Name: ____

Edexcel Forces

challenge questions

Date:

Time:

Total marks available:

Total marks achieved: ______

Questions

Q1.

Andrew skis down a hill.

Andrew returns to the top of the hill and starts again.

(i) His mass is 67 kg.

Show that his momentum is about 2000 kg m/s when his velocity is 31 m/s.

(2)

(ii) He falls over when his momentum is 2000 kg m/s.

After he falls over, he slows down by sliding across the snow.

It takes 2.3 s for his momentum to reduce to zero.

Calculate the average force on Andrew as he slows down.

(2)

force = ...N

(iii) Andrew is not injured by the fall even though he was moving quickly.

Use ideas about force and momentum to explain why he is not injured.

(2)

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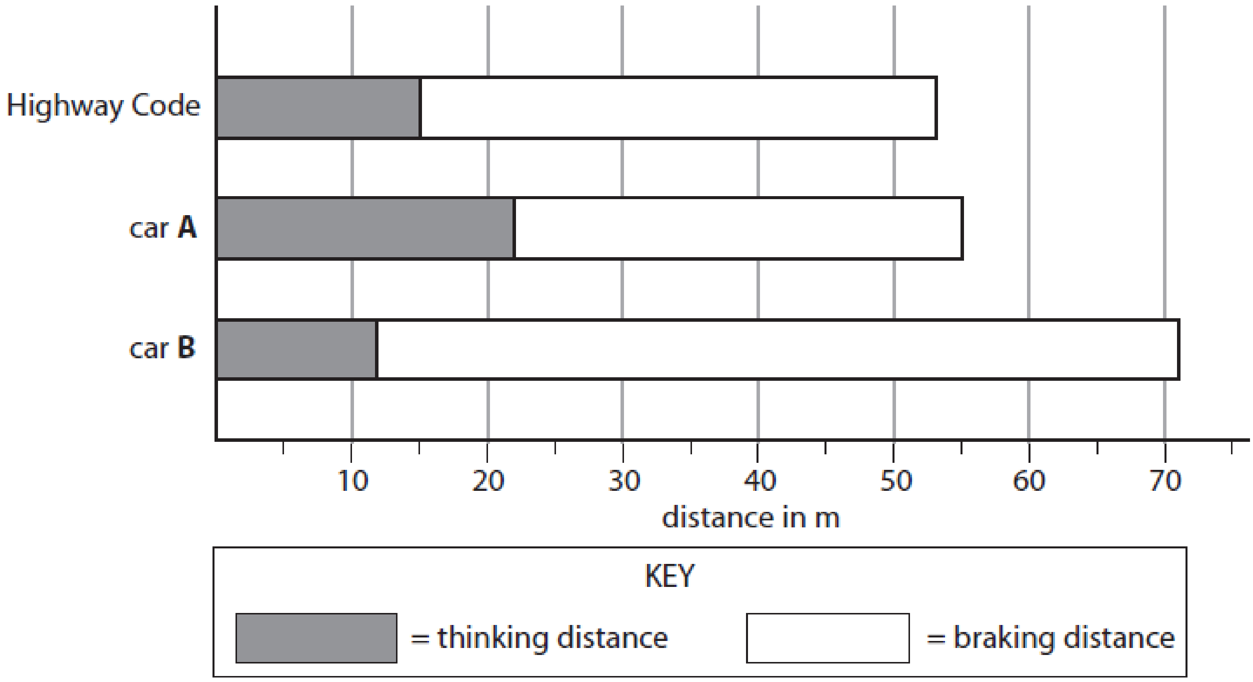
Q2.

* 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)

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Q3.

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

They drop balls into a tray filled with sand.

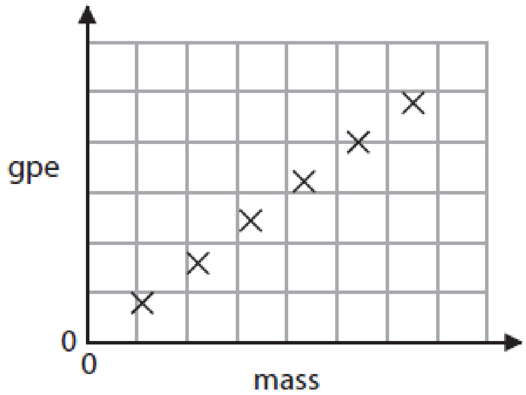
They use six balls with different masses.

They drop each ball from the same height.

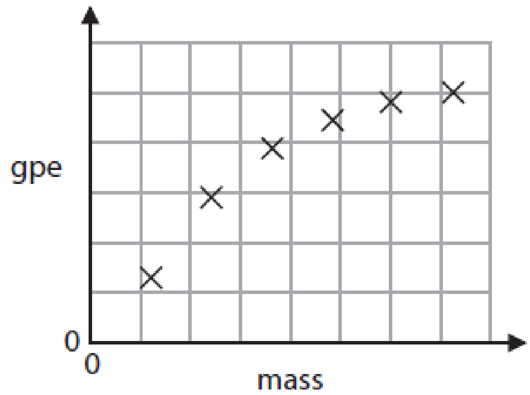
(a) (i) Which one of these graphs shows the relationship between the gravitational potential energy (gpe) of the balls and their mass when they are all at the same height?

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

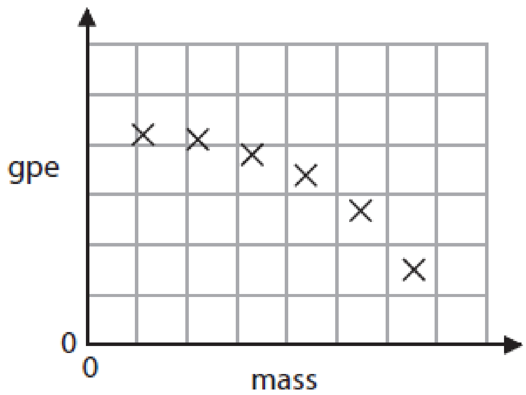
(1)



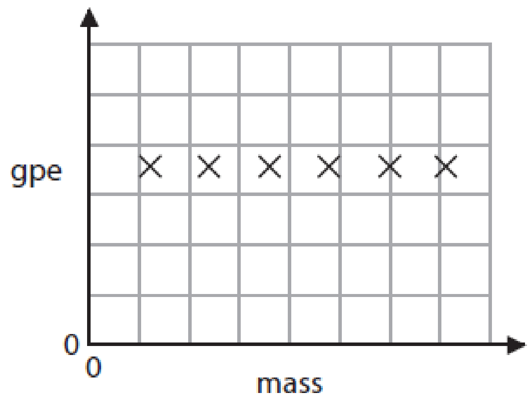
☐ **A**



☐ **B**



☐ **C**



☐ **D**

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

(2)

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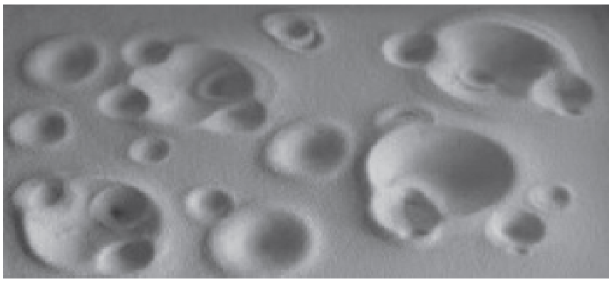
(b) This photograph shows the sand after several balls have hit it.



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)

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(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

Q4.

Some students investigate the speed of cars.
They measure the time it takes each car to travel a distance of 80 m.

(a) State **two** measuring instruments the students should use.

(2)

1

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2

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(b) The table shows some of their results.

colour of car	distance travelled / m	time / s
green	80	5.0
red	80	4.0
blue	80	5.5
black	80	4.3
white	80	5.6

(i) State the colour of the slowest car.

(1)

colour of the slowest car ....

(ii) Calculate the speed of the black car.

(2)

speed of the black car = ... m/s

(iii) 20 miles per hour is approximately 9 m/s.

Estimate the speed, in miles per hour, of the black car.

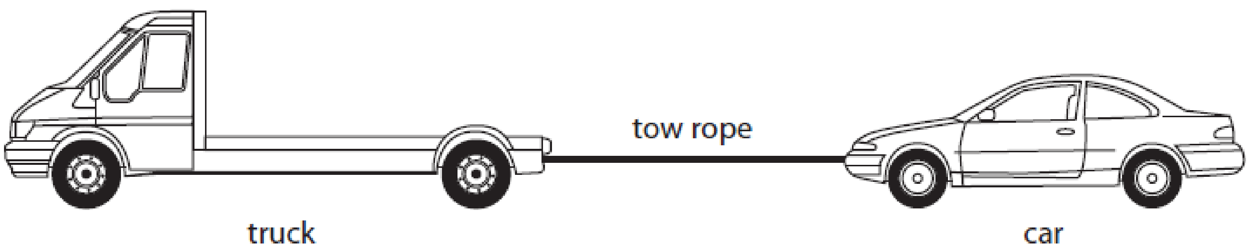
(1)

speed of the black car = ... miles per hour

Q5.

A truck is towing a car along a level road at a constant velocity.

A tow rope is attached to the truck and the car.



(a) Which of these shows the directions of the forces between the car and the tow rope?

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

(1)

	force exerted by car on tow rope	force exerted by tow rope on car
☒ **A**	←	→
☒ **B**	→	←
☒ **C**	→	→
☒ **D**	←	←

(b) The truck has to provide a force of 4000 N to the left on the car to keep the car at a constant velocity.

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

The resultant force on the car is

(1)

☒ **A** 0 N

☒ **B** 4000 N to the left

☒ **C** 4000 N to the right

☒ **D** 8000 N to the left

(c) Both vehicles are travelling at 13 m/s.

The driver of the truck then accelerates at 1.2 m/s^2 until both vehicles are travelling at 20 m/s.

(i) Calculate the time taken for this acceleration.

(3)

time = ... s

(ii) The mass of the car is 1400 kg.

Calculate the resultant force on the car needed to produce an acceleration of 1.2 m/s^2.

(2)

force = ... N

(iii) A rope can withstand a tension of 12 000 N before it breaks. The weight of the car is 14 000 N.

Discuss whether this rope could be strong enough to tow the car with the truck.

(3)

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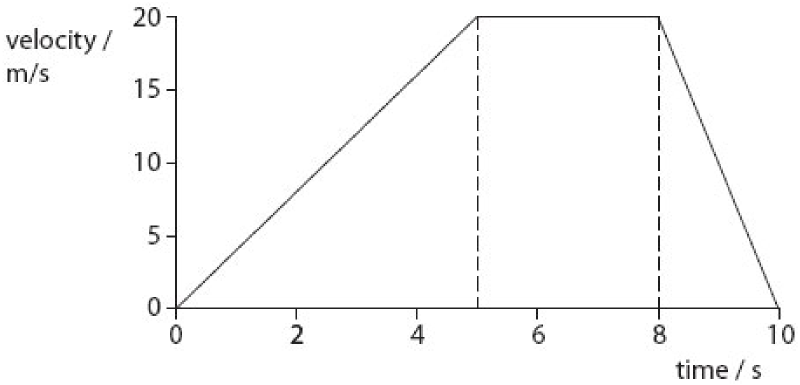
(Total for Question = 10 marks)

Q6.

The graph shows how the velocity of a small car changes with time.



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

The resultant force on the car will be zero when the car is

(1)

☐ **A** accelerating

☐ **B** decelerating

☐ **C** changing velocity

☐ **D** moving at a constant velocity

(b) (i) Use the graph to estimate the velocity of the car at three seconds.

(1)

velocity ....m/s

(ii) Calculate the acceleration of the car when it is speeding up.

(2)

acceleration = ...m/s^2

(iii) Explain why the units of acceleration are m/s^2.

(2)

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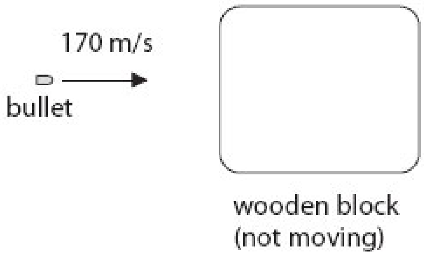
(iv) Show that the car travels further at a constant velocity than it does when it is slowing down.

(3)

(Total for Question is 9 marks)

Q7.

The diagram shows a bullet moving towards a wooden block.



(i) The bullet is moving with a velocity of 170 m/s.
The mass of the bullet is 0.030 kg.

Show that the momentum of the bullet is about 5.0 kg m/s.

(1)

(ii) The bullet collides with the wooden block and sticks in it.
The bullet and the wooden block move off together.
The mass of the wooden block is 0.80 kg.

Calculate the velocity of the wooden block and bullet immediately after the collision.

(3)

velocity = ...m/s

(iii) The collision between the bullet and the wooden block is an inelastic collision.

State what is meant by an **inelastic collision.**

(2)

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Q8.

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.

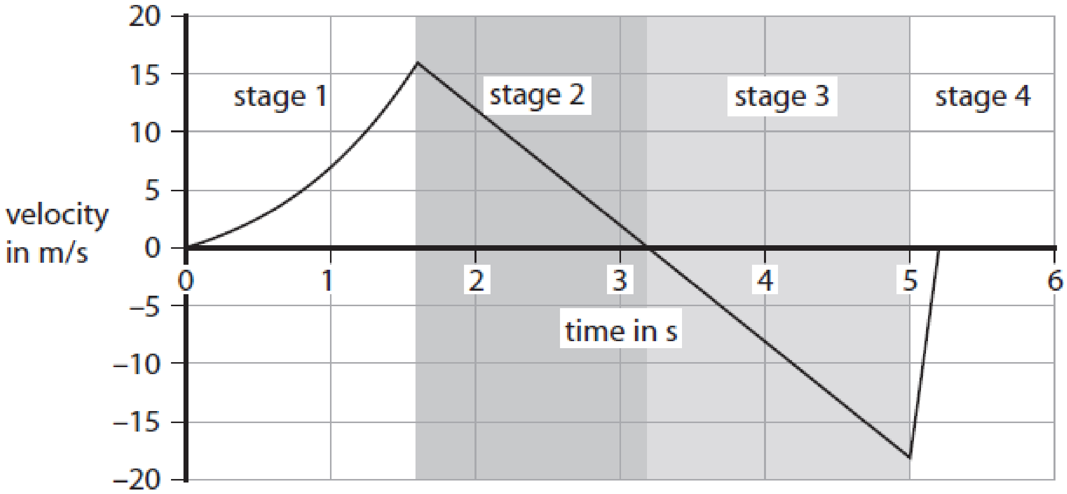
(2)

resultant force = ... N

*(ii) The rocket contains 50 g of fuel when it takes off.
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)

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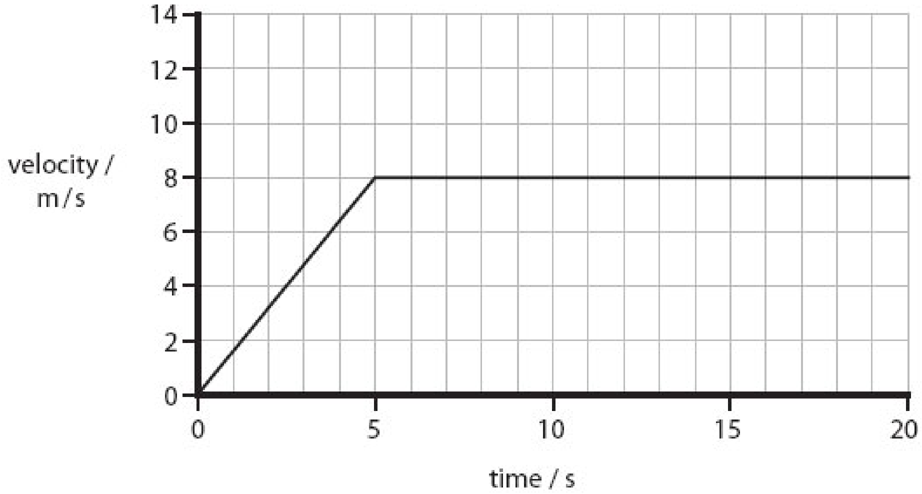
Q9.

(a) Here is the velocity-time graph for a car for the first 20 s of a journey.



(i) Calculate the change in velocity of the car during the first 5 s.

(1)

change in velocity = ...m/s

(ii) Calculate the acceleration of the car during the first 5 s.

(2)

acceleration = ...m/s^2

(iii) State the size of the resultant force between 10 s and 15 s

(1)

resultant force = ...N

(b) The mass of a car is 1200 kg.

Calculate the resultant force on the car required to produce an acceleration of 0.8 m/s^2.

(2)

resultant force = ...N

*(c) A car, travelling at 20 m/s, with just the driver inside takes 70 m to stop in an emergency. The same car is then fully loaded with luggage and passengers as well as the driver.

Explain why it will take a different distance to stop in an emergency from the same speed.

(6)

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(Total for Question = 12 marks)

Q10.

(a) A car is travelling along a level road.

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

When the velocity of the car is constant, the force of friction on it is

(1)

☐ **A** zero

☐ **B** greater than the driving force

☐ **C** smaller than the driving force

☐ **D** the same size as the driving force

(ii) The car now accelerates in a straight line.
Its average acceleration is 12 m/s^2.

Calculate the increase in velocity of the car in 4.0 s.

(3)

speed = ...m/s

(b) This table shows data about two other cars.

car	mass	time taken to reach 30 m/s from rest
family car	1400 kg	10 s
sports car	600 kg	5 s

The owner of the family car claims that although the sports car has greater acceleration, it produces a smaller accelerating force than his family car.

Explain how these figures support his claim.

(2)

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*(c) After going to the shops, a car driver places a bag of shopping on the passenger seat. During the journey home, the driver has to use the brakes to stop very suddenly. The driver is wearing a seat belt.

Explain what happens next to the car, the driver and the shopping bag.

(6)

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(Total for Question = 12 marks)

Q11.

The photograph shows a man dropping an egg inside a padded box from a height.

He is investigating to see if the padding stops the egg from breaking.

(a) State the type of energy which the egg gains as it falls.

(1)

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(b) The weight of the egg is 0.6 N.

Calculate the work done on the egg to lift it up by 20 m. State the unit.

(3)

work done on egg = ...unit ....

(c) The velocity of the container was 18 m/s as it hit the floor.
The mass of the container was 0.5 kg.

Calculate the momentum of the container.

(2)

momentum = ...kg m/s

....

*(d) A student stands on the ground with an egg in his hand.
He throws the egg vertically upwards.
The egg rises to a height of 10 m.
Then the egg falls and lands on the ground.

Describe the energy changes of the egg during this sequence of events.

(6)

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(Total for Question = 12 marks)

Q12.

A pilot begins to land an aircraft.

(a) The height of the aircraft decreases from 200 m above the ground to 100 m.

(i) What happens to the gravitational potential energy of the aircraft?

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

(1)

☐ **A** it becomes zero

☐ **B** it decreases

☐ **C** it does not change

☐ **D** it increases

(ii) The velocity of the aircraft remains constant.

What happens to the kinetic energy of the aircraft?

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

(1)

☒ **A** it becomes zero

☒ **B** it decreases

☒ **C** it does not change

☒ **D** it increases

(b) The aircraft lands with its wheels on the runway as shown.

The aircraft is moving forwards.

(i) Draw an arrow on the diagram to show the direction of the momentum of the aircraft.

(1)

(ii) The velocity of the aircraft when it lands is 75 m/s.

The mass of the aircraft is 130 000 kg.

Calculate the momentum of the aircraft.

(2)

momentum = ...kg m/s

(iii) The aircraft comes to a stop.

State the momentum change of the aircraft from when it lands to when it stops.

(1)

change in momentum = ...kg m/s

(c) When the aircraft lands, the momentum of each passenger also changes.

(i) Explain why it is more comfortable for a passenger if the aircraft takes a longer time to slow down.

(2)

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(ii) Suggest why some aircraft need a very long runway to land safely.

(2)

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(Total for Question is 10 marks)

Q13.

(a) A cyclotron accelerates charged particles.

(i) Describe the shape of the path a charged particle takes in the cyclotron.

(1)

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(ii) Explain how radioactive isotopes can be produced using cyclotrons.

(3)

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

In an **inelastic** collision there is conservation of

(1)

☐ **A** kinetic energy

☐ **B** momentum

☐ **C** kinetic energy and momentum

☐ **D** velocity

(ii) State why momentum has the unit kg.m/s.

(1)

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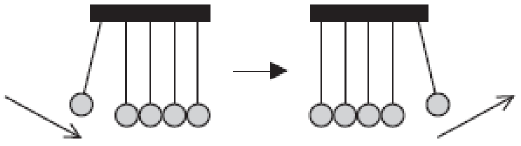
*(iii) Different types of collision are shown in the diagrams.

Analyse both collisions in terms of momentum and kinetic energy.

collision 1



collision 2

(6)

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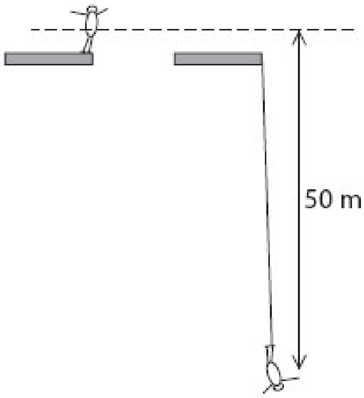
(Total for Question = 12 marks)

Q14.

A 60 kg student weighs 600 N.
He does a bungee jump.



The bungee cord becomes straight and starts to stretch when he has fallen 50 m.

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

He first stops moving

(1)

☒ **A** before all the energy has disappeared

☒ **B** before the bungee cord starts to stretch

☒ **C** when the bungee cord is stretched the most

☒ **D** when the elastic potential energy is zero

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

When his speed is 10 m/s his momentum is

(1)

☒ **A** 600 kg m/s

☒ **B** 3 000 kg m/s

☒ **C** 6 000 N m/s

☒ **D** 30 000 N m/s

(c) (i) Calculate the change in gravitational potential energy as the student falls 50 m.

Give the unit.

(3)

change in gravitational potential energy = ...unit ....

(ii) State at what point in the bungee jump the student has maximum kinetic energy.

(1)

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(iii) Explain why his maximum kinetic energy is likely to be less than your answer to (c)(i).

(2)

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(Total for Question = 8 marks)