AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.1.1.3

Energy changes in systems

Past-paper questions

Tier	**Foundation**
Question groups	**7**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

6.1.1.3 Energy changes in systems

Question 01

June 2018 | 8464/P/1F | Original Q5

0 5 Radioactive nuclei can emit alpha, beta or gamma radiation.

0 5 . 1 Which type of radiation is the most penetrating?

[1 mark]

Tick **one** box.

Alpha (α) ☐

Beta (β) ☐

Gamma (γ) ☐

0 5 . 2 Which type of radiation is the most ionising?

[1 mark]

Tick **one** box.

Alpha (α) ☐

Beta (β) ☐

Gamma (γ) ☐

0 5 . 3 Which type of radiation has the longest range in air?

[1 mark]

Tick **one** box.

Alpha (α) ☐

Beta (β) ☐

Gamma (γ) ☐

Question 5 continues on the next page

Question 01 · continued

When radioactive isotopes in the Earth's crust decay they release energy.

The decay causes the heating of rocks in the crust.

0 5 . 4 **Figure 8** shows the decay of uranium–238 (U–238) into thorium–234 (Th–234).

Figure 8

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

Complete **Table 2** to show the number of neutrons and protons in the nuclei.

[2 marks]

Table 2

Isotope	Number of neutrons	Number of protons
uranium–238	146	
thorium–234		90

0 5 . 5 Geothermal power stations pump water through heated rocks.

The temperature of the water increases from 20 °C to its boiling point of 100 °C

Calculate the change in thermal energy when the mass of water heated is 150 kg

Specific heat capacity = 4 200 J/kg °C

Use the Physics Equations Sheet.

[3 marks]

Change in thermal energy = _____ J

8

6.1.1.3 Energy changes in systems

Question 02

November 2020 | 8464/P/1F | Original Q4

0 4 A scientist had a balloon which was filled with air.

0 4 . 1 Which statement describes how air particles move?

[1 mark]

Tick (✓) **one** box.

- At random speeds in random directions ☐
- At random speeds in the same direction ☐
- At the same speed in random directions ☐
- At the same speed in the same direction ☐

The temperature of the air was 19 °C

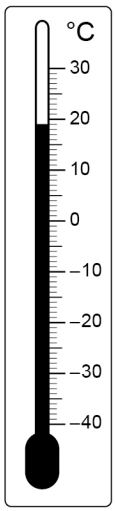
The scientist dipped the balloon into liquid nitrogen.

The temperature of the liquid nitrogen was −196 °C

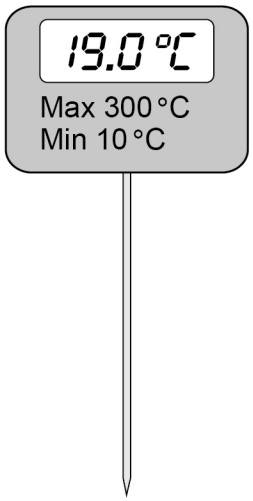
0 4 . 2 Which thermometer could be used to measure the temperature of the liquid nitrogen?

[1 mark]

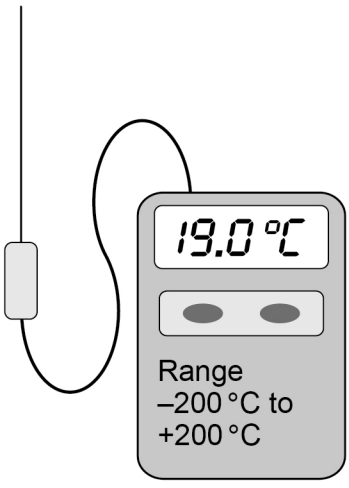
Tick (✓) **one** box.



☐



☐



☐

0 4 . 3 The scientist wore special insulating gloves when putting the balloon into the liquid nitrogen.

Suggest why.

[1 mark]

0 4 . 4 When the balloon was put into liquid nitrogen the temperature of the air in the balloon decreased.

Complete the sentences.

Choose answers from the box.

Each answer may be used once, more than once or not at all.

[2 marks]

decreased	**stayed the same**	**increased**

As the air in the balloon cooled down, the speed of the particles

_____ . This is because the kinetic energy of the

particles _____ .

Question 4 continues on the next page

6.1.1.3 Energy changes in systems

Question 02 · continued

0 4 . 5 The air in the balloon had a mass of 0.00320 kg

The temperature of the air in the balloon decreased by 215 °C

The change in thermal energy of the air in the balloon was 860 J

Calculate the specific heat capacity of the air in the balloon.

Use the Physics Equations Sheet.

[3 marks]

Specific heat capacity = _____ J/kg°C

0 4 . 6 The liquid nitrogen boiled.

What happens to the temperature of nitrogen as it boils?

[1 mark]

Tick (✓) **one** box.

Temperature decreases ☐

Temperature increases ☐

Temperature stays the same ☐

Question 02 · continued

The scientist recorded measurements to calculate the specific latent heat of vaporisation of nitrogen.

0 4 . 7 What is meant by vaporisation?

[1 mark]

Tick (✓) **one** box.

A change of state from liquid to gas ☐

A change of state from solid to gas ☐

A change of state from solid to liquid ☐

0 4 . 8 The mass of nitrogen that vaporised was 0.0072 kg

1440 J of energy was transferred to the nitrogen as it vaporised.

Calculate the specific latent heat of vaporisation of nitrogen.

Use the Physics Equations Sheet.

[3 marks]

Specific latent heat of vaporisation = _____ J/kg

13

6.1.1.3 Energy changes in systems

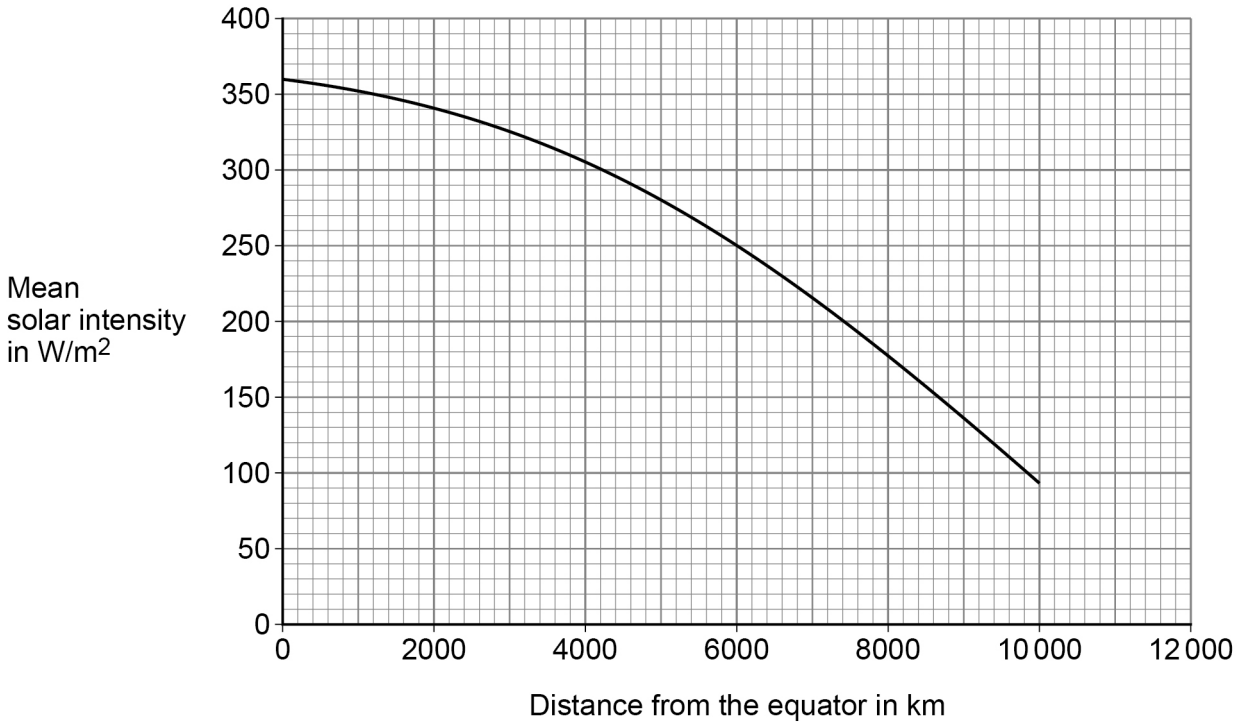
Question 03

November 2021 | 8464/P/1F | Original Q4

0 4 Solar intensity is a measure of the radiation received from the Sun at the surface of the Earth.

Figure 7 shows how the mean solar intensity changes with the distance from the equator.

Figure 7



0 4 . 1 The city of Athens is 4200 km from the equator.

What is the mean solar intensity in Athens?

[1 mark]

Mean solar intensity = _____ W/m^2

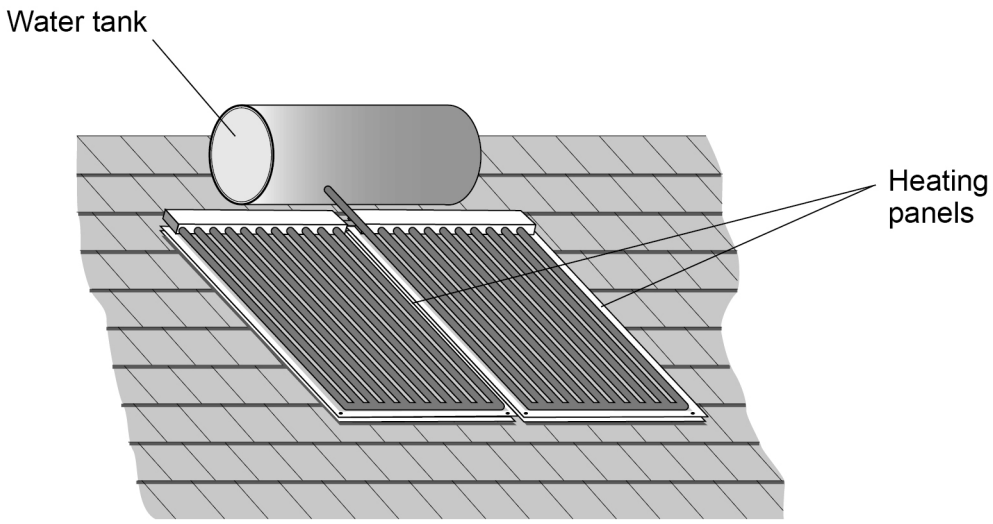
Question 03 · continued

Solar water heaters use radiation from the Sun to heat water.

The heated water is stored in a water tank.

Figure 8 shows a solar water heater on the roof of a building.

Figure 8



0 4 . 2 Cities closer to the equator have many more buildings with solar water heaters than cities further away from the equator.

Suggest why.

[1 mark]

0 4 . 3 The use of solar water heaters may reduce the need to burn fossil fuels.

Complete the sentence.

Choose the answer from the box.

[1 mark]

carbon dioxide	**nitrogen**	**oxygen**

Burning fossil fuels contributes to global warming because there is an increase in the amount of _____ in the atmosphere.

Question 03 · continued

0 4 . 4 The efficiency of the solar water heater is 0.61

Calculate the useful power output when the total power input to the solar water heater is 1100 W.

Use the equation:

useful power output = efficiency × total power input

[2 marks]

Useful power output = _____ W

0 4 . 5 Different solar water heaters have different sized heating panels.

Suggest how the size of the heating panels affects the input power to a solar water heater.

[1 mark]

0 4 . 6 Water has a high specific heat capacity.

What is meant by the specific heat capacity of water?

[1 mark]

Tick (✓) **one** box.

- The energy required to change the state of 1 kg of water from liquid to gas. ☐
- The energy required to increase the temperature of 1 kg of water by 1 °C. ☐
- The power required to change the state of 1 kg of water from liquid to gas. ☐
- The power required to increase the temperature of 1 kg of water by 1 °C. ☐

6.1.1.3 Energy changes in systems

Question 03 · continued

0 4 . 7 The water tank contained 80 kg of water.

The change in thermal energy of the water was 8 400 000 J.

specific heat capacity of water = 4200 J/kg °C

Calculate the temperature change of the water.

Use the Physics Equations Sheet.

[3 marks]

Temperature change = _____ °C

0 4 . 8 The water tank is thermally insulated.

How does thermal insulation affect the rate of energy transfer from the water in the tank?

[1 mark]

Tick (✓) **one** box.

- Thermal insulation decreases the rate of energy transfer. ☐
- Thermal insulation does not change the rate of energy transfer. ☐
- Thermal insulation increases the rate of energy transfer. ☐

Question 4 continues on the next page

6.1.1.3 Energy changes in systems

Question 03 · continued

0 4 . 9 **Table 1** shows information about different materials.

Table 1

Material	Thermal conductivity in arbitrary units
A	3
B	2
C	8
D	4

Which material in **Table 1** is the best thermal insulator?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

12

6.1.1.3 Energy changes in systems

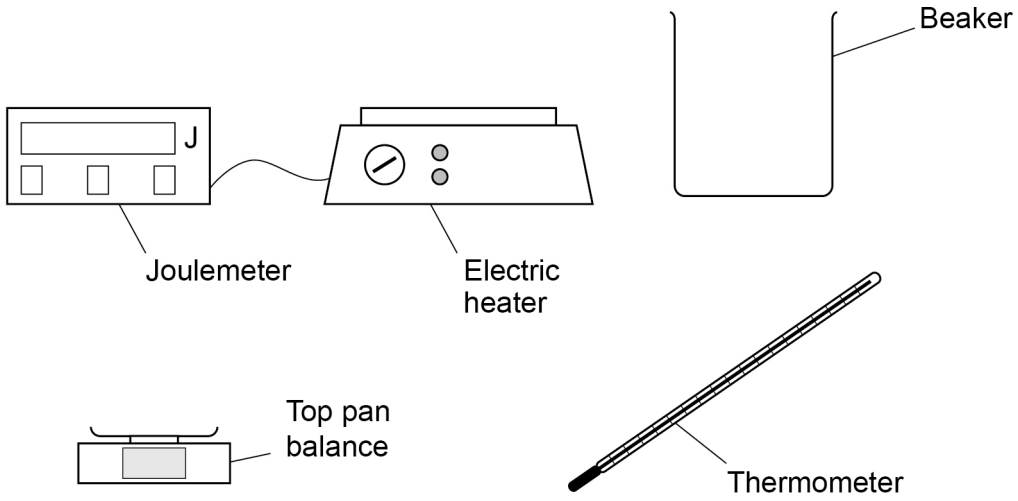
Question 04

June 2022 | 8464/P/1F | Original Q6

0 6 A student made measurements to determine the specific heat capacity of vegetable oil.

Figure 10 shows the equipment used.

Figure 10



0 6 . 1 Describe how the student could use the equipment shown in **Figure 10** to determine the specific heat capacity of vegetable oil.

[6 marks]

Question 04 · continued

0 6 . 2 Give **one** risk when using the equipment in **Figure 10**.

[1 mark]

A different student did not have a joulemeter and calculated the energy transferred by the electric heater.

Use the Physics Equations Sheet to answer questions **06.3** and **06.4**.

0 6 . 3 Write down the equation linking energy transferred (*E*), power (*P*) and time (*t*).

[1 mark]

0 6 . 4 The electric heater had a power output of 50 watts.

Calculate the time taken for the electric element to transfer 4750 joules of energy to the vegetable oil.

[3 marks]

Time taken = _____ s

Question 6 continues on the next page

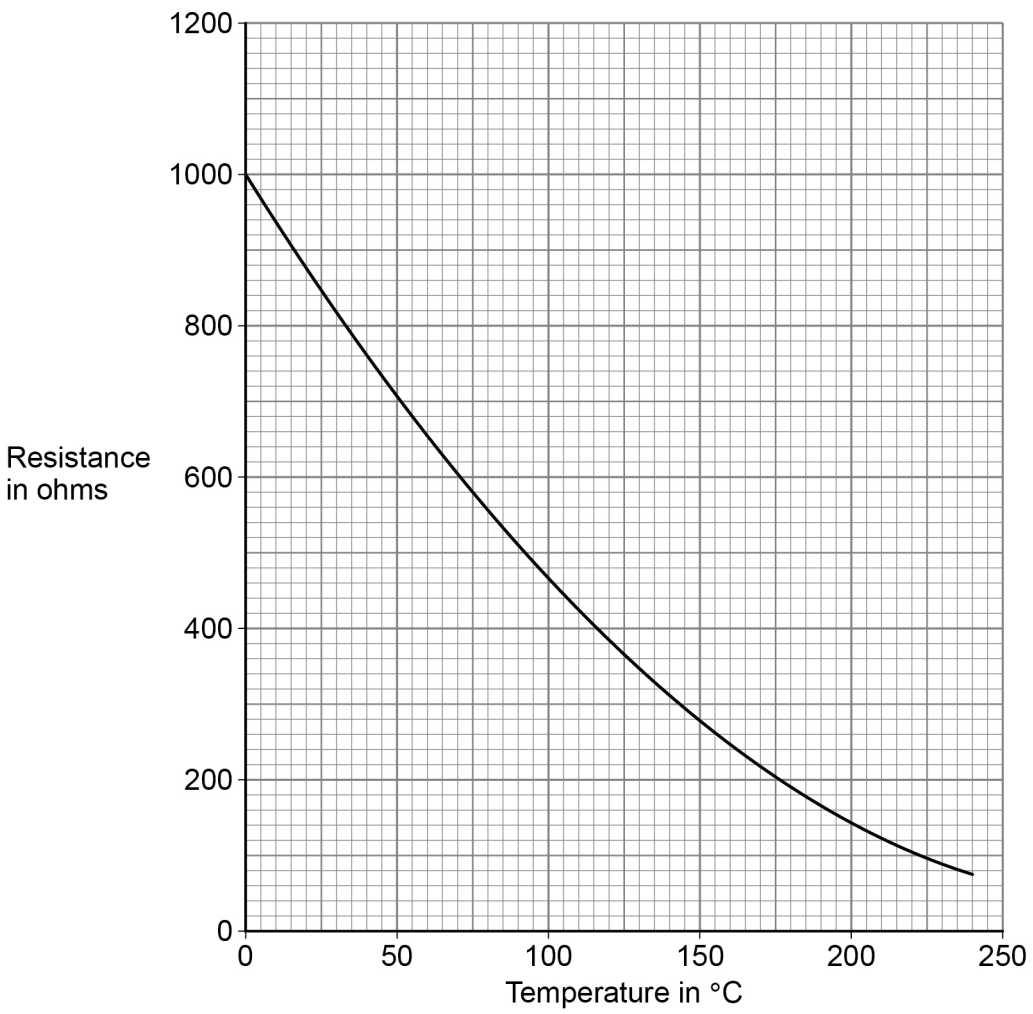
Question 04 · continued

In a deep fryer, vegetable oil is heated by an electric heating element. Food is then cooked in the hot vegetable oil.

The deep fryer contains an electrical component to monitor the temperature of the vegetable oil.

Figure 11 shows how the resistance of this electrical component changes with temperature.

Figure 11



0 6 . 5 What electrical component is used to monitor the temperature of the vegetable oil?

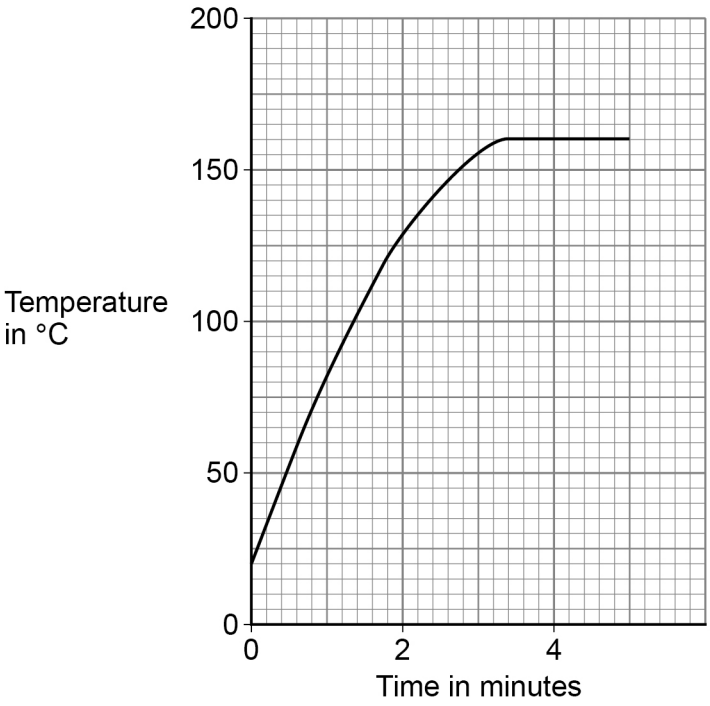
[1 mark]

Question 04 · continued

0 6 . 6 The electric heating element in the deep fryer automatically switches off when the vegetable oil reaches a certain temperature.

Figure 12 shows how the temperature of the vegetable oil changed after the deep fryer was switched on.

Figure 12



Determine the resistance of the electrical component when the electric heating element automatically switched off.

Use **Figure 11** and **Figure 12**.

[2 marks]

Resistance = _____ Ω

Question 6 continues on the next page

6.1.1.3 Energy changes in systems

Question 04 · continued

June 2022 | 8464/P/1F | Original Q6

0 6 . 7 Some chips were put in the deep fryer.

In the deep fryer, water in the chips underwent a physical change and became steam.

Why is this a physical change?

[1 mark]

Tick (✓) **one** box.

All water can change to steam. ☐

No chemicals are involved when water changes to steam. ☐

The change from water to steam can be detected visually. ☐

The water will recover its original properties if the steam is cooled. ☐

15

6.1.1.3 Energy changes in systems

Question 05

June 2023 | 8464/P/1F | Original Q3

0 3 A piece of steel is heated until it has all melted.

0 3 . 1 Calculate the change in thermal energy when the temperature of the piece of steel is increased by 50 °C.

mass of steel = 4.0 kg

specific heat capacity of steel = 420 J/kg °C

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

[2 marks]

Change in thermal energy = _____ J

0 3 . 2 The internal energy of the steel increases as the steel is heated.

What is meant by 'internal energy of the steel'?

[1 mark]

Tick (✓) **one** box.

- The change in energy of the steel particles as the steel melts. ☐
- The energy added to the steel particles as they are heated. ☐
- The total kinetic energy and potential energy of the steel particles. ☐

6.1.1.3 Energy changes in systems

Question 05 · continued

0 3 . 3 Solid steel cannot be poured.

Which statement about the particles in a solid gives the reason why?

[1 mark]

Tick (✓) **one** box.

- The number of particles always stays the same. ☐
- The particles are close together. ☐
- The particles are in fixed positions. ☐
- The particles have a fixed size. ☐

0 3 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

decreases	**stays the same**	**increases**

As the piece of solid steel melts, the mass of the steel _____.

Question 3 continues on the next page

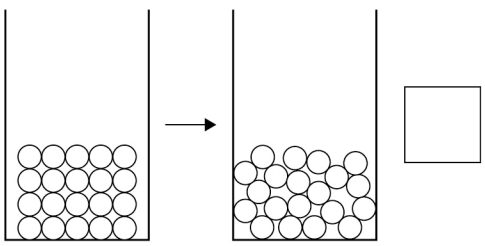
6.1.1.3 Energy changes in systems

Question 05 · continued

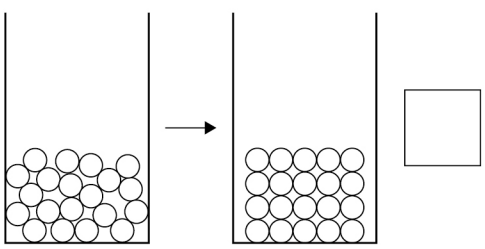
0 3 . 5 Which diagram shows how the arrangement of particles changes when a solid melts and becomes a liquid?

[1 mark]

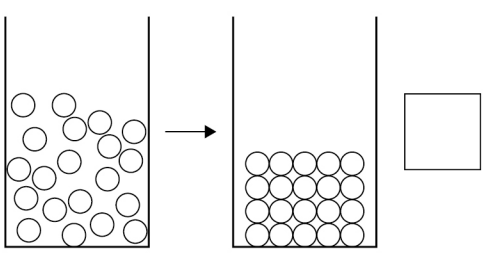
Tick (✓) **one** box.



☐



☐



☐

0 3 . 6 The density of steel decreases as it melts.

How does the spacing of the particles change as the steel melts?

[1 mark]

Question 05 · continued

0 3 . 7 Complete the sentence.

Choose the answer from the box.

[1 mark]

chemical	**permanent**	**physical**

Melting is an example of a _____ change.

0 3 . 8 Steel is a mixture of iron and a small amount of carbon.

Table 1 shows the mass of carbon in 1.0 kg of different types of steel.

Table 1

Type of steel	Mass of carbon in 1.0 kg of steel
Low carbon	2.0 g
Medium carbon	4.5 g
High carbon	7.0 g

A 4.0 kg piece of steel contains 18 grams of carbon.

Determine which type of steel the 4.0 kg piece is made from.

You should include a calculation in your answer.

[3 marks]

Type of steel _____

6.1.1.3 Energy changes in systems

Question 05 · continued

0 3 . 9 The 4.0 kg piece of solid steel was heated until it reached its melting point.

The additional energy required to melt the piece of steel was 280 000 J.

Calculate the specific latent heat of fusion of the steel.

Use the Physics Equations Sheet.

[3 marks]

Specific latent heat of fusion of steel = _____ J/kg

14

6.1.1.3 Energy changes in systems

Question 06

June 2024 | 8464/P/1F | Original Q2

0 2 **Figure 2** shows an outdoor swimming pool.

The water in the swimming pool comes from the sea.

Figure 2



The water in the pool is heated using a geothermal energy resource.

0 2 . 1 Which of the following describes a geothermal energy resource?

[1 mark]

Tick (✓) **one** box.

A non-renewable energy resource with high carbon emissions. ☐

A non-renewable energy resource with low running costs. ☐

A renewable energy resource that uses hot rocks underground. ☐

A renewable energy resource that uses the tides. ☐

6.1.1.3 Energy changes in systems

Question 06 · continued

0 2 . 2 15 kg of seawater is heated before it is added to the pool.

specific heat capacity of seawater = 3800 J/kg °C

Calculate the change in thermal energy of 15 kg of seawater when its temperature is increased by 9.0 °C.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

[2 marks]

Change in thermal energy = _____ J

0 2 . 3 The energy transferred from 1.0 m^2 of the surface of the pool to the air is 80 J each second.

The surface area of the pool is 120 m^2.

Calculate the energy transferred from the whole surface of the pool to the air each second.

[1 mark]

Energy transferred each second = _____ J

Question 2 continues on the next page

Question 06 · continued

0 2 . 4 Which of the following units is the same as 1 J/s?

[1 mark]

Tick (✓) **one** box.

1 N ☐

1 Pa ☐

1 W ☐

0 2 . 5 The pool is above sea level.

5.0 kg of water is pumped from sea level into the pool.

The water gains 196 J of gravitational potential energy.

gravitational field strength = 9.8 N/kg

Calculate the height of the pool above sea level.

Use the equation:

$$\text{height} = \frac{\text{gravitational potential energy}}{\text{mass} \times \text{gravitational field strength}}$$

[2 marks]

Height = _____ m

6.1.1.3 Energy changes in systems

Question 06 · continued

0 2 . 6 The water in some swimming pools is heated by burning fossil fuels.

Explain **one** environmental **disadvantage** of burning fossil fuels.

[2 marks]

9

Turn over for the next question

6.1.1.3 Energy changes in systems

Question 07

June 2025 | 8464/P/1F | Original Q6

0 6 A student investigated the specific heat capacity of aluminium.

The student used an electric heater to increase the temperature of an aluminium block.

The student measured the:

- mass of the block
- energy transferred to the block
- temperature change of the block.

Table 2 shows the results.

Table 2

Mass in kilograms	0.75
Energy transferred in joules	13 800
Temperature change in °C	20

0 6 . 1 Calculate the specific heat capacity of aluminium.

Use the Physics Equations Sheet.

[3 marks]

Specific heat capacity = _____ J/kg °C

6.1.1.3 Energy changes in systems

Question 07 · continued

0 6 . 2 Describe a method the student could have used to obtain the results in **Table 2**.

[6 marks]

Extra space

Question 6 continues on the next page

6.1.1.3 Energy changes in systems

Question 07 · continued

0 6 . 3 Wrapping the aluminium block in insulation makes the value for the specific heat capacity of aluminium more accurate.

Which are **two** reasons why?

[2 marks]

Tick (✓) **two** boxes.

- The amount of wasted energy is less. ☐
- The energy transferred to the aluminium block is greater. ☐
- The insulation heats the aluminium block. ☐
- The power of the electric heater increases. ☐
- The temperature increase of the aluminium block is greater. ☐

11