# WJEC Physics GCSE
# Topic 2.3: Work and energy
## Questions by topic

**1.**

A car of mass 800 kg is moving at a constant velocity of 10 m/s. It has 40 000 J of kinetic energy.

*(a)* (i) Use the equation:

momentum = mass × velocity

to find the momentum of the car at this velocity. [2]

momentum = .................................... kg m/s

(ii) A braking force of 2 500 N is applied to reduce the car's kinetic energy to zero.

Use the equation:

$$\text{distance} = \frac{\text{work}}{\text{force}}$$

to calculate the distance the car travels until it stops. [2]

distance = .................................... m

(iii) State the momentum of the car when it has stopped. [1]

momentum = .................................... kg m/s

(iv) A van, of greater mass than the car, also moves at 10 m/s. The van needs to stop in the same time as the car.

Underline two quantities in the box which are bigger for the van than the car. [2]

| | | | |
|---|---|---|---|
| its velocity | its kinetic energy | its momentum | its deceleration |

*(b)* The table shows how the thinking distance, braking distance and overall stopping distance depend upon the speed of a car.

| Speed (m/s) | Thinking distance (m) | Braking distance (m) | Overall stopping distance (m) |
|---|---|---|---|
| 9 | 6 | 6 | 12 |
| 13.5 | 9 | 14 | .................. |
| 18 | 12 | 24 | 36 |
| 27 | .................. | 56 | 74 |

(i) **Complete the table.** [2]

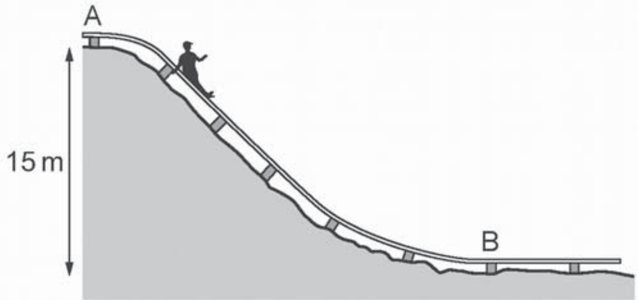
(ii) Use the information in the table to help you complete the sentences below. [2]

As the speed doubles, the thinking distance ..........................................................................

As the speed doubles, the braking distance ..........................................................................

**2 (HIGHER).**

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]

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(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 = .................................... %

**3 (part (b) HIGHER).**

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 2940 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]

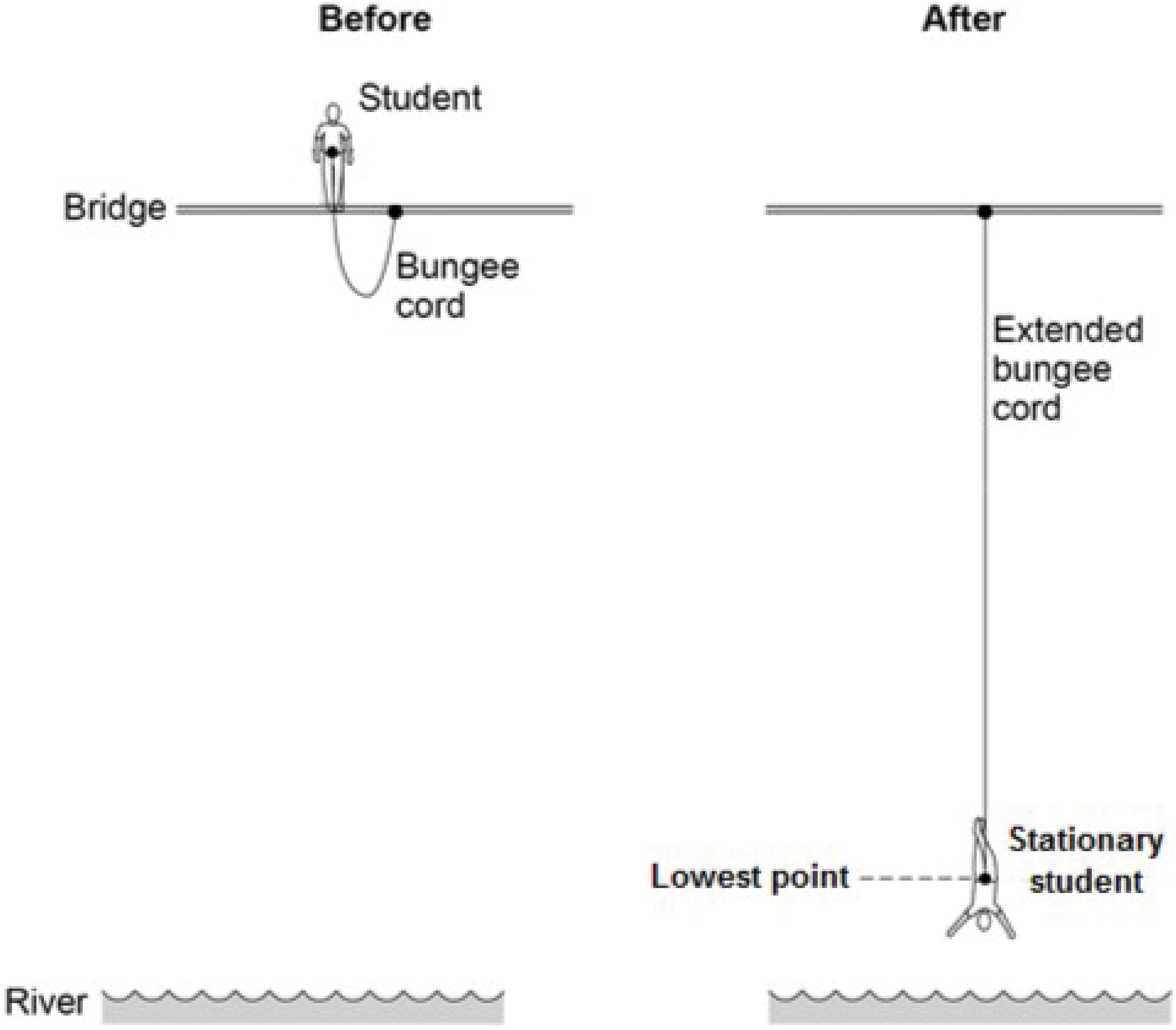
drag force = .......................................... N

4 (part (iii) HIGHER).

**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.

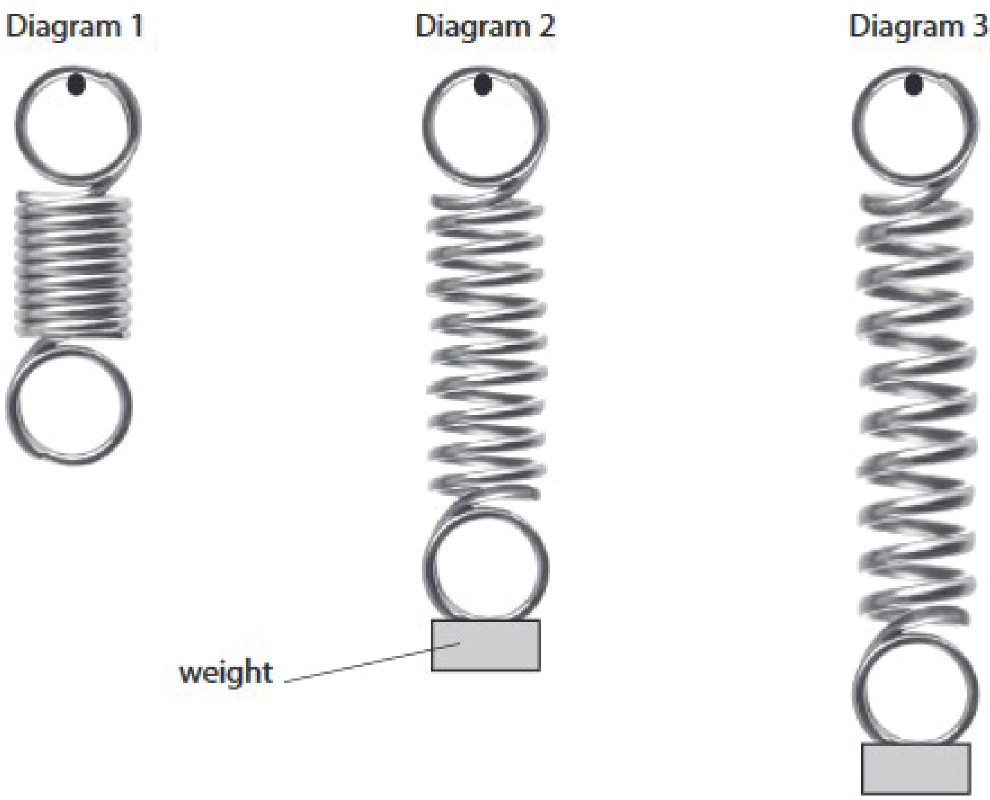
**[2 marks]**

Energy = ____________ J

**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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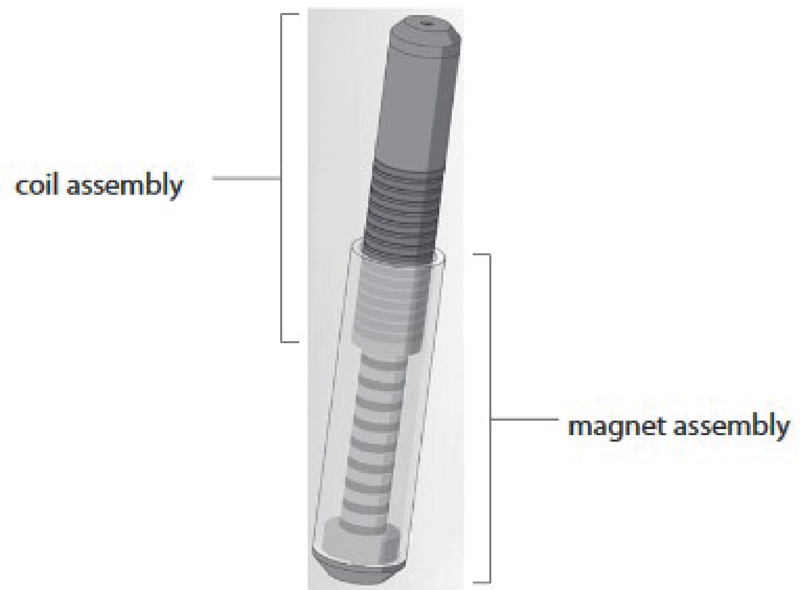
(b) Shock absorbers with springs are used on some motorcycles.
These shock absorbers reduce the bounce on an uneven road.
A new shock absorber has been developed to convert some of the movement energy into another form.
It consists of magnets which slide inside a coil when the motorcycle goes over a bump.



Some of the energy which would otherwise be wasted can be recovered and so fuel is saved.

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

This device is designed to

(1)

☒ **A** increase the thermal energy obtained from the fuel

☒ **B** increase the efficiency of the motorcycle

☒ **C** decrease the speed of the motorcycle

☒ **D** decrease the braking power of the motorcycle

(ii) Explain how this new type of shock absorber can provide electrical energy.

(2)

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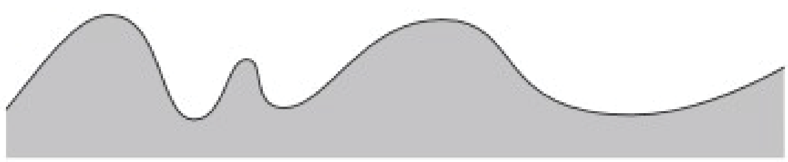
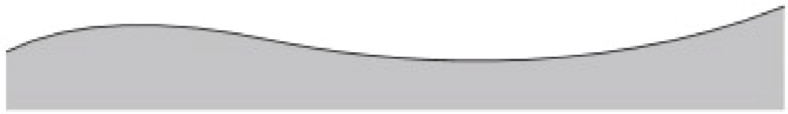
(iii) The diagram shows the bumps on the surface of two roads, L and M.
Explain why the device will transfer more energy on road L than on road M for a motorcycle travelling at the same speed.

(3)



road L



road M

6.

Cars are built with a number of safety features to reduce the chance of injury to the passengers during a collision.

Seat belts and airbags are two of these features.


Use ideas about forces to explain why passengers are injured in a collision and how seat belts and airbags reduce the injury.

*The quality of written communication will be assessed in your answer.*

[6]

**7.**

Cars have a number of features that make them safer in a collision.

(a) Apart from seat belts, name two safety features that reduce the risk of serious injury in a car crash.

**(2)**

1 ..................................................................................................................................................

2 ..................................................................................................................................................

(b) Photograph A shows a person wearing a seat belt.


Photograph A

(i) Using ideas of momentum and force, explain how a seat belt reduces the risk of serious injury in a car crash.

**(4)**

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(ii) Photograph B shows a full-body harness used in a racing car.

full-body harness

Photograph B

Suggest why a full-body harness is used in a racing car, instead of an ordinary seatbelt.

**(1)**

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(c) Photograph C shows a crash-test dummy in a car. The car has crashed into a concrete wall.



Photograph C

State what happens to the momentum of the car during the crash.

**(1)**