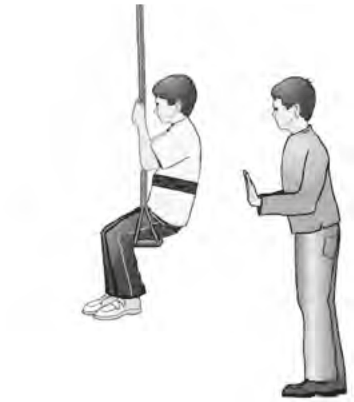
The swing

1 A child is stationary on a swing.



(a) The child is given a push by his brother to start him swinging.
His brother applies a steady force of 84 N over a distance of 0.25 m.

(i) Calculate the work done by this force.

(2)

work done = ... J

(ii) State how much energy is transferred by this force.

(1)

energy transferred = ... J

(iii) After several more pushes, the child has a kinetic energy of 71 J.

The mass of the child is 27 kg.

Show that the velocity of the child at this point is about 2.3 m/s.

(2)

(iv) Which one of these quantities changes in both size and direction while he is swinging?

Put a cross (☒) in the box next to your answer.

(1)

☐ **A** his gravitational potential energy

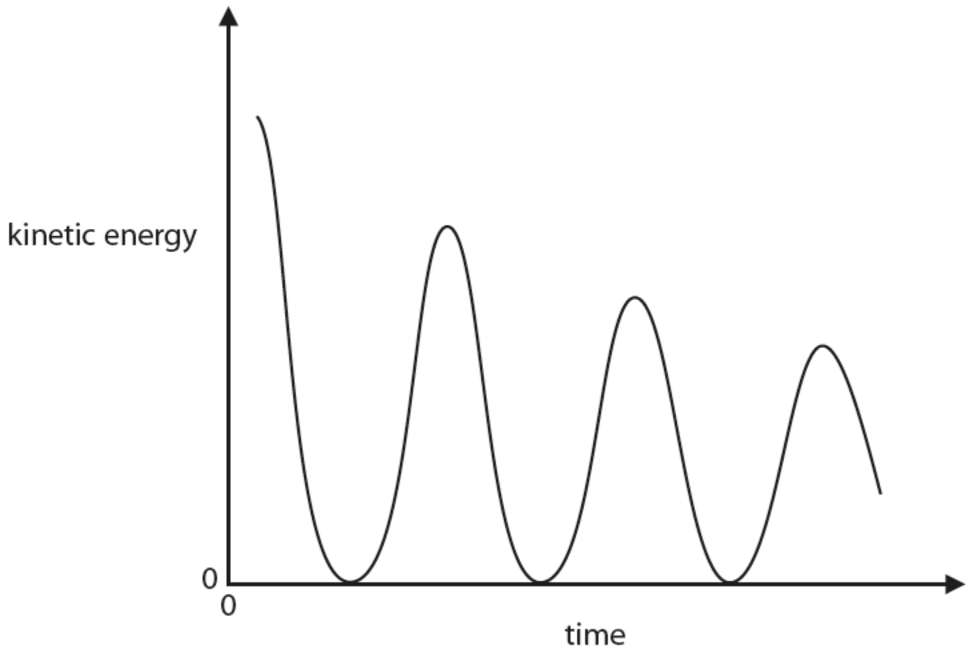
☐ **B** his momentum

☐ **C** the force of gravity acting on him

☐ **D** his kinetic energy

*(b) The brother then stops pushing the child.

The graph shows how the kinetic energy of the child varies over the next few swings.



Explain the energy changes during this time.

(6)

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(Total for Question 5 = 12 marks)

2 The efficiency of an electric motor is investigated as shown in Figure 11.

The motor lifts a mass at a constant speed.

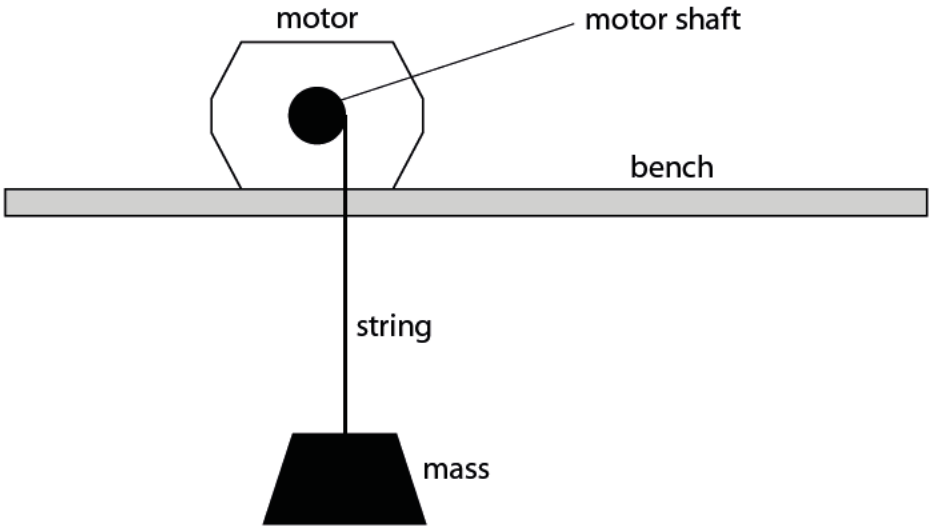

Figure 11

The results are shown in Figure 12.

current in motor	1.9 A
voltage across motor	10.0 V
time taken to lift mass	9.0 s

Figure 12

(a) (i) Which of these changes would improve the results?

(1)

☐ **A** Repeating the investigation with different masses

☐ **B** Repeating the readings and calculating averages

☐ **C** Using a motor that works with a higher voltage

☐ **D** Using a shorter piece of string to lift the mass

(ii) Which of thes lifted?

(1)

		kinetic energy of the mass	potential energy of the mass
☒	**A**	constant	increasing
☒	**B**	constant	decreasing
☒	**C**	decreasing	increasing
☒	**D**	decreasing	decreasing

(b) (i) Show that the total energy supplied to the motor in the 9 s is about 170 J.

(2)

(ii) During the 9 s the efficiency of the motor is 70%.

Calculate the amount of useful energy transferred in the 9 s.

Use the equation

$$\text{efficiency} = \frac{\text{useful energy transferred}}{\text{total energy supplied}}$$

(3)

useful energy = ... J

(c) Which row of the table is correct for the resistance of the motor?

(1)

	resistance of motor =	resistance of motor =
☒ **A**	$I \div V$	$I^2 \div P$
☒ **B**	$V \div I$	$P \div I^2$
☒ **C**	$V \div I$	$P \times I^2$
☒ **D**	$I \times V$	$P \div I^2$

(d) When the motor lifts the mass, the coil in the motor becomes warm.

Explain why the coil becomes warm.

(3)

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(Total for Question 5 = 11 marks)

3 Figure 1 shows part of a roller coaster ride seen from the side.

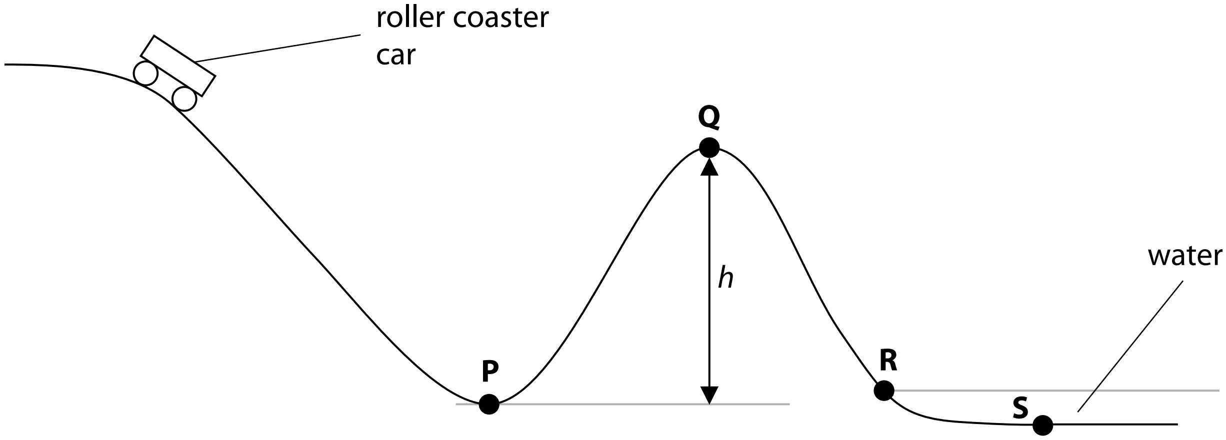


Figure 1

(a) The roller coaster car rolls down towards **P**. The car has mass, m kg and velocity v m/s.

Which of these is the correct equation for calculating the kinetic energy of the car?

(1)

☒ **A** $KE = mv$

☒ **B** $KE = mv^2$

☒ **C** $KE = \frac{1}{2}mv^2$

☒ **D** $KE = 2mv^2$

(b) The mass of the car is 580 kg.

The car gains 39 000 J of gravitational potential energy as it climbs from **P** to **Q**.

(i) State the equation relating change in gravitational potential energy, mass, gravitational field strength and change in vertical height.

(1)

(ii) Calculate the height *h*, shown in Figure 1.

(gravitational field strength, g = 10 N/kg)

(3)

h = ... m

(c) The car enters a pool of water at **R**. It slows down and stops at **S**.

Describe how the total energy of the system is conserved as the car travels between **R** and **S**.

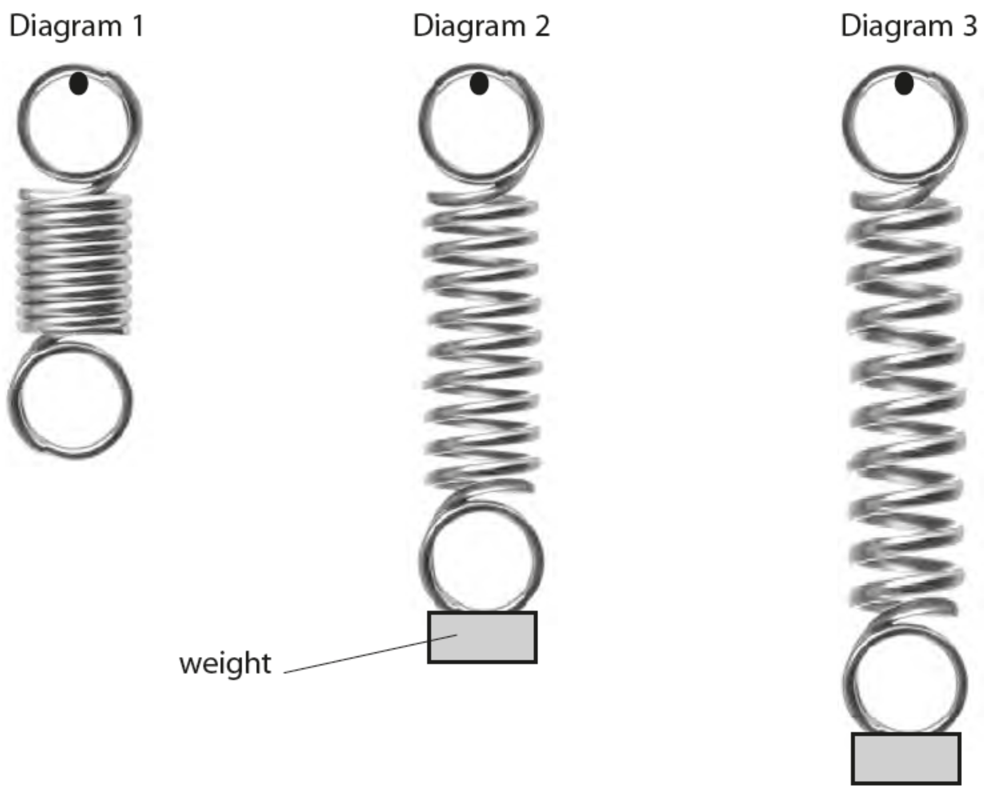
(2)

(Total for Question 1 = 7 marks)

Springs and shock absorbers

4 (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 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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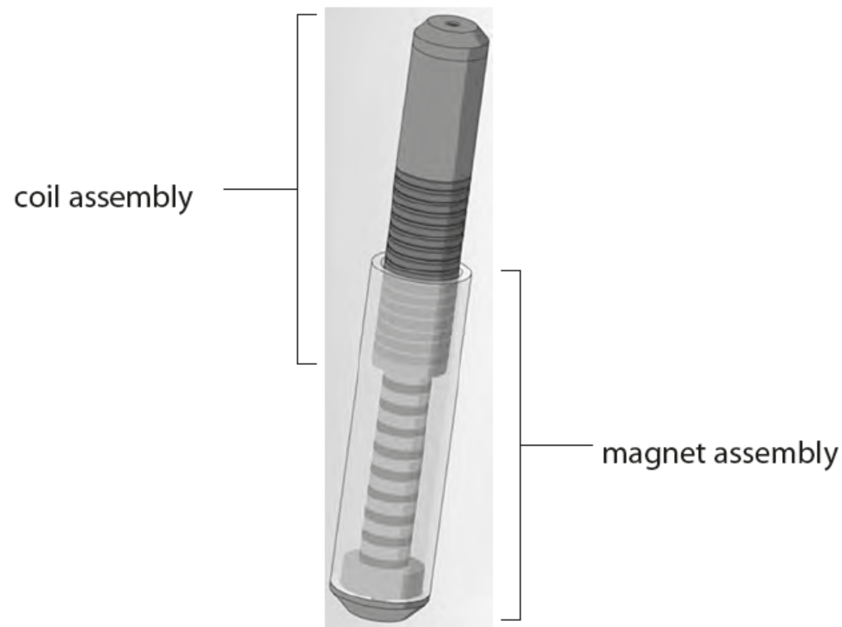
(b) Shock absorbers with springs are used on some motorcycles.
These shock absorbers reduce the bounce on an uneven road.
A new shock absorber has been developed to convert some of the movement energy into another form.
It consists of magnets which slide inside a coil when the motorcycle goes over a 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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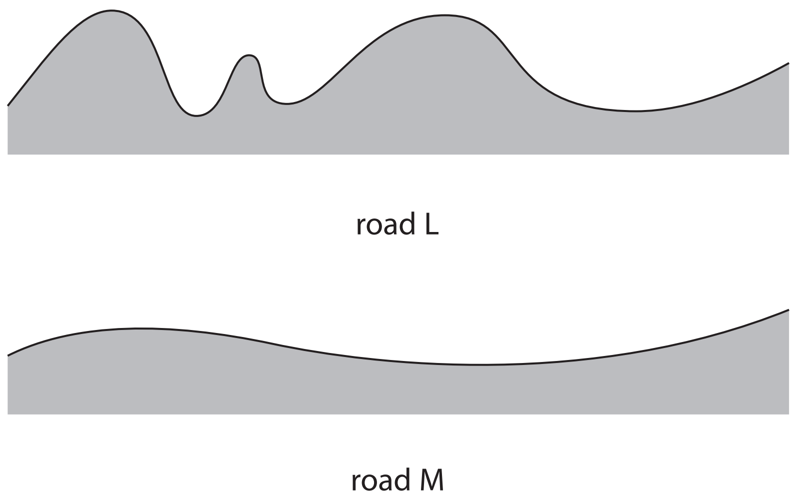
(iii) The diagram shows the bumps on the surface of two roads, L and M.
Explain why the device will transfer more energy on road L than on road M for a motorcycle travelling at the same speed.

(3)



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(Total for Question 3 = 10 marks)