Cars and safety

1 (a) Which of these situations can increase the reaction time of a driver?

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

(1)

- ☒ **A** an icy road
- ☒ **B** worn tyres on his car
- ☒ **C** stopping for a cup of coffee
- ☒ **D** driving for a long time without taking a break

(b) (i) A car engine produces an average driving force of 1200 N.

The car travels 8.0 m.

Calculate the work done by the force over this distance.

(2)

work done = ... J

(ii) The car has a mass of 1400 kg and travels at a velocity of 25 m/s.

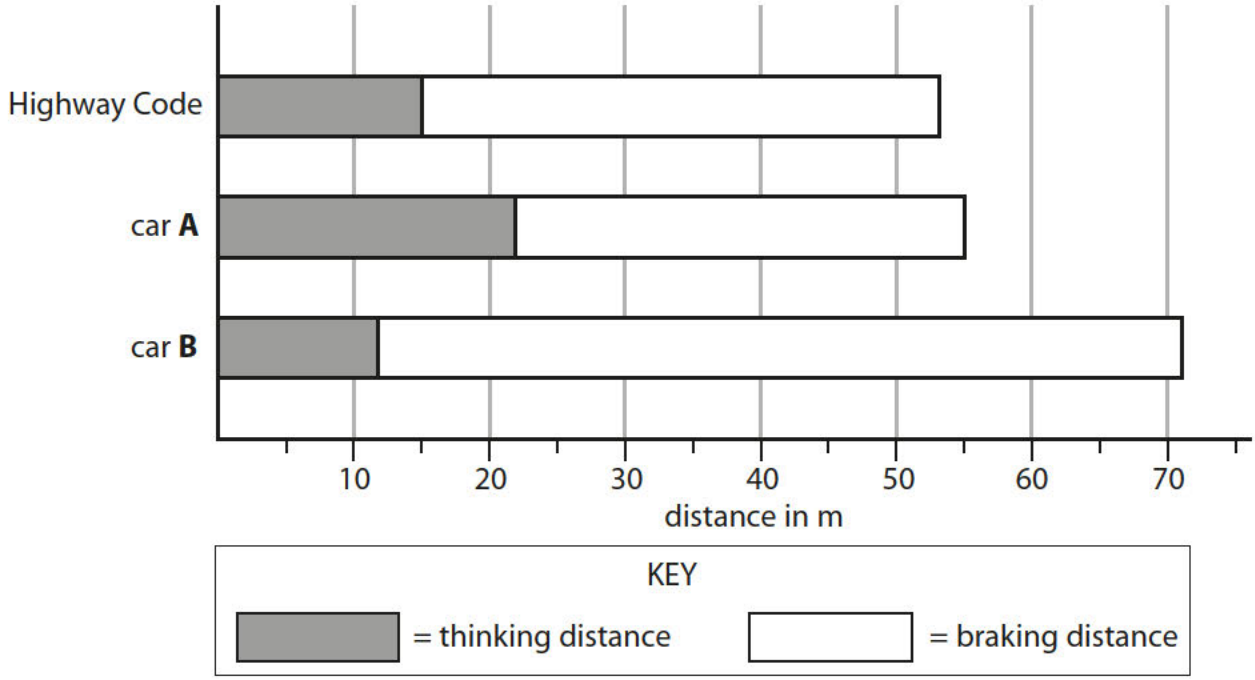
Calculate the kinetic energy of the car.

(3)

kinetic energy = ... J

*(c) The chart shows the thinking, braking and stopping distances for an average car and driver stopping from 50 miles per hour as shown in the Highway Code.

It also shows the thinking, braking and stopping distances for drivers of cars **A** and **B**, both stopping from 50 miles per hour.



A and **B** are different cars on different roads.

Use the factors that can affect thinking and braking distances to explain the differences in stopping distances for cars **A** and **B**.

(6)

(Total for Question 5 = 12 marks)

Modelling meteorite impacts

2 Some students investigate a model of the craters produced by meteorite impacts.

They drop balls into a tray filled with sand.

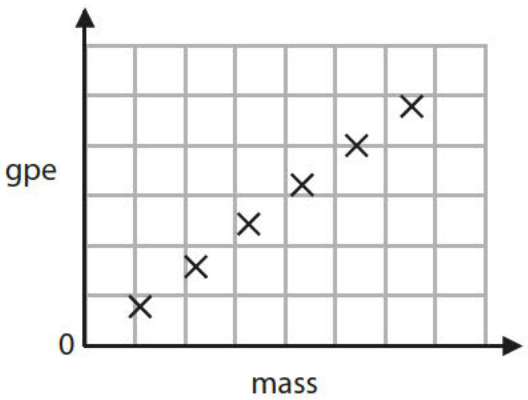
They use six balls with different masses.

They drop each ball from the same height.

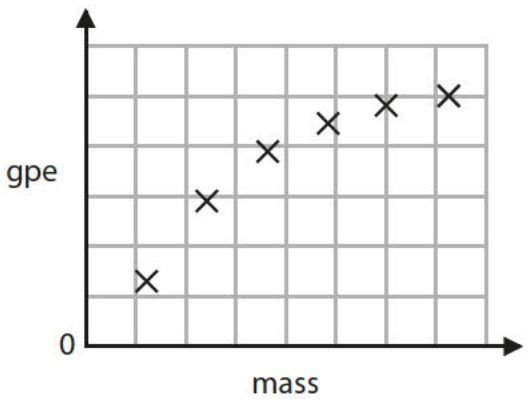
(a) (i) Which one of these graphs shows the relationship between the gravitational potential energy (gpe) of the balls and their mass when they are all at the same height?

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

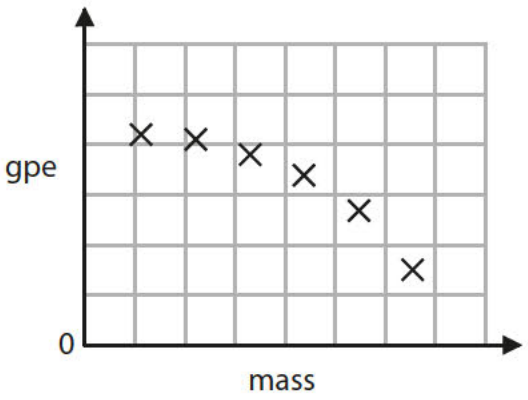
(1)



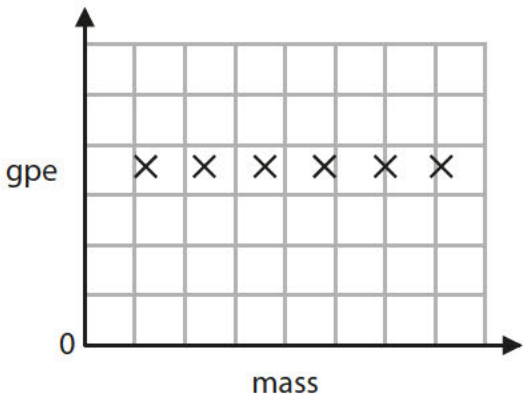
☐ **A**



☐ **B**



☐ **C**



☐ **D**

(ii) Describe how the energy of a ball changes as it drops towards the sand.

(2)

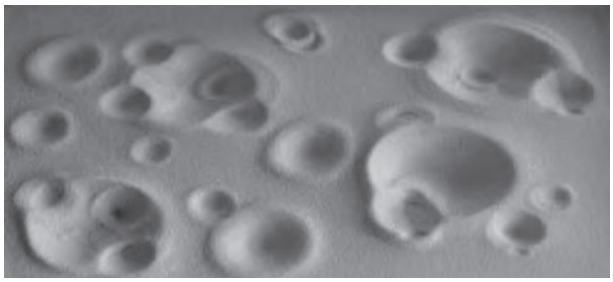
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(b) This photograph shows the sand after several balls have hit it.



The students read this information in a textbook:

'When work is done, energy is transferred.'

Explain how work is done when the balls impact on the sand.

(2)

.....

.....

.....

.....

(c) When one ball hits the sand, it has a velocity of 6.2 m/s.

It has a momentum of 0.46 kg m/s.

(i) Calculate the mass of the ball.

(3)

mass of ball = ... kg

(ii) The ball takes 0.17 s to come to rest after it hits the sand.

Calculate the average impact force.

(2)

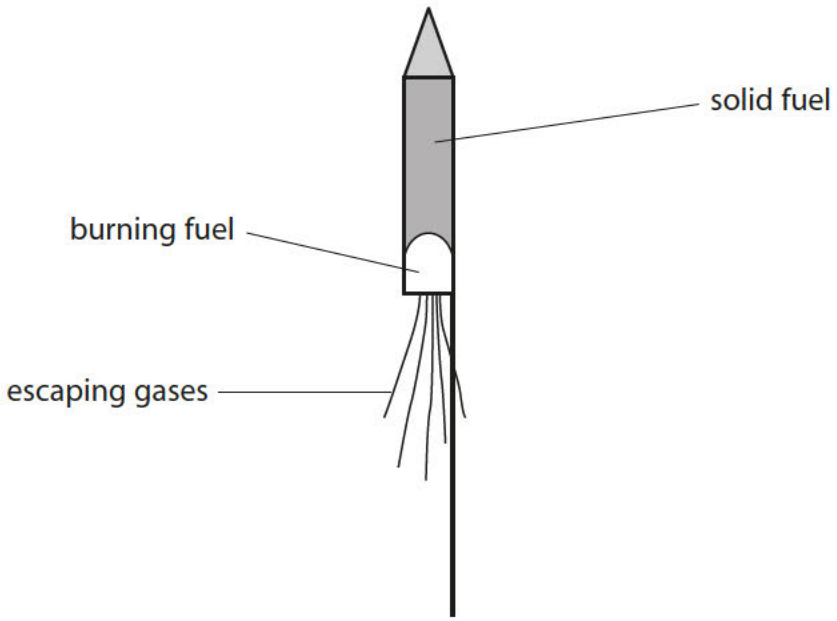
average impact force = ... N

(Total for Question 3 = 10 marks)

Forces and rockets

3 (a) A firework rocket contains a solid fuel inside a cardboard tube.

The burning of the fuel creates a thrust to propel the rocket upwards.



(i) Scientists can refer to several different quantities when describing the motion of the rocket.

mass	**gy**	spe	orce

Only one of these quantities is a vector.

Complete this sentence using **one** of the words from the box.

(1)

The vector quantity is .....

(ii) Before the fuse is lit, the total weight of a rocket including fuel is 0.7 N.

The gravitational field strength is 10 N/kg.

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

The total mass of the rocket including fuel is

(1)

☒ **A** 0.007 kg

☒ **B** 0.07 kg

☒ **C** 0.7 kg

☒ **D** 7 kg

(iii) There is a resultant force on the rocket of 0.5 N upwards when it takes off.

The arrow on the diagram shows the size and direction of the force of gravity acting on the rocket when it takes off.



Add another arrow to the diagram to show the thrust produced by the burning fuel at the time the rocket takes off.

You should label the arrow with the size of the thrust.

(2)

(b) Another rocket has a total mass of 90 g when it takes off.
The acceleration of the rocket when it takes off is 3.3 m/s^2.

(i) Calculate the resultant force on the rocket when it takes off.

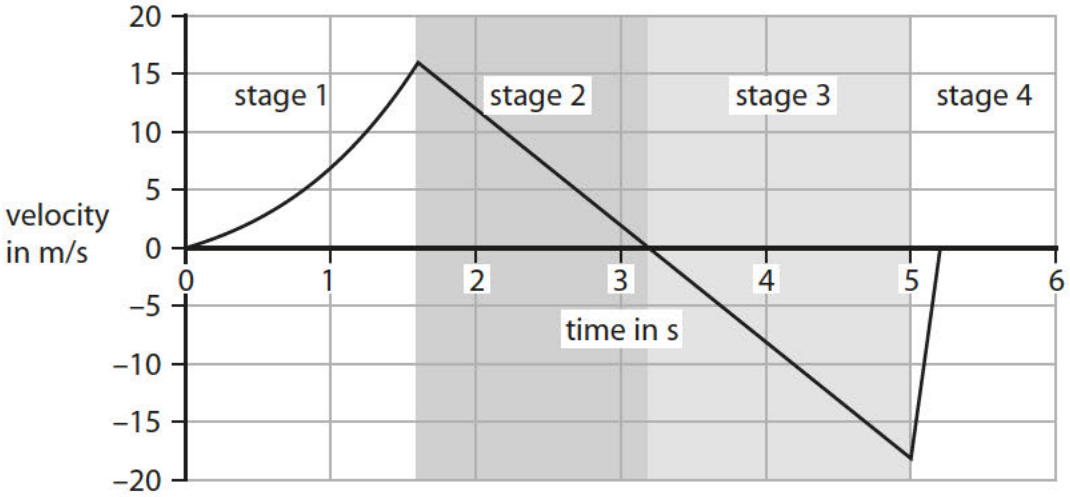
(2)

resultant force = ... N

*(ii) The rocket c
The fuel burns and the rocket rises vertically.
After a while, there is no fuel left.
Eventually the empty rocket falls back to the ground.

The graph is a velocity–time graph for the rocket.

Four stages are labelled on the graph.



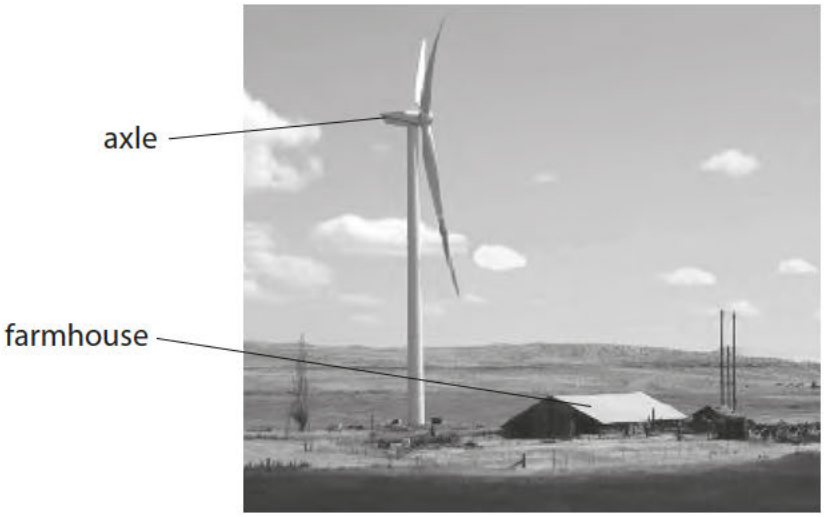
Explain why the velocity of the rocket changes as shown in the graph.

(6)

(Total for Question 5 = 12 marks)

Energy

4 (a) A wind generator is used as the source of energy for a remote farmhouse.



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

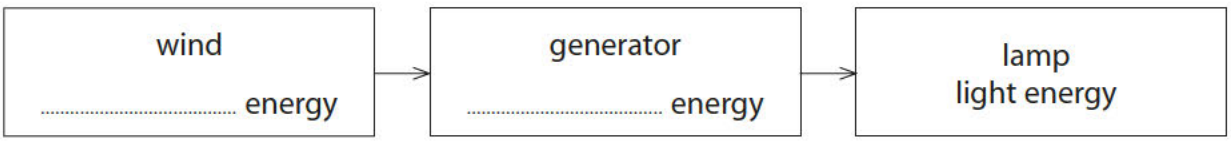
If the farmhouse is about 7 m high, the height of the axle of the generator is

(1)

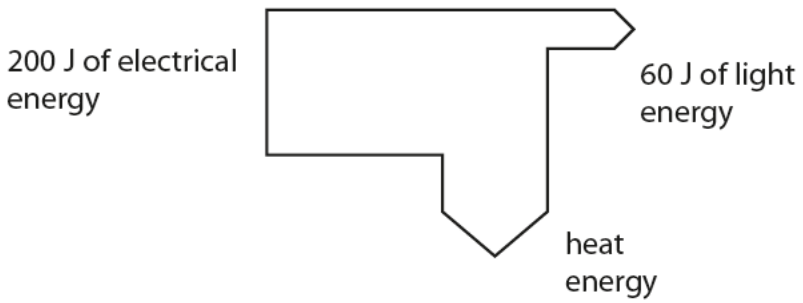
- ☐ **A** 20 m
- ☐ **B** 50 m
- ☐ **C** 100 m
- ☐ **D** 150 m

(ii) Complete the flow chart to show the energy transfers that take place from the wind to light a lamp.

(2)



(b) A student produced a diagram to show energy changes in a lamp.



(i) Calculate the amount of heat energy produced by the lamp.

(1)

heat energy = ... J

(ii) Calculate the efficiency of the lamp.

(2)

efficiency = ...

(iii) When the lamp is first switched on, it heats up.
It then reaches a constant temperature.

Explain why the temperature of the lamp remains constant.

(2)

.....

.....

.....

.....

(c) A wind power system costs £6000 to install.
It saves £250 each year.

Calculate the payback time.

(2)

payback time = ...

(Total for Question 3 = 10 marks)