

# Forces and energy

## Question Paper

Level	IGCSE
Subject	Physics (4403)
Exam Board	AQA
Unit	P2
Topic	The Kinetic Energy of Objects Speeding Up or Slowing Down
Sub-Topic	Forces and energy
Booklet	Question Paper

**Time Allowed:** 59 minutes

**Score:** /59

**Percentage:** /100

**Grade Boundaries:**

**Q1.**Quantities in physics are either scalars or vectors.

- (a) Use the correct answers from the box to complete the sentence.

<b>acceleration</b>	<b>direction</b>	<b>distance</b>	<b>speed</b>	<b>time</b>
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Velocity is ..... in a given .....

(2)

- (b) Complete the table to show which quantities are scalars and which quantities are vectors.

Put **one** tick (✓) in each row.

The first row has been completed for you.

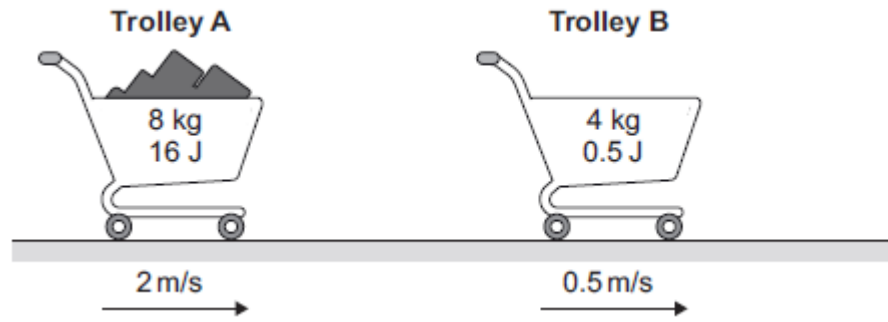
<b>Quantity</b>	<b>Scalar</b>	<b>Vector</b>
Momentum		✓
Acceleration		
Distance		
Force		
Time		

(3)

- (c) The diagram shows two supermarket trolleys moving in the same direction.

Trolley **A** is full of shopping, has a total mass of 8 kg and is moving at a velocity of 2 m / s with a kinetic energy of 16 J.

Trolley **B** is empty, has a mass of 4 kg and is moving at a velocity of 0.5 m / s with a kinetic energy of 0.5 J.



- (i) Calculate the momentum of both trolley **A** and trolley **B**.

Give the unit.

Use the correct equation from the Physics Equations Sheet.

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Momentum of trolley **A** = .....

Momentum of trolley **B** = .....

Unit .....

(4)

- (ii) The trolleys in the diagram collide and join together. They move off together.

Calculate the velocity with which they move off together.

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Velocity = ..... m / s

(3)

- (iii) In a different situation, the trolleys in the diagram move at the same speeds as before but now move towards each other.

Calculate the total momentum and the total kinetic energy of the two trolleys before they collide.

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Total momentum = .....

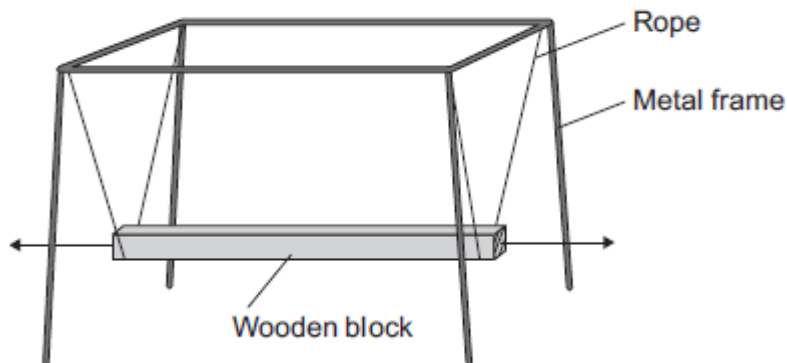
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Total kinetic energy = ..... J

(2)  
(Total 14 marks)

Q2. Figure 1 shows the design of a playground ride.

Figure 1



A large wooden block rests on ropes. The ropes are attached to a metal frame.

Children sit on the wooden block.

When the wooden block is moved to the left and released it moves to and fro.

When the wooden block returns to the point of release it has completed one cycle.

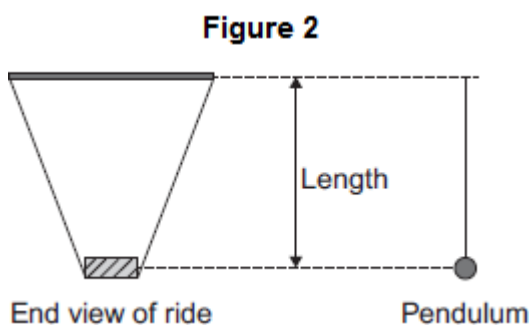
(a) Identify **two** possible hazards of the ride in **Figure 1**.

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(2)

- (b) The designer of the ride wants to know if the ride has the same time period as a pendulum of the same length.

The designer used a model of the ride and a pendulum as shown in **Figure 2**.



The designer measured the time taken to complete 10 cycles for different lengths of both the model ride and the pendulum.

The results for the model ride are shown in **Table 1**.

**Table 1**

Length in metres	Time for 10 cycles in seconds				Mean time period in seconds
	First time	Second time	Third time	Mean	
0.100	6.36	6.37	6.29	6.34	0.63
0.150	7.76	7.74	7.80		
0.200	8.97	8.99	8.95	8.97	0.90

The results for the pendulum are shown in **Table 2**.

**Table 2**

Length in metres	Time for 10 cycles in seconds				Mean time period in seconds
	First time	Second time	Third time	Mean	
0.250	10.00	10.04	10.02	10.02	1.00
0.300	10.99	11.01	10.94	10.98	1.10
0.350	11.88	11.83	11.87	11.86	1.19

- (i) Complete **Table 1**, giving values to an appropriate number of significant figures.

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(3)

- (ii) The investigation already includes repeated readings.

Suggest **one** improvement that could be made to this investigation.

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(1)

- (iii) The designer reads in an Advanced Physics textbook that:  
'The square of the time period,  $T$ , for a simple pendulum is proportional to its length,  $l$ .'

$$T^2 \propto l$$

Would the model ride have the same time period as a simple pendulum of the same length?

Use **one** row of data from **Table 1** and **one** row of data from **Table 2** to work out your answer.

State your conclusion.

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(3)

- (c) The ride was redesigned and built to make it safer.

The wood was moving at maximum speed. The maximum kinetic energy of the wood was 180 J.

A parent applied a force to the wood and stopped it in a distance of 0.25 m.

Calculate the force required.

Use the correct equation from the Physics Equations Sheet.

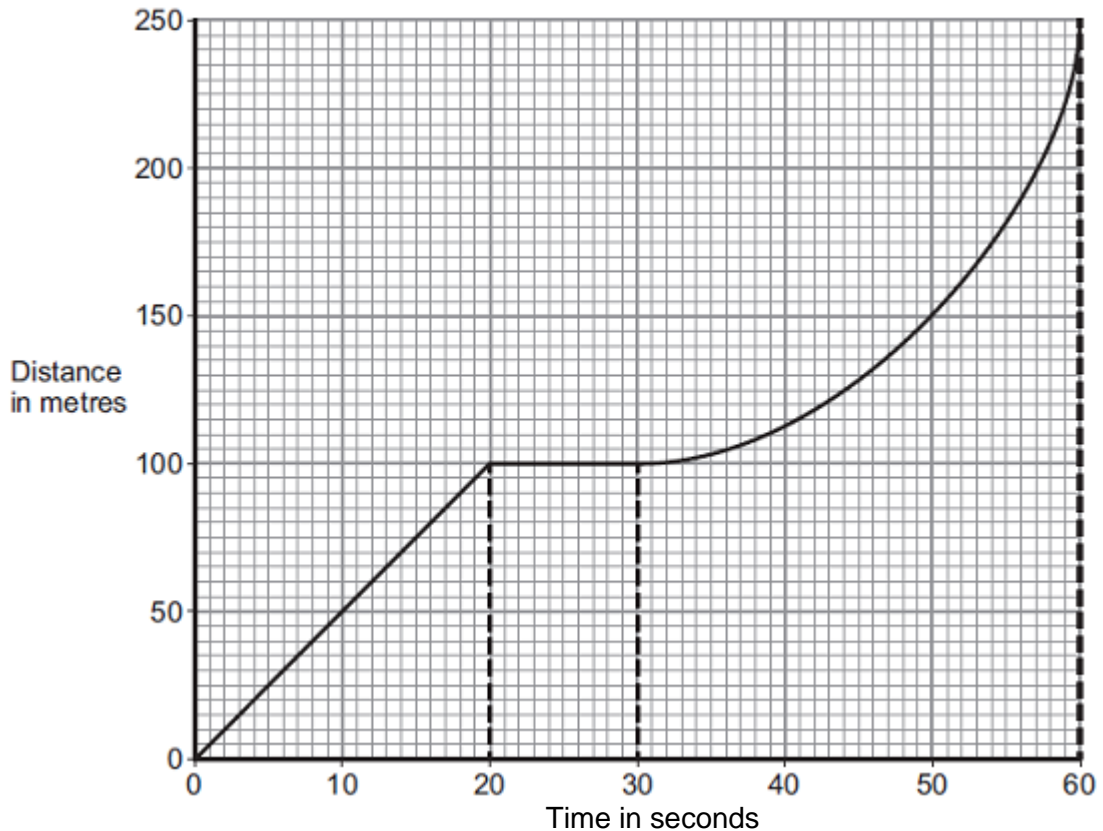
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Force = ..... N

(3)  
 (Total 12 marks)

**Q3.**A bus is taking some children to school.

- (a) The bus has to stop a few times. The figure below shows the distance–time graph for part of the journey.



- (i) How far has the bus travelled in the first 20 seconds?

Distance travelled = ..... m

(1)

(ii) Describe the motion of the bus between 20 seconds and 30 seconds.

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(1)

(iii) Describe the motion of the bus between 30 seconds and 60 seconds.

Tick (✓) **one** box.

	Tick (✓)
Accelerating	
Reversing	
Travelling at constant speed	

(1)

(iv) What is the speed of the bus at 45 seconds?

Show clearly on the figure above how you obtained your answer.

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Speed = ..... m / s

(3)

(b) Later in the journey, the bus is moving and has 500 000 J of kinetic energy.

The brakes are applied and the bus stops.

(i) How much work is needed to stop the bus?

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Work = ..... J

(1)



- (ii) The bus stopped in a distance of 25 m.

Calculate the force that was needed to stop the bus.

Use the correct equation from **Section A** of the Physics Equations Sheet.

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Force = ..... N

(2)

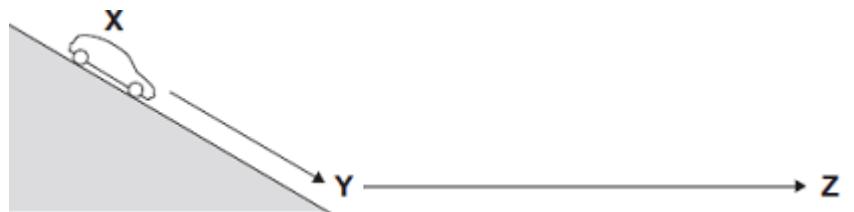
- (iii) What happens to the kinetic energy of the bus as it is braking?

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(2)

(Total 11 marks)

- Q4.(a) The diagram shows a car at position X.



The handbrake is released and the car rolls down the slope to Y.  
The car continues to roll along a horizontal surface before stopping at Z.  
The brakes have **not** been used during this time.

- (i) What type of energy does the car have at X?

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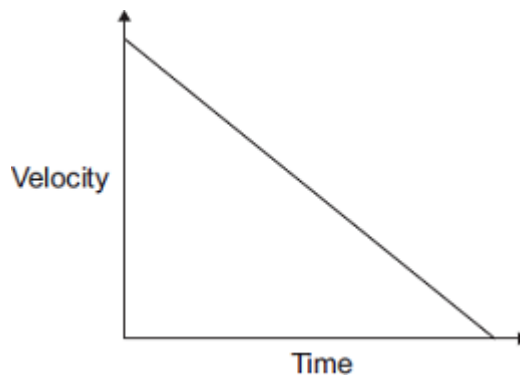
(1)

- (ii) What type of energy does the car have at **Y**?

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(1)

- (b) The graph shows how the velocity of the car changes with time between **Y** and **Z**.



- (i) Which feature of the graph represents the negative acceleration between **Y** and **Z**?

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(1)

- (ii) Which feature of the graph represents the distance travelled between **Y** and **Z**?

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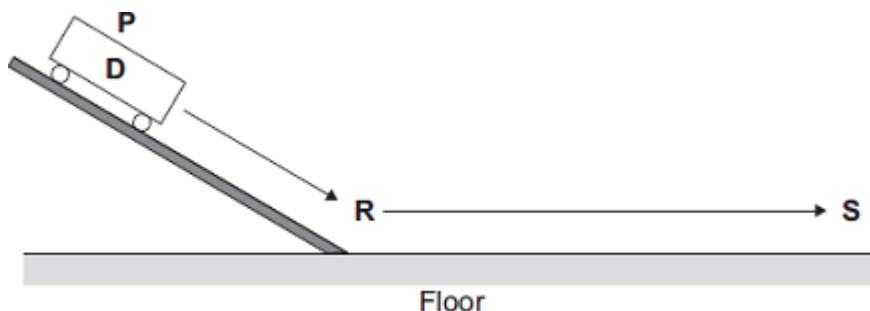
(1)

- (iii) The car starts again at position **X** and rolls down the slope as before. This time the brakes are applied lightly at **Y** until the car stops.

Draw on the graph another straight line to show the motion of the car between **Y** and **Z**.

(2)

- (c) Three students carry out an investigation. The students put trolley **D** at position **P** on a slope. They release the trolley. The trolley rolls down the slope and along the floor as shown in the diagram.



The students measure the distance from **R** at the bottom of the slope to **S** where the trolley stops. They also measure the time taken for the trolley to travel the distance **RS**.

They repeat the investigation with another trolley, **E**.

Their results are shown in the table.

Trolley	Distance RS in centimetres	Time taken in seconds	Average velocity in centimetres per second
<b>D</b>	65	2.1	
<b>E</b>	80	2.6	

- (i) Calculate the average velocity, in centimetres per second, between **R** and **S** for trolleys **D** and **E**. Write your answers in the table.

Use the correct equation from **Section A** of the Physics Equations Sheet.

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(3)

(ii) Before the investigation, each student made a prediction.

- Student 1 predicted that the two trolleys would travel the same distance.
- Student 2 predicted that the average velocity of the two trolleys would be the same.
- Student 3 predicted that the negative acceleration of the two trolleys would be the same.

Is each prediction correct?

Justify your answers.

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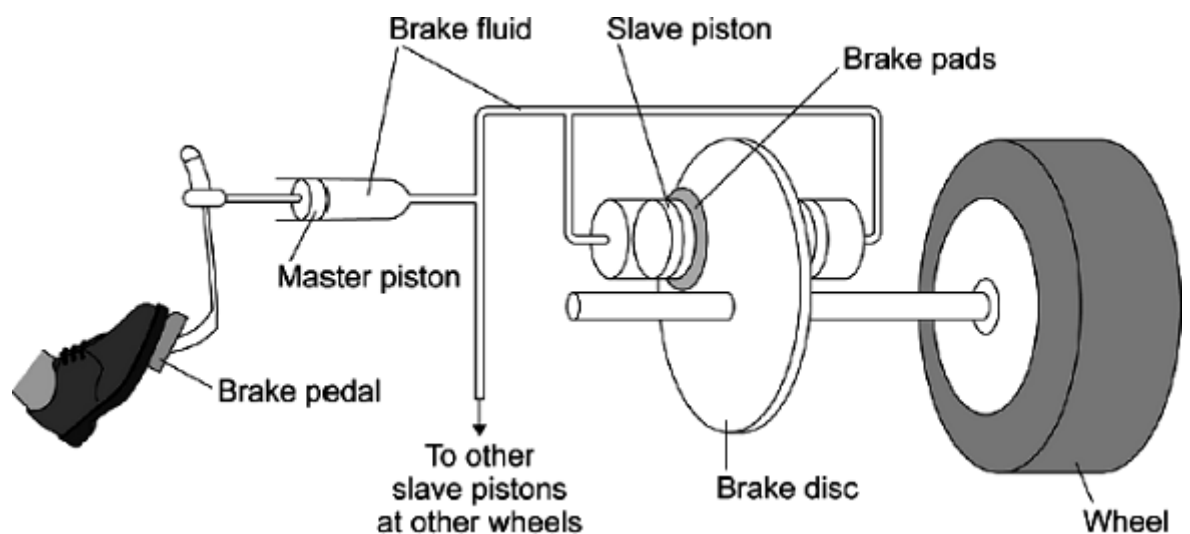
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(3)  
(Total 12 marks)

Q5.(a) The diagram shows part of the hydraulic brake system for a car.



What property of a liquid is essential for a hydraulic brake system to work?

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(1)

- (b) Describe how a force exerted on the brake pedal leads to a force acting on each of the brake discs.

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(5)

- (c) Applying the brakes of a car leads to an increase in the temperature of the brakes. Explain why.

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(4)

(Total 10 marks)