vessels each made of the same metal and containing water.

Vessels A, B, C and D are identical in size and shape. Vessel E is shallower and wider. The temperature of the air surrounding each vessel is 20 °C.

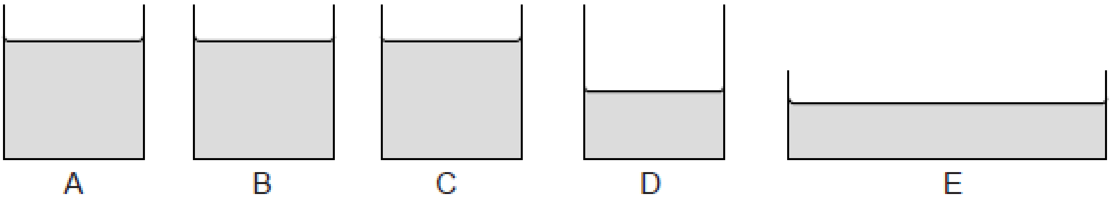

Fig. 7.1

The table shows details about each vessel and their contents.

vessel	outer surface	volume of water / cm^3	initial temperature of water / °C
A	dull	200	80
B	shiny	200	80
C	dull	200	95
D	dull	100	80
E	dull	200	80

The following questions are about the time taken for the temperature of the water in the vessels to fall by 10 °C from the initial temperature.

(i) Explain why the water in B takes longer to cool than the water in A.

....

.... [1]

(ii) Explain why the water in C cools more quickly than the water in A.

....

.... [1]

(iii) Explain why the water in D cools more quickly than the water in A.

....

.... [1]

(iv) Suggest **two** reasons why the water in E cools more quickly than the water in A.

1. ....

....

2. ....

....

[2]

[Total: 7]

6 **(a)** Define *specific latent heat of fusion.*

....

....

.... [1]

(b) **(i)** A tray of area 0.25 m^2, filled with ice to a depth of 12 mm, is removed from a refrigerator.

Calculate the mass of ice on the tray. The density of ice is 920 kg / m^3.

mass = ... [2]

(ii) Thermal energy from the Sun is falling on the ice at a rate of 250 W / m^2. The ice absorbs 60 % of this energy.

Calculate the energy absorbed in 1.0 s by the 0.25 m^2 area of ice on the tray.

energy = ... [2]

(iii) The ice is at its melting temperature.

Calculate the time taken for all the ice to melt. The specific latent heat of fusion of ice is 3.3×10^5 J / kg.

time = ... [3]

[Total: 8]

5 **(a)** Suggest

(i) an example of a change of state resulting from the removal of thermal energy from a quantity of material,

.... [1]

(ii) the effect of this change of state on the temperature of the material.

.... [1]

(b) Define the *thermal capacity* of a body.

....

....

.... [2]

(c) A polystyrene cup holds 250 g of water at 20 °C. In order to cool the water to make a cold drink, small pieces of ice at 0 °C are added until the water reaches 0 °C and no unmelted ice is present.

[specific heat capacity of water = 4.2 J / (g °C), specific latent heat of fusion of ice = 330 J / g]

Assume no thermal energy is lost or gained by the cup.

(i) Calculate the thermal energy lost by the water in cooling to 0 °C.

thermal energy lost = ... [2]

(ii) State the thermal energy gained by the ice in melting.

thermal energy gained = ... [1]

(iii) Calculate the mass of ice added.

mass of ice = ... [2]

[Total: 9]

6 Fig. 6.1 shows a glass flask full of water at 10 °C and sealed with a bung. A long glass tube passes through the bung into the water. The water level in the tube is at X.

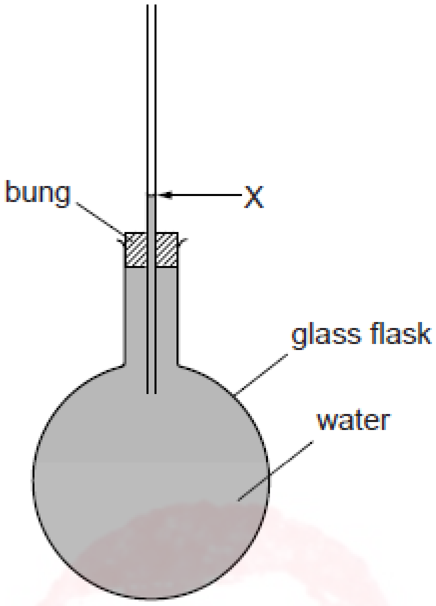

Fig. 6.1

When the flask is placed in hot water, the water level initially falls a little below X, and then rises some way above X.

(a) Suggest why

(i) the water level initially falls,

....

.... [2]

(ii) the water level then rises,

....

.... [2]

(iii) the rise is greater than the fall.

....

.... [1]

(b) Suggest a change to the apparatus that would make the fall and rise of the water level greater.

....

.... [1]

[Total: 6]

5 **(a)** Equal volumes of a gas held at constant pressure, a liquid and a solid undergo the same temperature rise.

(i) State which of the three, solid, liquid or gas,

1. expands the most, ...

2. expands the least. ....

(ii) Explain why the pressure of the gas must be kept constant for this comparison.

....

....[2]

(b) Fig. 5.1 shows an alcohol thermometer.

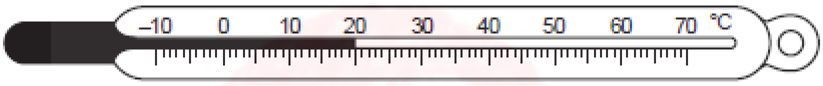

Fig. 5.1

(i) State two properties of alcohol which make it suitable for use in a thermometer.

1. ....

....

2. ....

....[2]

(ii) State **two** changes to the design of this thermometer which would make it more sensitive.

1. ....

....

2. ....

....[2]

(c) Explain why it is an advantage for the glass surrounding the alcohol in the bulb of the thermometer to be very thin.

....

....[1]

[Total: 7]

11 A mass of 0.36 kg of a certain substance is in the solid state in a well-insulated container. The substance is heated at the rate of 1.2×10^4 J / minute.

2.0 minutes after starting the heating, the substance is all at the same temperature, and it starts to melt.

11.0 minutes after starting the heating, the substance finishes melting and the temperature starts to rise again.

(a) Calculate the specific latent heat of the substance.

specific latent heat = ...[3]

(b) **(i)** After 11 minutes of heating, when the temperature starts rising again, in which state is the substance?

....[1]

(ii) Describe what happens to the molecules as thermal energy is supplied to them in this state.

....

....

....

....[2]

[Total: 6]

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4 A student in a laboratory uses the apparatus shown in Fig. 4.1 to determine the specific heat capacity of aluminium.

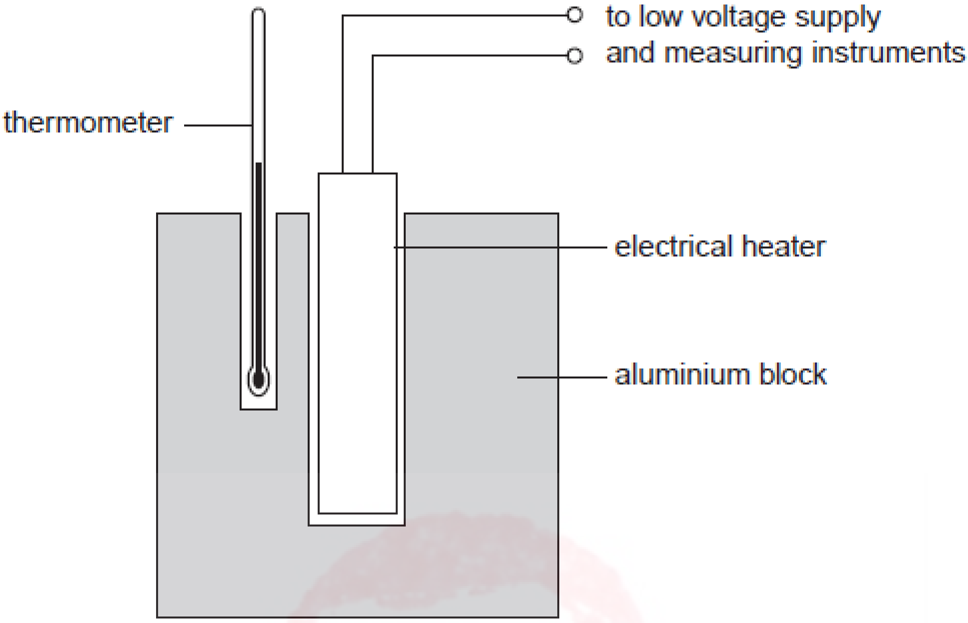

Fig. 4.1

The readings obtained in the experiment are given below.

mass of aluminium block = 0.930 kg

initial temperature of block = 13.1 °C

final temperature of block = 41.3 °C

electrical energy supplied = 23 800 J

(a) Define *specific heat capacity*.

....

.... [2]

(b) Use the readings above to calculate the specific heat capacity of aluminium.

State the equation you use.

specific heat capacity = ... [3]

(c) Because the student knows it is good scientific practice to repeat readings, after a short time he carries out the experiment again, supplying the same quantity of electrical energy.

This time the temperature readings are:

initial temperature of block = 41.0 °C

final temperature of block = 62.1 °C

(i) Use these figures to calculate a second value for the specific heat capacity of aluminium.

specific heat capacity = ... [1]

(ii) The student did not make any mistakes when taking the readings.

Suggest why the second value for the specific heat capacity of the aluminium is greater than the first.

....

.... [2]

(d) Suggest two ways of improving the experiment in order to give as accurate a result as possible.

1. ....

....

2. ....

.... [2]

[Total: 10]

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5 A certain substance is in the solid state at a temperature of –36 °C. It is heated at a constant rate for 32 minutes. The record of its temperature is given in Fig. 5.1.

time / min	0	1	2	6	10	14	18	22	24	26	28	30	32
temperature / °C	–36	–16	–9	–9	–9	–9	32	75	101	121	121	121	121

Fig. 5.1

(a) State what is meant by the term *latent heat*.

....

.... [2]

(b) State a time at which the energy is being supplied as latent heat of fusion.

.... [1]

(c) Explain the energy changes undergone by the molecules of a substance during the period when latent heat of vaporisation is being supplied.

....

....

.... [2]

(d) **(i)** The rate of heating is 2.0 kW.

Calculate how much energy is supplied to the substance during the period 18 – 22 minutes.

energy supplied = ... [2]

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(ii) The specific heat capacity of the substance is 1760 J/(kg °C).

Use the information in the table for the period 18 – 22 minutes to calculate the mass of the substance being heated.

mass heated = ... [3]

[Total: 10]

4 **(a)** Four identical metal plates, at the same temperature, are laid side by side on the ground. The rays from the Sun fall on the plates.

One plate has a matt black surface.

One plate has a shiny black surface.

One plate has a matt silver surface.

One plate has a shiny silver surface.

State which plate has the fastest-rising temperature when the sunlight first falls on the plates.

.... [1]

(b) The apparatus shown in Fig. 4.1 is known as Leslie's Differential Air Thermometer.

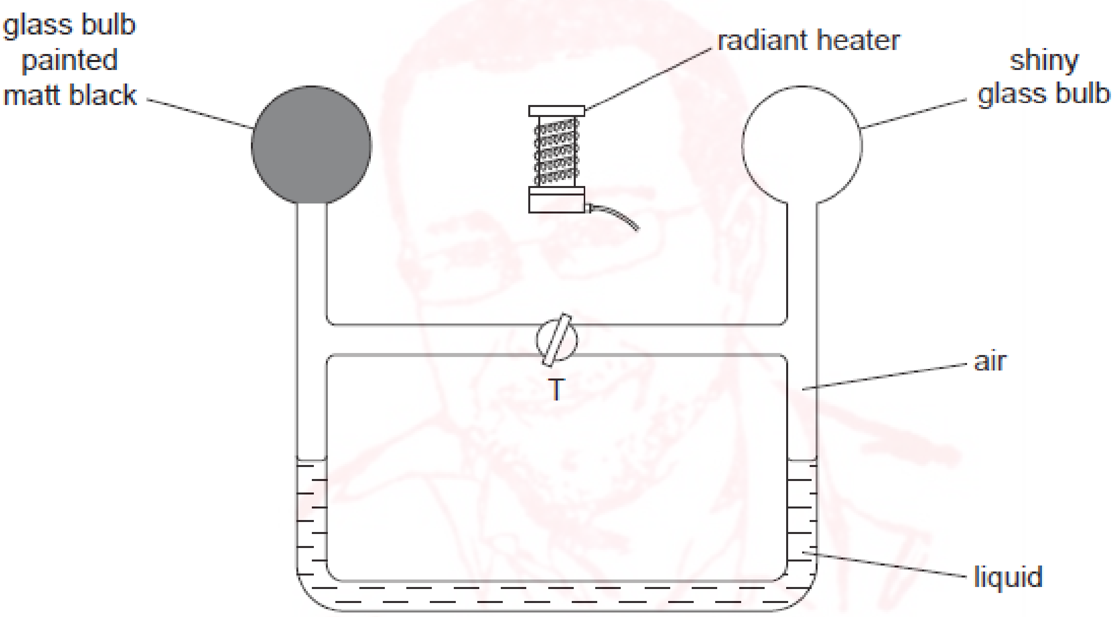

Fig. 4.1

The heater is switched off. Tap T is opened so that the air on the two sides of T has the same pressure. Tap T is then closed.

(i) The heater is switched on. On Fig. 4.1, mark clearly where the two liquid levels might be a short time later. [1]

(ii) Explain your answer to **(b)(i)**.

....

....

.... [2]

[Total: 4]

9 **(a)** State what is meant by *specific heat capacity*.

....

.... [2]

(b) Water has a very high specific heat capacity.

Suggest why this might be a disadvantage when using water for cooking.

....

.... [1]

(c) Fig. 9.1 illustrates an experiment to measure the specific heat capacity of some metal.

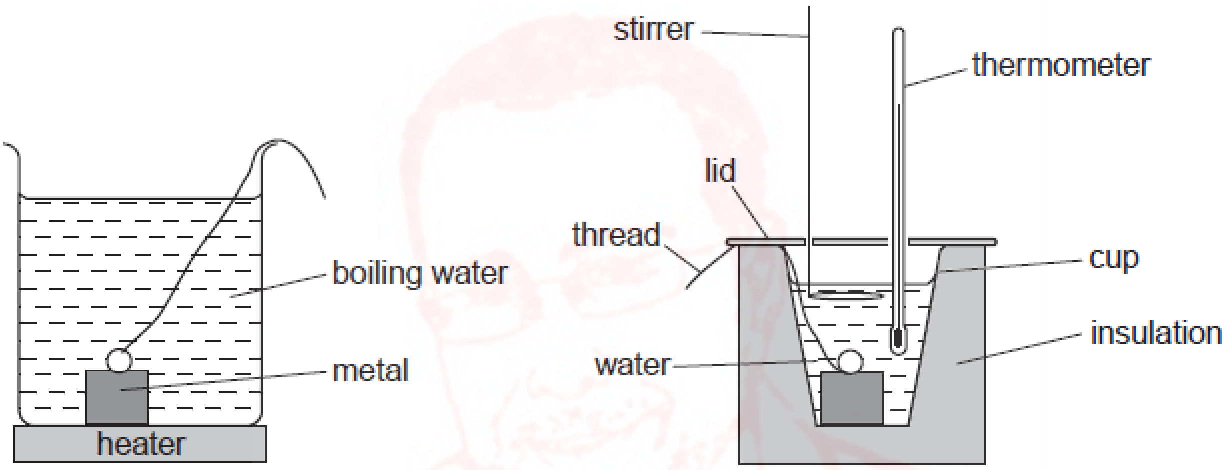

Fig. 9.1

The piece of metal is heated in boiling water until it has reached the temperature of the water. It is then transferred rapidly to some water in a well-insulated cup. A very sensitive thermometer is used to measure the initial and final temperatures of the water in the cup.

specific heat capacity of water = 4200 J / (kg K)

The readings from the experiment are as follows.

mass of metal = 0.050 kg
mass of water in cup = 0.200 kg
initial temperature of water in cup = 21.1 °C
final temperature of water in cup = 22.9 °C

(i) Calculate the temperature rise of the water in the cup and the temperature fall of the piece of metal.

temperature rise of water = ...

temperature fall of metal = ...
[1]

(ii) Calculate the thermal energy gained by the water in the cup. State the equation that you use.

thermal energy gained = ... [3]

(iii) Assume that only the water gained thermal energy from the piece of metal.

Making use of your answers to **(c)(i)** and **(c)(ii)**, calculate the value of the specific heat capacity of the metal. Give your answer to 3 significant figures.

specific heat capacity = ... [2]

(iv) Suggest one reason why the experiment might not have given a correct value for the specific heat capacity of the metal.

....

.... [1]

[Total: 10]

2 **(a)** A certain volume of water at room temperature and the same volume of ice in a freezer are each heated through the same temperature rise.

Which of them will have the greater expansion, and why?

Which? ....

Why? .... [1]

(b) For strength, concrete pillars are usually reinforced with metal rods, which are embedded in the concrete before it sets.

The list below shows how much a length of 1 m of each material expands when the temperature rises by 1 °C.

aluminium	0.03 mm
concrete	0.01 mm
steel	0.01 mm

Use this information to decide which metal should be used to reinforce concrete, why it is suitable, and why the other metal is not suitable.

Which metal should be used? ....

Why is it suitable? ....

Why is the other metal unsuitable? ....

.... [3]

[Total: 4]

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5 Fig. 5.1 shows apparatus that could be used to determine the specific latent heat of fusion of ice.

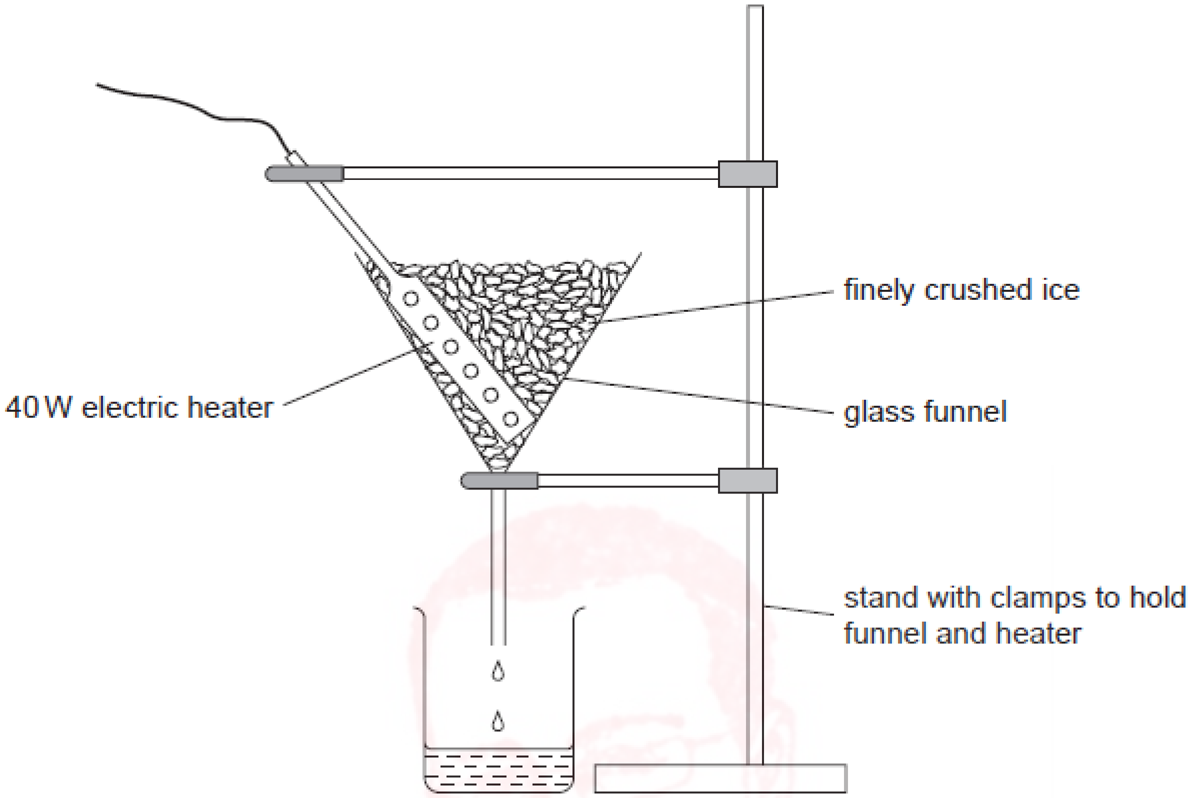

Fig. 5.1

(a) In order to obtain as accurate a result as possible, state why it is necessary to

(i) wait until water is dripping into the beaker at a constant rate before taking readings,

....

.... [1]

(ii) use finely crushed ice rather than large pieces.

....

.... [1]

(b) The power of the heater and the time for which water is collected are known. Write down all the other readings that are needed to obtain a value for the specific latent heat of fusion of ice.

....

.... [2]

(c) Using a 40 W heater, 16.3 g of ice is melted in 2.0 minutes. The heater is then switched off. In a further 2.0 minutes, 2.1 g of ice is melted.

Calculate the value of the specific latent heat of fusion of ice from these results.

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

[Total: 8]

5 **(a)** Explain, in terms of molecules, how thermal expansion takes place in a solid and in a gas.

solid ....

....

....

....

....

gas ....

....

....

....

.... [4]

(b) Complete Table 5.1 to show the relative expansion of equal volumes of liquids, gases and solids.

Choose words from

much less, **slightly less**, **slightly more** and **much more**. [2]

state of matter	expansion compared to solids, for the same temperature rise
liquids	
gases	

Table 5.1

(c) Alcohol is often used in thermometers.

State one property of alcohol that makes it suitable for use in thermometers.

....

.... [1]

[Total: 7]

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4 Fig. 4.1 shows a sealed steel cylinder filled with high pressure steam.

Fig. 4.1

Fig. 4.2 shows the same cylinder much later when all the steam has condensed.

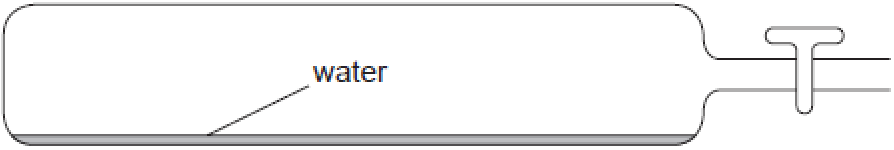

Fig. 4.2

(c) When all the steam has condensed, 75 g of water is in the cylinder.

Under these high pressure conditions, the specific latent heat of vaporisation of steam is 3200 J / g.

Calculate the heat lost by the steam as it condenses.

heat = ... [2]

5 Fig. 5.1 shows some apparatus which is to be used to compare the emission of infra-red radiation from four differently painted surfaces.

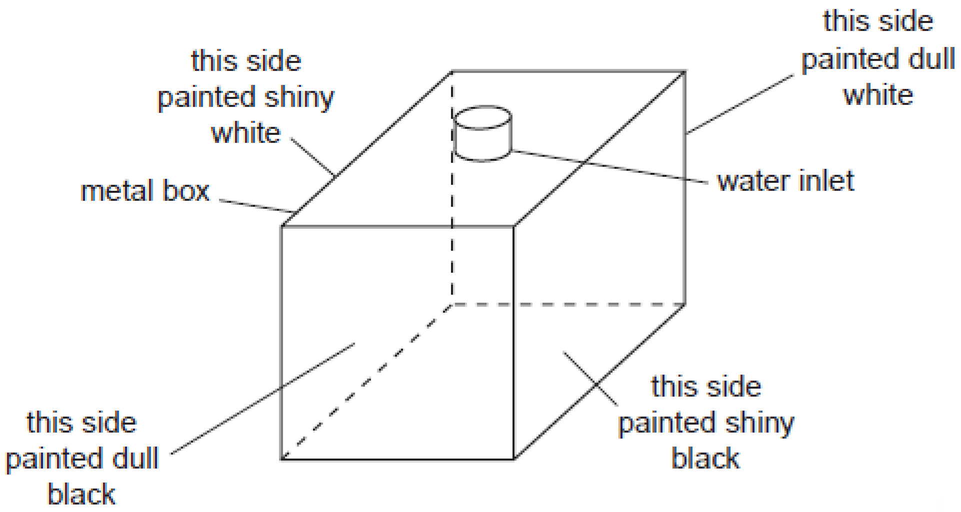

Fig. 5.1

Near the centre of each side is an infra-red detector. The four detectors are identical.

A supply of very hot water is available.

(a) Describe how you would use this apparatus to compare the infra-red radiation from the four surfaces.

....

....

.... [3]

(b) Suggest which surface will be the best emitter and which will be the worst emitter.

best emitter ....

worst emitter .... [1]

(c) The infra-red detectors are made from thermocouples soldered to blackened metal plates. These are connected to galvanometers.

In the space below, draw a labelled diagram of a thermocouple. [2]

[Total: 6]

4 Fig. 4.1 shows a student's attempt to estimate the specific latent heat of fusion of ice by adding ice at 0 °C to water at 20 °C. The water is stirred continuously as ice is slowly added until the temperature of the water is 0 °C and all the added ice has melted.

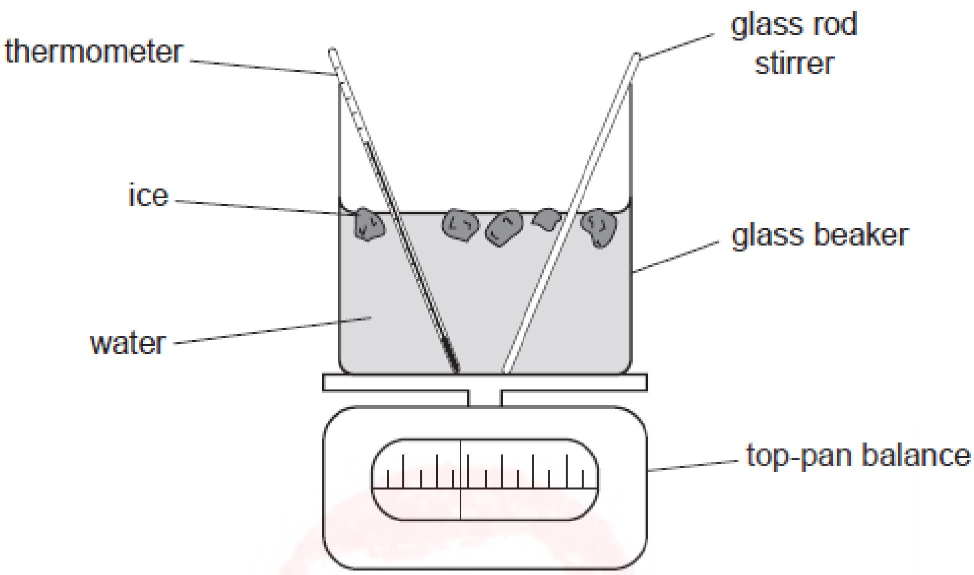

Fig. 4.1

(a) Three mass readings are taken. A description of the first reading is given.

Write down descriptions of the other two.

reading 1 the mass of the beaker + stirrer + thermometer

reading 2 ....

reading 3 .... [2]

(b) Write down word equations which the student could use to find

(i) the heat lost by the water as it cools from 20 °C to 0 °C,

.... [1]

(ii) the heat gained by the melting ice.

.... [1]

(c) The student calculates that the water loses 12 800 J and that the mass of ice melted is 30 g.

Calculate a value for the specific latent heat of fusion of ice.

specific latent heat of fusion = ... [2]

(d) Suggest two reasons why this value is only an approximate value.

Reason 1 ....

....

Reason 2 ....

.... [2]

[Total: 8]

5 Fig. 5.1 shows some apparatus designed to compare the ability of two surfaces to absorb infra-red radiation.

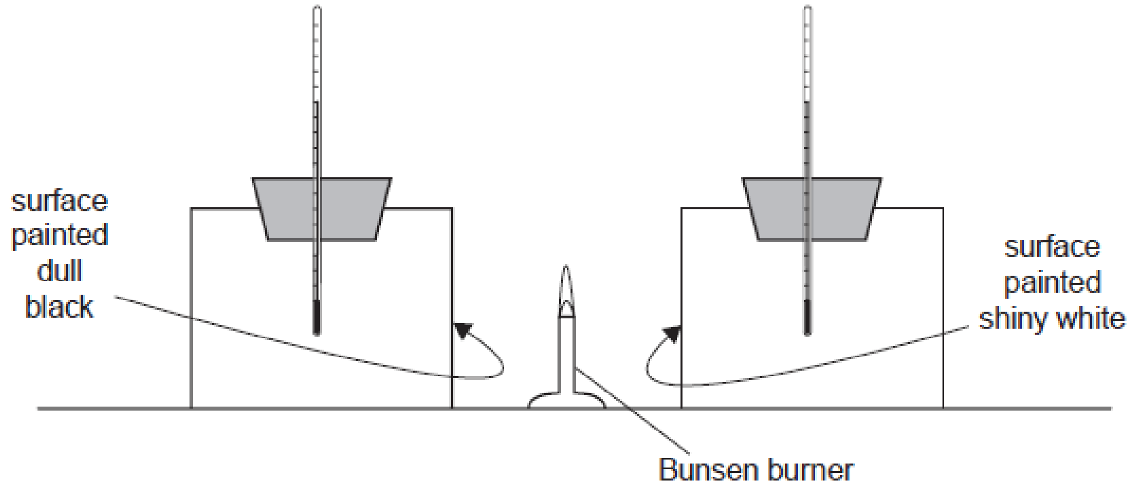

Fig. 5.1

The containers, which are identical, are painted on the outside. One is dull black, the other is shiny white. Both are filled with water, initially at the same temperature.

(a) **(i)** Describe how you would use the apparatus to compare the abilities of the two surfaces to absorb infra-red radiation.

....

....

....

.... [2]

(ii) State the result that you would expect.

.... [1]

(b) The thermometers used have high sensitivity and linear scales.

(i) State what is meant by *high sensitivity*.

....

.... [1]

(ii) Explain why a high sensitivity is important for this experiment.

....

.... [1]

(iii) State what is meant by a *linear scale*.

....

.... [1]

[Total: 6]

4 Some water is heated electrically in a glass beaker in an experiment to find the specific heat capacity of water. The temperature of the water is taken at regular intervals.

The temperature-time graph for this heating is shown in Fig. 4.1.

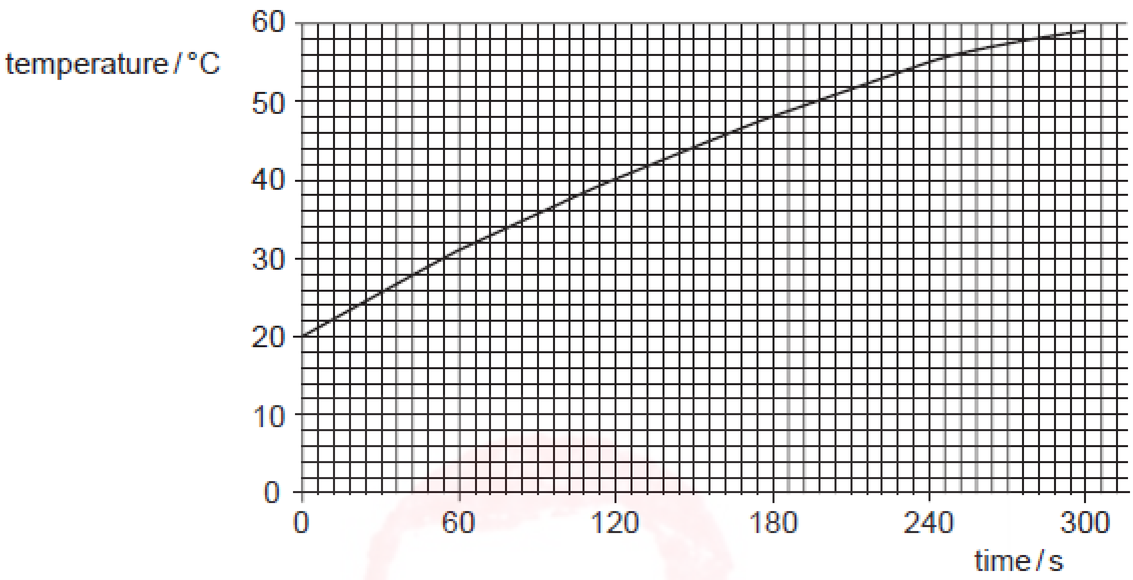

Fig. 4.1

(a) **(i)** Use the graph to find

1. the temperature rise in the first 120 s,

....

2. the temperature rise in the second 120 s interval.

....

(ii) Explain why these values are different.

....

....

[2]

(b) The experiment is repeated in an insulated beaker. This time, the temperature of the water increases from 20 °C to 60 °C in 210 s. The beaker contains 75 g of water. The power of the heater is 60 W. Calculate the specific heat capacity of water.

specific heat capacity = ... [4]

(c) In order to measure the temperature during the heating, a thermocouple is used.
Draw a labelled diagram of a thermocouple connected to measure temperature.

[2]

5 **(a)** Fig. 5.1 shows a copper rod AB being heated at one end.

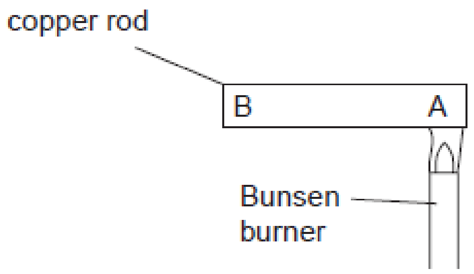

Fig. 5.1

(i) Name the process by which heat moves from A to B.

....

(ii) By reference to the behaviour of the particles of copper along AB, state how this process happens.

....

....

[3]

(b) Give an account of an experiment that is designed to show which of four surfaces will absorb most heat radiation.
The four surfaces are all the same metal, but one is a polished black surface, one is a polished silver surface, one is a dull black surface and the fourth one is painted white.
Give your answer under the headings below.

labelled diagram of the apparatus

readings to be taken

one precaution to try to achieve a fair comparison between the various surfaces

....

....[3]

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4 **(a)** State two differences between evaporation of water and boiling of water.

1. ....

2. ....[2]

(b) The specific latent heat of vaporisation of water is 2260 kJ / kg.
Explain why this energy is needed to boil water and why the temperature of the water does not change during the boiling.

....

....

....

....[3]

(c) A laboratory determination of the specific latent heat of vaporisation of water uses a 120 W heater to keep water boiling at its boiling point. Water is turned into steam at the rate of 0.050 g / s.
Calculate the value of the specific latent heat of vaporisation obtained from this experiment. Show your working.

specific latent heat of vaporisation = ...[3]

4 Fig. 4.1 shows apparatus that could be used to measure the specific latent heat of ice.

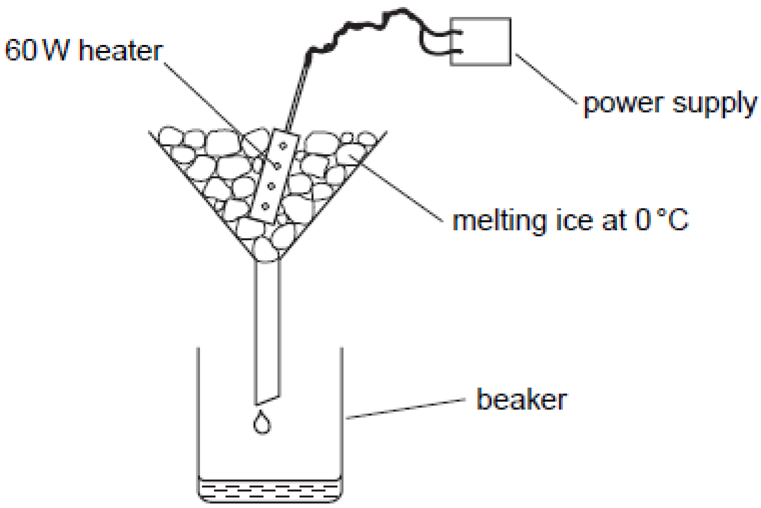

Fig. 4.1

(a) Describe how you would use the apparatus. You may assume that ice at 0 °C and a stopwatch are available. State all the readings that would be needed at each stage.

....

....

....

....

.... [4]

(b) In an experiment, 120 g of ice at 0 °C is to be melted. The specific latent heat of ice is 340 J/g. Assume that all the energy from the heater will be used to melt the ice.

Calculate the expected time for which the 60 W heater is switched on.

expected time = ... [2]

(c) When the experiment is carried out, the ice melts in slightly less time than the expected time.

(i) State one reason why this happens.

....

.... [1]

(ii) Suggest one modification to the experiment that would reduce the difference between the experimental time and the expected time.

....

.... [1]

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4 Fig. 4.1 shows apparatus that a student uses to make an estimate of the specific heat capacity of iron.

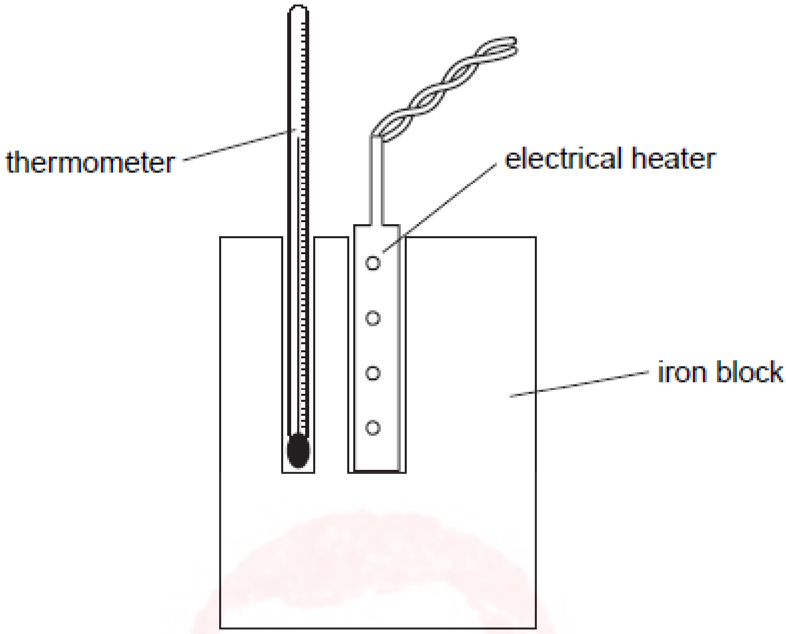

Fig. 4.1

(a) The power of the heater is known. State the four readings the student must take to find the specific heat capacity of iron.

1. ....

2. ....

3. ....

4. .... [3]

(b) Write down an equation, in words or in symbols, that could be used to work out the specific heat capacity of iron from the readings in **(a)**.

[2]

(c) (i) Explain why the value obtained with this apparatus is higher than the actual value.

....

.... [1]

(ii) State one addition to the apparatus that would help to improve the accuracy of the value obtained.

....

.... [1]

Q# 29/ iG Phx/2004/w/Paper 3/ www.SmashingScience.org

4 (a) Fig. 4.1 shows a simple type of thermocouple that has been calibrated to measure temperature.

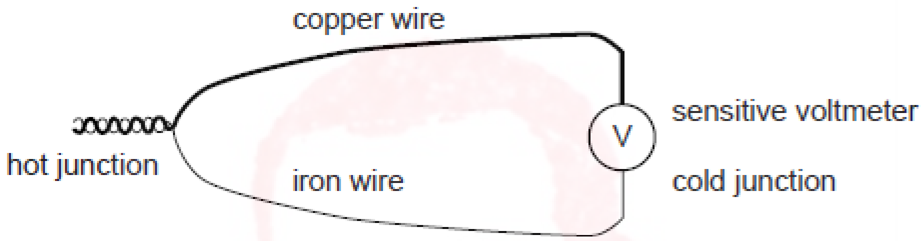

Fig. 4.1

(i) Describe how the thermocouple could be used to measure the temperature of a beaker of hot water.

....

....

....

(ii) State two situations where a thermocouple would be a good choice of thermometer to measure temperature.

1. ....

....

2. ....

....

[4]

(b) A mercury-in-glass thermometer is placed in an insulated beaker of water at 60 °C. The water is heated at a constant rate. The temperature of the water is measured and recorded on the graph shown in Fig. 4.2.

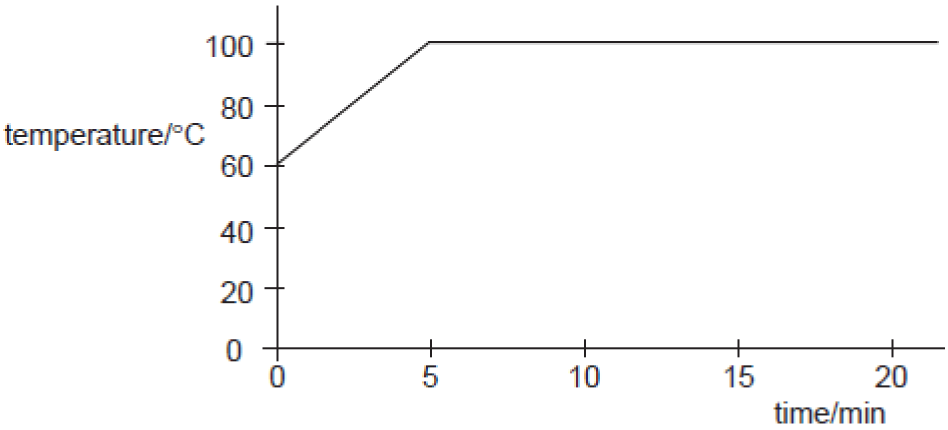

Fig. 4.2

State the effect of the heat supplied

(i) during the period 0 to 5 minutes,

....

....

(ii) during the period 10 to 15 minutes.

....

....
[2]

4 (a) Two identical open boxes originally contain the same volume of water.
One is kept at 15 °C and the other at 85 °C for the same length of time.

Fig. 4.1 shows the final water levels.

Fig. 4.1

With reference to the energies of the water molecules, explain why the levels are different.

....

....

....

....[3]

(b) In an experiment to find the specific latent heat of vaporisation of water, it took 34 500 J of energy to evaporate 15 g of water that was originally at 100 °C.

A second experiment showed that 600 J of energy was lost to the atmosphere from the apparatus during the time it took to evaporate 15 g of water.

Calculate the specific latent heat of vaporisation of water that would be obtained from this experiment.

specific latent heat = ...[3]

5 **(a)** Fig. 5.1 shows two identical metal plates. The front surface of one is dull black and the front surface of the other is shiny silver.
The plates are fitted with heaters that keep the surfaces of the plates at the same temperature.

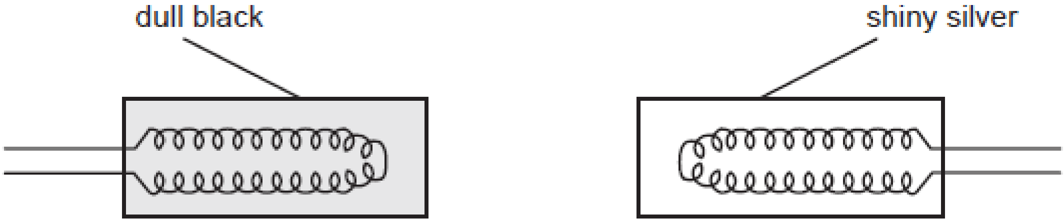

Fig. 5.1

(i) State the additional apparatus needed to test which surface is the best emitter of heat radiation.

....

(ii) State one precaution that is needed to ensure a fair comparison.

....

....

(iii) State the result that you expect.

....

(iv) Write down another name for heat radiation.

....

[4]

(b) In the space below, draw a labelled diagram of an everyday situation in which a convection current occurs.

Mark the path of the current with a line and show its direction with arrows. [3]

5 **(a)** Equal volumes of nitrogen, water and copper at 20 °C are heated to 50 °C.

(i) Which one of the three will have a much greater expansion than the other two?

....

(ii) Explain your answer in terms of the way the molecules are arranged in the three substances.

....

....

....

[3]

(b) Fig. 5.1 shows a thermometer with a range of –10 °C to 50 °C.

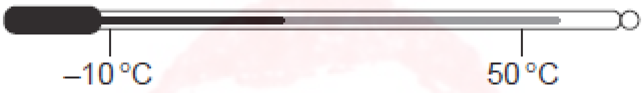

Fig. 5.1

Explain what is meant by

(i) the *sensitivity* of a thermometer,

....

....

(ii) the *linearity* of a thermometer.

....

....

[2]

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4 Fig. 4.1 shows water being heated by an electrical heater. The water in the can is not boiling, but some is evaporating.

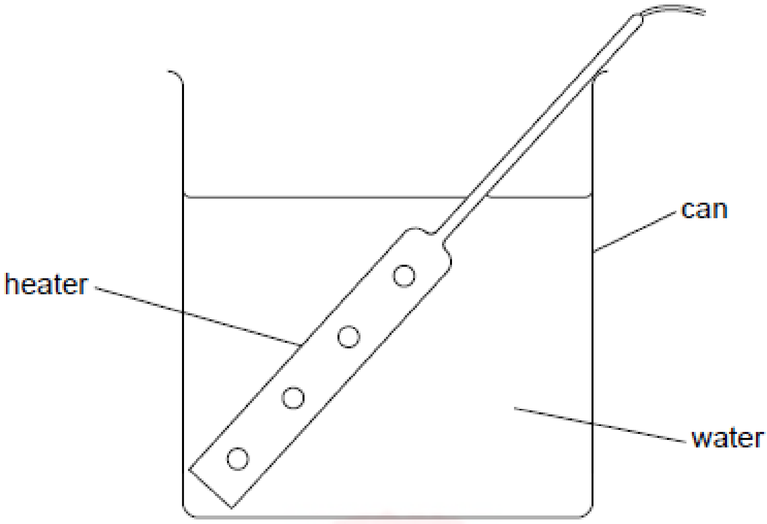

Fig. 4.1

(a) Describe, in terms of the movement and energies of the water molecules, how evaporation takes place.

....

....

....

.... [2]

(b) State two differences between evaporation and boiling.

1 ....

....

2 ....

.... [2]

(c) After the water has reached its boiling point, the mass of water in the can is reduced by 3.2 g in 120 s. The heater supplies energy to the water at a rate of 60 W. Use this information to calculate the specific latent heat of vaporisation of water.

specific latent heat = ... [3]

5 Fig. 5.1 shows a thermocouple set up to measure the temperature at a point on a solar panel.

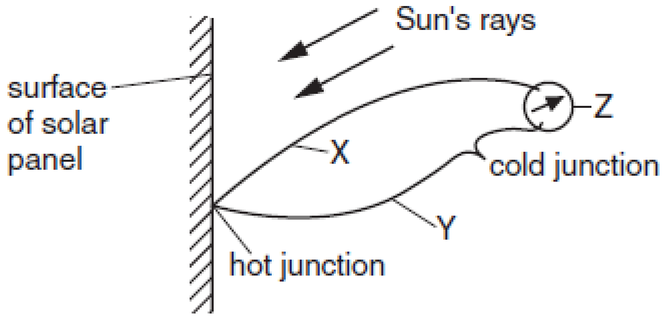

Fig. 5.1

(a) X is a copper wire.

(i) Suggest a material for Y.

....

(ii) Name the component Z.

....
[2]

(b) Explain how a thermocouple is used to measure temperature.

....

....

....[3]

(c) Experiment shows that the temperature of the surface depends upon the type of surface used.

Describe the nature of the surface that will cause the temperature to rise most.

....

....[1]

SMASHING!!!

3 A thermocouple is used to measure the temperature of the inner wall of a pottery kiln.

(a) In the space below, draw a labelled diagram of a thermocouple that could be used for this purpose. [2]

(b) Describe

(i) how you would read the temperature of the wall from the thermocouple,

....

....

(ii) how the thermocouple works.

....

....

....

[2]

(c) State two conditions in which a thermocouple is very suitable for temperature measurement.

....

....[2]

4 **(a)** In an experiment to find the specific latent heat of water, the following readings were taken.

m_1	mass of water at 100 °C, before boiling starts	120 g
m_2	mass of water at 100 °C, after boiling finishes	80 g
V	voltage across the heater	12 V
I	current through the heater	2.0 A
t	time that the heater was supplying energy	3750 s

(i) Using the symbols above, write down the equation that must be used to find the value of the specific latent heat L of water.

(ii) Use the equation to calculate the specific latent heat of water from the readings above.

specific latent heat = ...

[4]

(b) Explain, in terms of the energy of molecules, why the specific latent heat of water has a high value.

....

....

....[2]

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Q# 1/ iG Phx/2014/s/Paper 31/ www.SmashingScience.org

1 (a) (i) (liquid) has a uniform expansion / expands at a constant rate / expands evenly / expands linearly — B1

(ii) any two from:
larger bulb / wider / longer bulb
more liquid
narrower capillary / tube
use liquid with greater expansion — B2

(iii) thermometer must be longer — B1

(b) any 2 from:
resistance / conductance of a metal / wire / conductor / thermistor
voltage / current of a thermocouple
volume / pressure / expansion / contraction of a gas
colour of a metal
amount of radiation OR frequency OR wavelength of radiation from a metal / furnace
colour / arrangement of liquid crystals
expansion of a solid / any dimension of a solid
bending of a bimetallic strip — B2

[Total: 6]

Q# 2/ iG Phx/2014/s/Paper 31/ www.SmashingScience.org

7 (a) (a liquid evaporates) at any temperature / below the boiling point / over a range of temperatures / below 100°C / at different temperatures / not at a fixed temperature — B1

(during evaporation) vapour forms at / escapes from the surface of the liquid — B1

(without a supply of thermal energy,) evaporation continues / occurs / doesn't stop OR causes liquid to cool / is slower / reduces — B1

(b) (i) $(Q =)\ mL$ OR $0.075 \times 2.25 \times 10^6$ — C1

1.7×10^5 J — A1

(ii) $(E =)\ VIt$ OR $240 \times 0.65 \times (20 \times 60)$ OR $P = IV$ and $P = E / t$ OR energy / time — C1

1.9×10^5 J — A1

(iii) energy is transferred to the surroundings OR in heating the surroundings / air / atmosphere / hot-plate — B1

[Total: 8]

Q# 3/ iG Phx/2013/w/Paper 31/ Q4

(ii) in words or symbols $Q = mc\theta$ OR $\theta = Q/mc$ — C1
$1.203 \times 10^5 = 4.5 \times 520 \times \theta$ OR $\theta = 1.203 \times 10^5 / (4.5 \times 520)$ — C1
51 °C or K — A1

Q# 4/ iG Phx/2013/w/Paper 31/ www.SmashingScience.org

5 (a) (i) heated air / warm air rises / moves up (not sideways) B1

(ii) air (between plate and hands) is a poor conductor / does not conduct B1

(b) left hand / palm (facing matt black side gets hotter)
OR hand facing matt black side (gets hotter) B1
matt black side is a better emitter / radiator (of heat than shiny side) B1

(c) conduction takes place B1
copper a good conductor / conduction is rapid / heat flows to equalise temperature B1

[Total: 6]

Q# 5/ iG Phx/2013/s/Paper 31/QiG Phx/2005/ www.SmashingScience.org

(b) (i) (Q =) $mc\Delta\theta$ OR mcT OR $60 \times 4000 \times 0.50$ C1
1.2×10^5 J / 120 kJ A1

(ii) $Q = mL$ in any form OR (m =) Q/L OR either with numbers C1
($m = 1.2 \times 10^5 / 2.4 \times 10^6 =$) 0.05 kg e.c.f from **(b)(i)** A1

[Total 7]

Q# 6/ iG Phx/2013/s/Paper 31/ www.SmashingScience.org

4 (a) (i) mention of vacuum OR glass is a poor conductor
OR vacuum/gap between walls has no molecules/atoms/particles B1

(ii) surface/silver (of walls) is good reflector/poor absorber (of radiation) B1
surface/silver (of walls) is poor emitter (of radiation) B1

(b) add a stopper/lid/bung/cover/top to reduce/prevent (loss of heat by) convection/ M1
conduction/radiation/evaporation OR to prevent steam/hot vapour leaving B1

made of insulator OR example of insulator to reduce/prevent (loss of heat by)
convection/radiation/evaporation OR to prevent steam/hot air leaving B1

[Total 6]

Q# 7/ iG Phx/2012/w/Paper 31/QiG Phx/2007/ www.SmashingScience.org

(b) (i) Dull surface is better radiator / radiates faster
OR Shiny surface is poorer radiator / radiates slower B1

(ii) C hotter (than A) OR A cooler (than C) (so evaporates at a faster rate in C) B1

(iii) Less liquid in D OR more liquid in A B1

(iv) E has greater (surface) area / more open to air / is shallower B1
greater rate of loss of heat by evaporation / convection /
conduction / radiation B1 [7]

Q# 8/ iG Phx/2012/w/Paper 31/ www.SmashingScience.org

6 (a) Heat required to change state of / melt 1 kg / 1 g / unit mass of solid (with no change of temperature) B1

Allow specific example e.g. ice to water
NOT liquid to gas

(b) (i) d = m/V in any form OR (m =) V × d C1
OR (m =) 0.25 × 0.012 × 920
= 2.76 kg at least 2 significant figures. *Unit penalty applies A1

(ii) 60% of 250 = 150 (W/m^2) OR 250 × 0.25 = 62.5 (J) C1
Heat absorbed in 1 s = 150 × 0.25 = 37.5 (J)
OR 60 % of 62.5 = 37.5 J OR J/s OR W *Unit penalty applies A1

Allow J/s or W because in one second.

(iii) Q = mL OR m = Q/L OR m = 37.5 / 3.3×10^5 ecf from **(b)(ii)** C1
m = 0.0001136 (kg) (in 1 s) C1
Time taken = 2.76/0.000114 = 24300 s at least 2 significant figures. *Unit penalty applies A1
OR
P = Q/t OR t = Q/P OR t = mL/P (C1)
t = 2.76 × 3.3×10^5 / 37.5 (C1)
= 24300 s *Unit penalty applies (A1) **[8]**

*Apply unit penalty once only

Q# 9/ iG Phx/2012/s/Paper 31/ www.SmashingScience.org

5 (a) (i) e.g. freezing, solidification, condensation
OR example e.g. water to ice, steam to water, gas to solid B1

(ii) No change B1

(b) Heat/energy required to change temperature of the body B1
by 1 °C / 1 K / 1 unit / 1 deg B1
OR
mass (of body) × specific heat capacity (B2)

(c) (i) $Q = mc\theta$ OR in words OR 250 × 4.2 × 20 C1
= 21000 J A1

(ii) 21000 J OR same as **(c)(i)** B1

(iii) $Q = mL$ OR $m = Q/L$ OR either in words
OR 21000 = m × 330 OR m = 21000/330 C1
= 63.6 g at least 2 s.f. A1

[Total: 9]

Q# 10/ iG Phx/2012/s/Paper 31/ www.SmashingScience.org

6 (a) (i) Glass / flask receives heat / rises in temperature B1
Glass / flask expands B1

(ii) Heat flows through glass to water OR Water receives heat / thermal energy from / conducted by glass OR Water temperature <u>rises</u> OR Water molecules move faster / gain K.E. B1
Water expands / Water molecules move further apart B1

(iii) Glass / solid expands less OR water / liquid expands more B1

(b) Use a bigger flask OR a narrower tube
OR Use a solid <u>and</u> a liquid that expand more B1

[Total: 6]

Q# 11/ iG Phx/2011/w/Paper 31/ www.SmashingScience.org

5 (a) (i) most: gas
least: solid both required B1

(ii) because change of pressure (also) causes volume change (in a gas) B1
NOT 'gas can be compressed'

(b) (i) two from:
expands uniformly (over required range)
remains liquid over required range
expands more than glass / has high expansivity / expansion
has (reasonably) low specific heat capacity.
has low freezing point / lower freezing point than mercury max B2

(ii) make (capillary) tube narrower (and longer) / thinner / smaller diameter B1
make bulb larger (and tube longer) B1
allow 'bore' for tube ignore 'smaller' ignore narrow <u>thermometer</u>

(c) allows fast(er) flow of heat to / from alcohol
OR allows fast response (to temperature change)
OR because glass is a poor conductor / good insulator (so needs to be thin for fast response)
OR heat transfer more efficient / faster
OR glass takes up less heat B1 [7]
ignore reference to sensitivity ignore 'easier'

Q# 12/ iG Phx/2011/s/Paper 31/ www.SmashingScience.org

11 (a) Pt OR $1.2 \times 10^4 \times 9$ OR $1.2 \times 10^4 \times (11 - 2)$ C1
(l=) E/m OR $E/0.36$ OR Pt/m OR $Pt/0.36$ C1
3×10^5 J/kg A1

(b) (i) liquid ignore vapour/gas/water A1

(ii) move around more rapidly / faster / more KE
ignore **start to** vibrate etc but accept starts to vibrate faster
move further apart / spreads out (NOT molecules expand)
break free / evaporate / overcome bonds / overcome forces of attraction /escape / change state (accept boils)
convection (current)
} any 2 B1

[6]

Q# 13/_iG Phx/2010/w/Paper 31/ www.SmashingScience.org

4 **(a)** heat/energy to raise/change temperature — M1
of 1 kg/1g/unit mass through 1°C/1K — A1
(mention of change of state scores zero)

(b) Q = mcθ (for θ accept t, T, Δθ, Δt, or ΔT) — B1
23800 = 0.93 × c × (41.3 – 13.1) — C1
907.5 or 907 or 908 or 910 J/(kg °C) or J/(kg K) at least 2 sig. figs — A1
(for unit in **(b)** and **(c)(i)** condone no brackets and extra solidus)

(c) **(i)** 1212.9 or 1200 or 1210 or 1213 or 1214 J/(kg °C) or J/(kg K) — B1

(ii) more energy lost (to surroundings) — B1
(average) temperature is higher/initial temperature higher/no cooling time allowed/temperature rise is lower/time of heating may be longer/ rate of heating may be lower — B1

(d) any 2 of: — B1 + B1
- insulate block/provide lid/cover with shiny foil
- start & finish same amount below & above room temperature
- get heater up to temperature before inserting
- put oil in gap between heater & block

[Total: 10]

Q# 14/_iG Phx/2010/s/Paper 31/ www.SmashingScience.org

5 **(a)** <u>energy</u> / <u>heat</u> required to change state / phase / any example of change of state / phase — M1

with no change in temperature / at a specified temperature — A1
OR energy to break bonds between molecules /atoms — M1
with no change in K.E. — A1

(b) any time or range of time between 1.6 (min) and 14.0 (min) inclusive [no UP] — B1

(c) turns substance to gas / vapour OR causes evaporation OR escape from liquid — C1

energy to break bonds/separate molecules/overcome intermolecular forces
Ignore move faster / PE increases — A1

(d) **(i)** Pt / 2 × 4 / 2000 × 4 / 2 × 240 / 2000 × 240 / 8 / 8000 / 480 / 480000 — C1
480 000 J OR 480 kJ — A1

(ii) (θ =) 43 (°C) seen anywhere — C1
Q = mcθ OR 480000 = m x 1760 × 43 in any form ecf. from **(i)** — C1
6.34 kg or 6.3 kg ecf. — A1 [10]

Q# 15/ iG Phx/2010/s/Paper 31/ www.SmashingScience.org

4 **(a)** matt black B1

(b) **(i)** L down and R up, equal amounts (by eye) B1

(ii) on black side or on left (more) energy / heat absorbed OR greater temp rise OR heats up quicker B1

on black side or on left greater expansion of air / greater pressure of air B1 [4]

Q# 16/ iG Phx/2009/w/Paper 31/ www.SmashingScience.org

9 **(a)** (quantity of) heat/energy to raise temp by 1 °C/1degC/1K/unit temp rise M1
1 kg OR 1 g OR unit mass (Mention of change of state gets M0 A0) A1

(b) long time to heat up/cook)
long time to cool down) any 1 B1
expensive to heat)
takes a lot of energy to heat up)

(c) **(i)** 1.8 degC OR 1.8 °C OR 1.8 K
AND 77.1 degC OR 77.1 °C OR 77.1K B1

(ii) (Q =) mcT in any form, seen anywhere B1
0.2 × 4200 × 1.8 e.c.f. from **(c)** **(i)** C1
1512 J (minimum 2 s.f.) c.a.o. A1

(iii) 1512 = 0.05 × c × 77.1 in any form e.c.f. from **(c)** **(i)** and/or **(c)** **(ii)** C1
392 J/kg K (N.B. must be to 3 sf ; A0 for wrong s.f.) e.c.f. A1

(iv) heat lost during transfer)
boiling water not at 100 °C / reason for not boiling
at 100 °C e.g. water not pure/ not standard pressure)
energy lost to cup etc. / surroundings) any 1 B1
thermometer not accurate / sensitive enough)
temperature / mass(es) not accurately measured)

[10]

Q# 17/ iG Phx/2009/s/Paper 31/ www.SmashingScience.org

2 **(a)** water AND liquids expand more than solids B1

(b) steel M1
(steel) expands at same rate / has same expansion (as concrete) A1
different expansion AND cracks / breaks / damages / destroys concrete A1 [4]

Q# 18/_iG Phx/2008/w/Paper 31/ www.SmashingScience.org

5 (a) (i)	funnel no longer giving heat to ice OR ice at M.P./constant temp OR heater reached max temp		B1	
(ii)	inside of large pieces could be well below freezing point) OR smaller air gaps if pieces smaller) OR better contact between heater and ice) OR to ensure heat from heater only goes to the ice) OR larger surface area) Ignore ice melts faster	any 1	B1	
(b)	mass of beaker NOT mass of ice NOT mass of water mass of beaker + water (apply ✓ + × = 0 for extras other than power & time)		B1 B1	
(c)	(mass of ice melted by heater = 16.3 – 2.1) = 14.2 g ml in any form, words, symbols or numbers Wt or Pt in any form, words, symbols or numbers accept VIt 338 J/g OR 338 000 J/kg c.a.o		C1 C1 C1 A1	[8]

Q# 19/_iG Phx/2008/s/Paper 31/ www.SmashingScience.org

5 (a)	SOLID	higher temperature means higher energy/greater speed of mols/particles/atoms NOT more vibration NOT vibrate more	B1	
		vibrations get bigger or movement greater/take up more space or separation larger	B1	
	GAS	(ave) speed/energy of mols/particles/atoms greater	B1	
		(ave) separation of mols/particles/atoms greater or mols/particles/atoms take up more space or increased pressure causes container to get bigger	B1	
(b)		liquids: slightly more gases: much more	B1 B1	
(c)		regular/uniform expansion or appropriate range (be generous if numbers quoted) or expands a lot/large expansivity or (relatively) non-toxic or low freezing point/melting point or measures low temperatures any 1 IGNORE reacts to small temp change IGNORE high boiling point	B1	[7]

Q# 20/_iG Phx/2007/w/Paper 31/Q4

(c)	75 × 3200 OR ml 240 000 J OR 240 kJ OR 2.4×10^5 J	C1 A1

Q# 21/_iG Phx/2007/w/Paper 31/ www.SmashingScience.org

5	(a)	take readings of the detectors	B1
		fill box with water	B1
		take readings (again)	B1
	(b)	dull black best AND shiny white worst	B1
	(c)	two different metals	B1
		two junctions (could be at meter) hot and cold need not be indicated	B1
		any cell, max B1,B0	
			[Total: 6]

Q# 22/_iG Phx/2007/s/Paper 31/ www.SmashingScience.org

4	(a)		total mass before ice added	B1	
			total mass after all ice melted	B1	[2]
	(b)	(i)	mass × sp ht cap × change in temp or 20 OR $mc\theta$	B1	[1]
		(ii)	mass (of melted ice) × sp latent ht OR ml OR (heat gained by ice) = heat lost by water	B1	[1]
	(c)		heat/mass or 12 800/30	C1	
			427 J/g OR 426667 J/kg any no s.f. ≥ 2	A1	[2]
	(d)		heat <u>gained from</u> surroundings OR no lagging	B1	
			heat needed to cool beaker/stirrer and thermometer) any 2	+	
			too much ice added or similar point)	B1	[2]
			allow stirring gives energy, allow evaporation/condensation		
			(ignore "mistakes when taking readings" or similar)		
					[Total: 8]

Q# 23/_iG Phx/2007/s/Paper 31/ www.SmashingScience.org

5	(a)	(i)	heat for the same time	B1	
			take temps on both thermometers	B1	[2]
		(ii)	dull black box temp > white box temp OR black is hotter etc.	B1	[1]
	(b)	(i)	large expansion/change in reading for small change in temp NOT detect/respond to small temp changes	B1	[1]
		(ii)	temperature rise small and/or small difference between them	B1	[1]
		(iii)	distance between each degree on scale is the same	B1	[1]
					[Total: 6]

Q# 24/_iG Phx/2006/w/Paper 31/ www.SmashingScience.org

4	(a)	(i)	1 is 20°C 2 is 15 ± 1°C, need both correct for a mark	A1	
		(ii)	more heat lost at higher temperature	B1	[2]
	(b)		heat in = 60 x 210 or *Wt* or 12 600 (J) heat in water = *m* x *s* x $\Delta\theta$ or 75 x *s* x 40 *s* = 12600/75 x 40 = 4.2 J/g °C	C1 C1 C1 A1	[4]
	(c)		outline correct, two wires with <u>clear</u> junction and a meter/datalogger/computer labels, hot and cold junctions or clear, two different metals	M1 A1	[2]
					[Total: 8]

Q# 25/_iG Phx/2006/w/Paper 31/ www.SmashingScience.org

5	(a)	(i)	conduction	B1	
		(ii)	particles/atoms/ions vibrate or electrons move and carry energy pass on energy from one particle to the next	B1 B1	[3]
	(b)		four surfaces facing <u>one</u> heat source suitable detector e.g. thermometer behind surface-read all 4 precaution e.g. equal distance/time (Can not score last two marks if experiment is totally wrong)	B1 B1 B1	[3]
					[Total: 6]

Q# 26/_iG Phx/2006/s/Paper 31/ www.SmashingScience.org

4	(a)	on surface/throughout; no bubbles/bubbles; all temps./b.p.; s.v.p. < at. pressure; svp = at. pressure	any two	B2	2
	(b)	energy/work to separate molecules (against) forces of attraction between water molecules (to break bonds C1)		B1 B1	2
		The k.e./speed of the molecules does not increase		B1	1
	(c)	Wt = mL or 120 x 1 = 0.05 x L L = 120/0.05 L = 2400 J/g		C1 C1 A1	3
					[8]

Q# 27/_iG Phx/2005/w/Paper 31/ www.SmashingScience.org

4	(a)	turn on heater and wait until water starts dripping in beaker empty beaker & replace, start watch stop watch & remove beaker at same time record time find and record mass of water in beaker	B1 B1 B1 B1 B1	[M4]
	(b)	60 x t = 120 x 340 t = 680 s	C1 A1	[2]
	(c) (i)	ice gains heat from surroundings/ice falls through funnel	B1	
	(ii)	lag or fit lid to funnel/place gauze in funnel bottom	B1	[2] Total [8]

Q# 28/ iG Phx/2005/s/Paper 3 www.SmashingScience.org

4	(a)		start temp. and final temp. or change in temperature	B1	
			mass of iron	B1	
			time heater on	B1	3
	(b)		P x t, VIt or in words	B1	
			= m x shc x cit or words	B1	2
	(c)	(i)	heat lost to surroundings/air	B1	
		(ii)	add lagging/insulate	B1	2
					[7]

Q# 29/ iG Phx/2004/w/Paper 3/ www.SmashingScience.org

4	(a)	(i)	put hot junction in beaker (of hot water)	1	
			read temperature from galvo. in some way (calibration)	1	2
		(ii)	high/low temperatures stated or high/low values quoted or temperature varying rapidly or small site/at point or remote place (from meter) or in control systems any 2	2	2
	(b)	(i)	raises the water temperature	1	
		(ii)	provides latent heat or boils/evaporates water	1	2
					(6)

Q# 30/ iG Phx/2004/s/Paper 3 www.SmashingScience.org

4	(a)	Water molecules at higher temps. have higher (av) k.e. / energy	B1	
		Higher energy molecules (have greater chance to) escape the surface	B1	
		Higher energy molecules have energy to break liquid "bonds" or separate liquid molecules or more evaporation at 85°C (lowers level)	B1	3
	(b)	Heat for evaporation = 34 500 – 600 = (33 900)	C1	
		Sp. latent heat of evaporation = heat/mass evap. or 33 900 / 15	C1	
		2260 J/g (method and working correct, but no heat loss used, 2/3)	A1	
		(600 added or 34 500 used can score **2 max**)		3

Q# 31/ iG Phx/2004/s/Paper 3 www.SmashingScience.org

5	(a)	(i)	Thermopile / thermocouple / (blackened) thermometer / infra red detector or use ammeter / voltmeter in supply circuit	B1	
		(ii)	One of: same distance of plate to detector or use two identical detectors or same time (after switching on)	B1	
		(iii)	Dull black better radiator / radiates more than silver / or emits more heat / radiation	B1	
		(iv)	Infra red (i.r.)	A1	4
	(b)		any correct example e.g. heating water or chimney	M1	
			current clear and complete	A1	
			direction shown correctly by arrows	A1	3
					[7]

Q# 32/_iG Phx/2003/w/Paper 3/ www.SmashingScience.org

5 (a) (i)		nitrogen	M1	
	(ii)	copper-solid-molecules very tightly bonded together so separate little	B1	
		water – liquid – molecules less tightly bonded/still small separation	B1	
		nitrogen – gas – molecules "free" and not bonded so separate most	B1	M3
		(N.B. accept 2 bonding statements for 2 marks. 1 separation statement for 1 mark)		
(b) (i)		size of movement/change in length of liquid column per degree	B1	
	(ii)	change in length (of liquid column) same for all degrees	B1	2
				[5]

Q# 33/_iG Phx/2003/w/Paper 3/ www.SmashingScience.org

4 (a)	Some have extra/more energy than others	B1	
	most energetic leave surface/ break liquid bonds etc	B2	M2
(b)	evaporation occurs strictly at the surface/at all temperature	B1	
	boiling occurs throughout liquid/ at one temperature (at normal at. pr.)/100°C	B1	2
(c)	energy supplied = Wt /60 x 120	C1	
	sp.latent heat = energy/mass evaporated or 60 x 120/3.2	C1	
	value is 2250 J/g	A1	3
			[7]

Q# 34/_iG Phx/2003/s/Paper 3 www.SmashingScience.org

5 (a)	Y is a wire of different metal/not copper	B1	
	Z is a galvanometer/millivoltmeter/milliammeter	B1	2
(b)	2 junctions at different temperatures, accept one hot, one cold	B1	
	temperature difference causes e.m.f./voltage/current	B1	
	reading of meter changes (with temperature)	B1	
	1 junction at known temperature/need for calibration	B1	max 3
(c)	dull or black surface	B1	1
			[6]

Q# 35/_iG Phx/2002/w/Paper 3/ www.SmashingScience.org

3 a	junction of two metals, other ends to meter/alternative arrangements		C1	
	two metals named,meter labelled	2	A1	2
b(i)	meter calibrated in degrees or read value and use calibration chart		B1	
(ii)	change in temp. causes change in voltage/current	2	B1	2
c	high/low temperatures		B1	
	rapidly changing temperatures (or low thermal capacity)		B1	
	any valid physical reason e.g. distance reading needed, small site etc	2	B1	M2*
			QT	6

Q# 36/_iG Phx/2002/w/Paper 3/ www.SmashingScience.org

4 a(i)	$L = VIt/(m_1 - m_2)$ exact for 2 eg. $VIt = (m_1 - m_2)L$ only 1 or $m_2 - m_1$	2	C1, A1	
(ii)	= 12 x 2 x 3750 / 40		C1	
	= 2250 J/g * or 2.25×10^6 J/kg	2	A1	4
b	(large) (intermolecular) forces in liquid / bonds		B1	
	(great) energy needed to separate molecules of liquid	2	B1	2
			QT	6