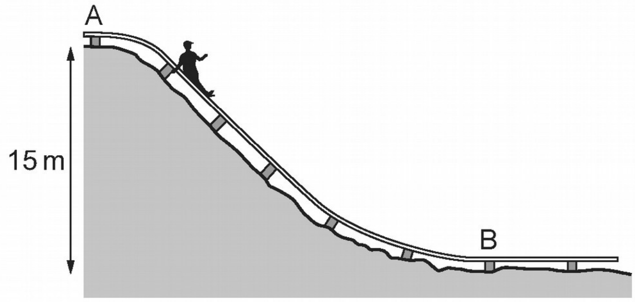
Eduqas Physics GCSE
Topic 1.1: Energy changes in a system
Questions by topic

1.

The diagrams show parts of an alpine coaster ride.



The first section of the ride is shown in the diagram on the right.
The cart and person of total mass 90 kg start from rest at A.

(a) (i) Use an equation from page 2 to calculate the change in potential energy of the cart and person when they move 15 m vertically downwards. [g = 10 N/kg] [2]

change in potential energy = ... J

(ii) I. Use an equation from page 2 to calculate the maximum possible speed at B. [2]

speed = ... m/s

II. Explain why the speed of the person would be different from your answer to the part above. [2]

....

....

....

(b) (i) The length of the track itself is 500 m. The vehicles (each of mass 15 kg) are dragged along the track back to the top of the ride **in stacks of 4**. The force required to drag them at constant speed is 200 N.
Use an equation from page 2 to calculate the total work done in dragging the stack back to the start of the ride. [1]

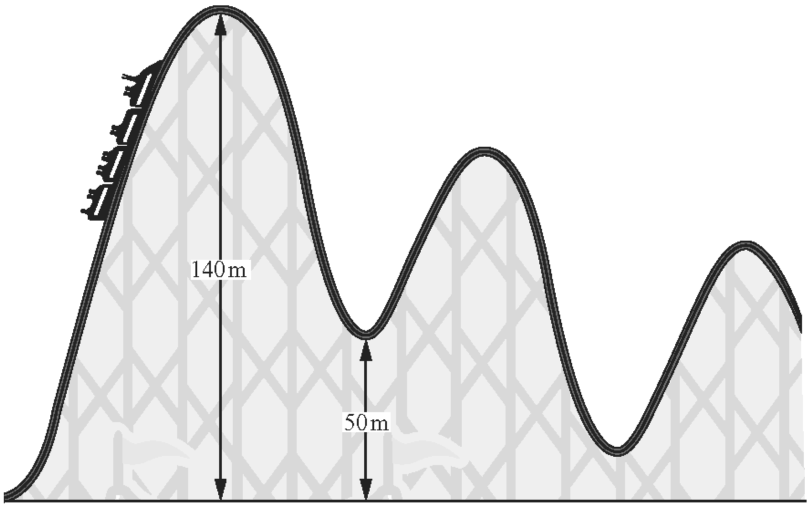
work = ... J

(ii) The complete ride involves a vertical drop of 120 m.
Calculate the percentage of the work done calculated in part *(b)*(i) that becomes potential energy. [2]

percentage = ... %

2.

A rollercoaster car has no engine. The car is pulled to the top of the first peak at the beginning of the ride, but after that the car must complete the ride on its own. Every peak on a rollercoaster must be lower than the one before it.



(a) Explain in terms of energy transfers how the car is able to complete the ride after being pulled to the top of the first peak and why each peak must be lower than the one before it. [6 QWC]

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(b) One of the world's tallest rollercoasters has an initial peak of height 140 m. After reaching the top, the car first falls to a height 50 m above the ground before it continues on its journey.

The mass of the car and passengers is 1 200 kg.

(i) Use equations from page 2 to calculate the theoretical maximum velocity of the car after this first fall. (g = 10 m/s^2) [4]

Maximum velocity = ... m/s

(ii) Discuss whether or not this theoretical maximum velocity depends on the mass of the passengers. [2]

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....

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(iii) In practice, the car reaches a velocity of 37 m/s after this first fall. The length of track on the fall is 100 m. Use equations from page 2 to calculate the mean resistive force on the car. [3]

Mean resistive force = ... N

15

3.

Use equations from page 2 to answer the following questions about a swimmer.

(a) A swimmer of mass 60 kg steps off a diving board, and enters the water with a kinetic energy of 2 940 J.

(i) Assuming that no air resistance acts on the swimmer, calculate a value for the height of the diving board. [3]
(gravitational field strength, g = 10 N/kg)

height = ... m

(ii) In practise, air resistance acts on the swimmer as he falls. State how and explain why the actual height of the diving board is different from your calculated value. [3]

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(b) (i) When swimming at constant speed, the kinetic energy of the swimmer is 7.5 J. Calculate the speed of the swimmer. [3]

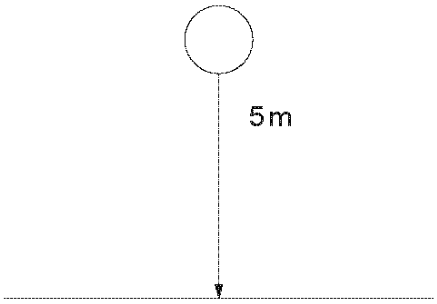
speed = ... m/s

(ii) The swimmer then glides to a stop in 2 m. Calculate the mean drag force acting on the swimmer. [3]

drag force = ... N

4.

A ball of mass 0.2 kg, initially at rest, is dropped from a height of 5 m.



Use equations from page 2 to answer the following questions.
Assume acceleration due to gravity = 10 m/s^2 and that air resistance is negligible.

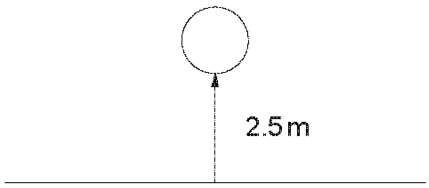
(i) Calculate the speed with which the ball hits the ground. [3]

speed = ... m/s

(ii) As the ball rebounds it loses **half of its kinetic energy**. Calculate the rebound speed. [2]

speed = ... m/s

(iii) The ball rebounds to a maximum height of 2.5 m. Calculate how long it takes to reach this height after it rebounds. [3]



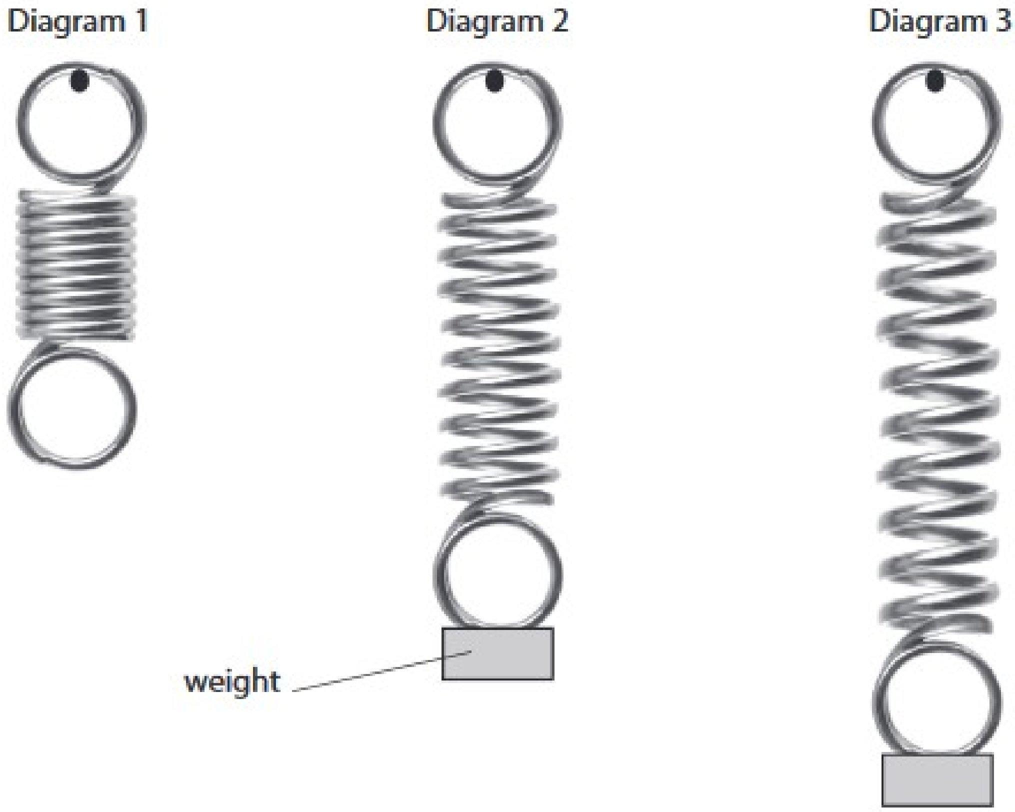
time = ... s

8

5.

(a) The diagrams show a spring hanging from a nail.

- In Diagram 1 there is no weight on the spring.
- Diagram 2 shows the spring after a weight is added.
- Diagram 3 shows the spring after the weight has been pulled down slightly.



(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

When held stationary as in Diagram 3,

(1)

☐ **A** the spring has zero elastic potential energy

☐ **B** the weight has equal amounts of elastic potential and kinetic energy

☐ **C** the weight has more kinetic energy than gravitational potential energy

☐ **D** the spring has more elastic potential energy than the weight has kinetic energy

(ii) The spring is stretched from the position shown in Diagram 2 to the position shown in Diagram 3.
The spring is then released.
Describe the energy changes that take place until the spring stops vibrating.

(3)

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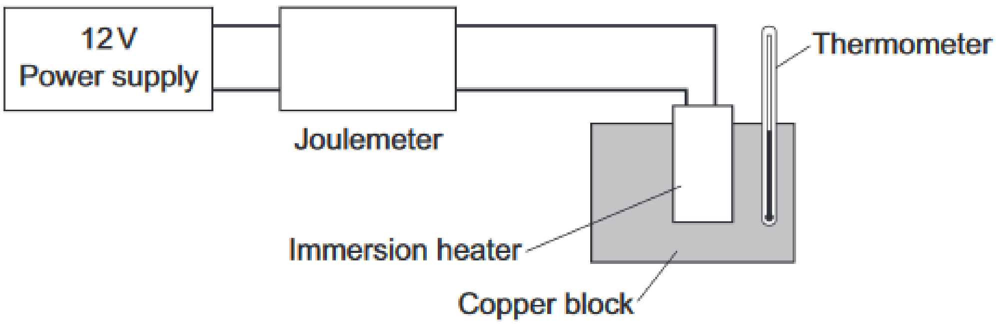
6.

A student used the apparatus in **Figure 7** to obtain the data needed to calculate the specific heat capacity of copper.

Figure 7



The initial temperature of the copper block was measured.

The power supply was switched on.

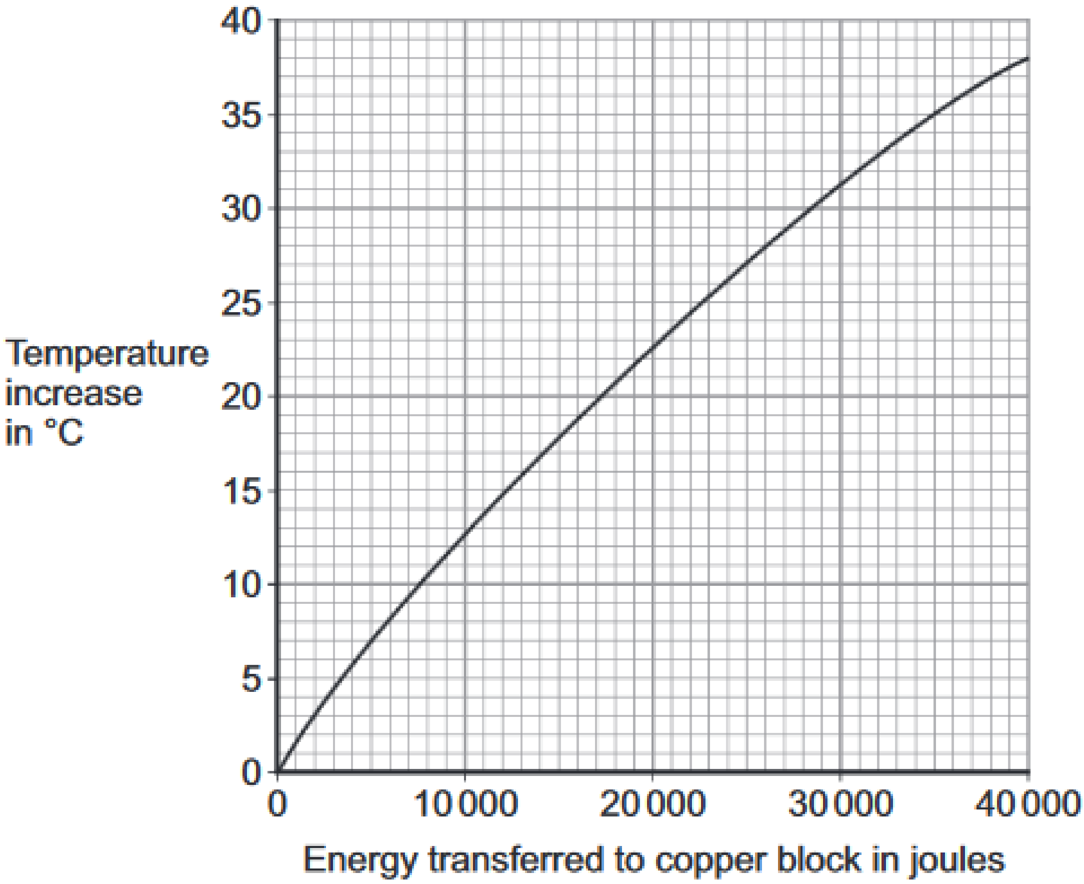
The energy transferred by the heater to the block was measured using the joulemeter.

The temperature of the block was recorded every minute.

The temperature increase was calculated.

Figure 8 shows the student's results.

Figure 8



(a) Energy is transferred through the copper block.

What is the name of the process by which the energy is transferred?

Tick (✓) **one** box.

[1 mark]

Conduction ☐

Convection ☐

Radiation ☐

(b) Use **Figure 8** to determine how much energy was needed to increase the temperature of the copper block by 35 °C.

[1 mark]

.... joules

(c) The copper block has a mass of 2 kg.

Use your answer to part **(b)** to calculate the value given by this experiment for the specific heat capacity of copper. Give the unit.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

....

....

....

....

Specific heat capacity = ...

(d) This experiment does **not** give the correct value for the specific heat of copper.

Suggest **one** reason why.

[1 mark]

....

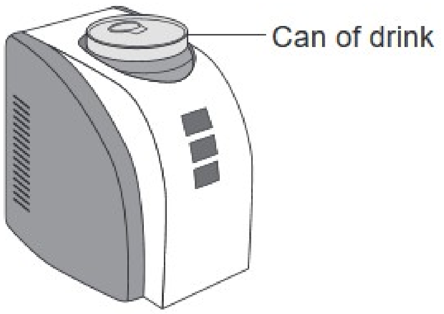
....

7.

A 'can-chiller' is used to make a can of drink colder.

Figure 7 shows a can-chiller.

Figure 7



(a) The initial temperature of the liquid in the can was 25.0 °C.
The can-chiller decreased the temperature of the liquid to 20.0 °C.
The amount of energy transferred from the liquid was 6930 J.
The mass of liquid in the can was 0.330 kg.

Calculate the specific heat capacity of the liquid.

Give the unit.

Use the correct equation from the Physics Equations Sheet.

[4 marks]

....

....

....

....

Specific heat capacity = ... unit ....

(b) Energy is transferred through the metal walls of the can of drink by conduction. Explain how.

[4 marks]

....

....

....

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....

(c) The energy from the can of drink is transferred to the air around the can-chiller. A convection current is set up around the can-chiller. Explain how.

[3 marks]

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(d) The can-chiller has metal cooling fins that are designed to transfer energy quickly to the surroundings.

Give **two** features that would help the metal cooling fins to transfer energy quickly to the surroundings.

[2 marks]

1 ....

2 ....

8.

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

....

....

.... [2]

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

The following data are obtained.

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

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

specific heat capacity = ... [4]

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

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

1. ....

2. ....

[2]

[Total: 8]

9.

(a) State what is meant by the *specific latent heat of fusion* (*melting*) of a substance.

....

....[2]

(b) Ice cubes of total mass 70 g, and at 0 °C, are put into a drink of lemonade of mass 300 g.

All the ice melts as 23 500 J of thermal energy transfers from the lemonade to the ice. The final temperature of the drink is 0 °C.

(i) Calculate the specific latent heat of fusion for ice.

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

(ii) The thermal energy that causes the ice to melt is transferred from the lemonade as it cools. The loss of this thermal energy causes the temperature of the 300 g of the lemonade to fall by 19 °C.

Calculate the specific heat capacity of the lemonade.

specific heat capacity = ...[2]

(iii) The melting ice floats on top of the lemonade.

Explain the process by which the lemonade at the bottom of the drink becomes cold.

....

....

....[2]

[Total: 8]

10.

(a) An object of mass m and specific heat capacity c is supplied with a quantity of thermal energy Q. The temperature of the object increases by $\Delta\theta$.

Write down an expression for c in terms of Q, m and $\Delta\theta$.

c = ... [1]

(b) Fig. 4.1 shows the heating system of a hot water shower.

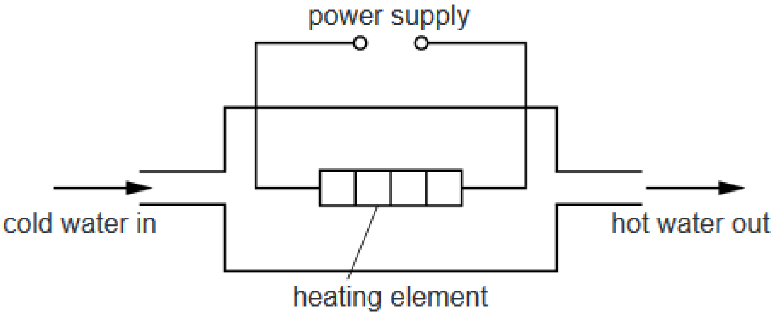


Fig. 4.1

Cold water at 15 °C flows in at the rate of 0.0036 m^3/minute. Hot water flows out at the same rate.

(i) Calculate the mass of water that passes the heating element in one minute. The density of water is 1000 kg/m^3.

mass = ... [2]

(ii) The power of the heating element is 8.5 kW.

Calculate the temperature of the hot water that flows out. The specific heat capacity of water is 4200 J/(kg °C).

temperature = ... [4]

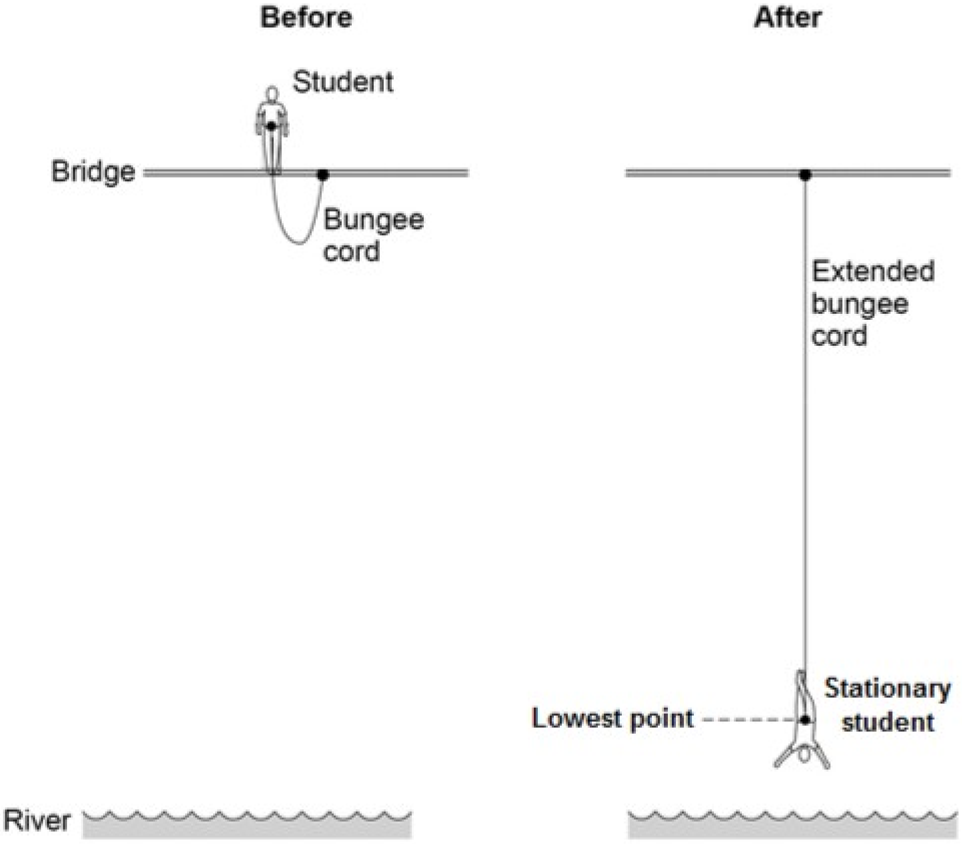
[Total: 7]

11.

Figure 2 shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20 m.

Figure 2



1 For safety reasons, it is important that the bungee cord used is appropriate for the student's weight.

Give **two** reasons why.

[2 marks]

1 ____

____

2 ____

____

2 The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

[3 marks]

elastic potential	**gravitational potential**	**kinetic**	**sound**	**thermal**

Before the student jumps from the bridge he has a store of

______________________ energy.

When he is falling, the student's store of ______________ energy increases.

When the bungee cord is stretched, the cord stores energy as

______________________ energy.

3 At the lowest point in the jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N/m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

Energy = ______________ J