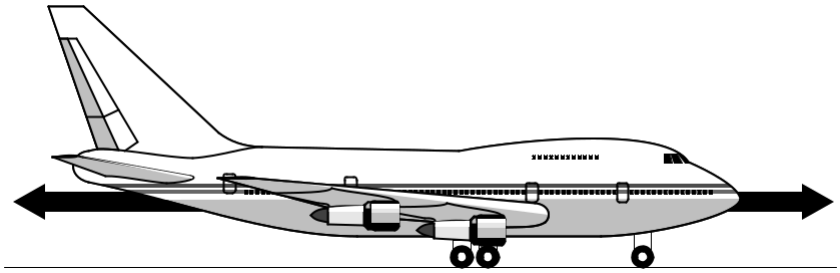
NEWTONS LAW

Q:1(a) The diagram shows an aircraft and the horizontal forces acting on it as it moves along a runway. The resultant force on the aircraft is zero.



(i) What is meant by the term resultant force?

_____

_____

(1 mark)

(ii) Describe the movement of the aircraft when the resultant force is zero.

_____

_____

_____

(1 mark)

(b) The aircraft has a take-off mass of 320 000 kg. Each of the 4 engines can produce a maximum force of 240 kN.

Use the equation in the box to calculate the maximum acceleration of the aircraft.

resultant force = mass × acceleration

Show clearly how you work out your answer and give the unit.

_____

_____

_____

Acceleration = _____

(3 marks)

(c) As the aircraft moves along the runway to take off, its acceleration decreases even though the force from the engines is constant.

Explain why.

_____

_____

_____

(2 marks)

Q:2 A cyclist travelling along a straight level road accelerates at 1.2 m/s2 for 5 seconds. The mass of the cyclist and the bicycle is 80 kg.

(a) Use the equation in the box to calculate the resultant force needed to produce this acceleration.

resultant force=mass $\times$ acceleration

Show clearly how you work out your answer and give the unit.

_____

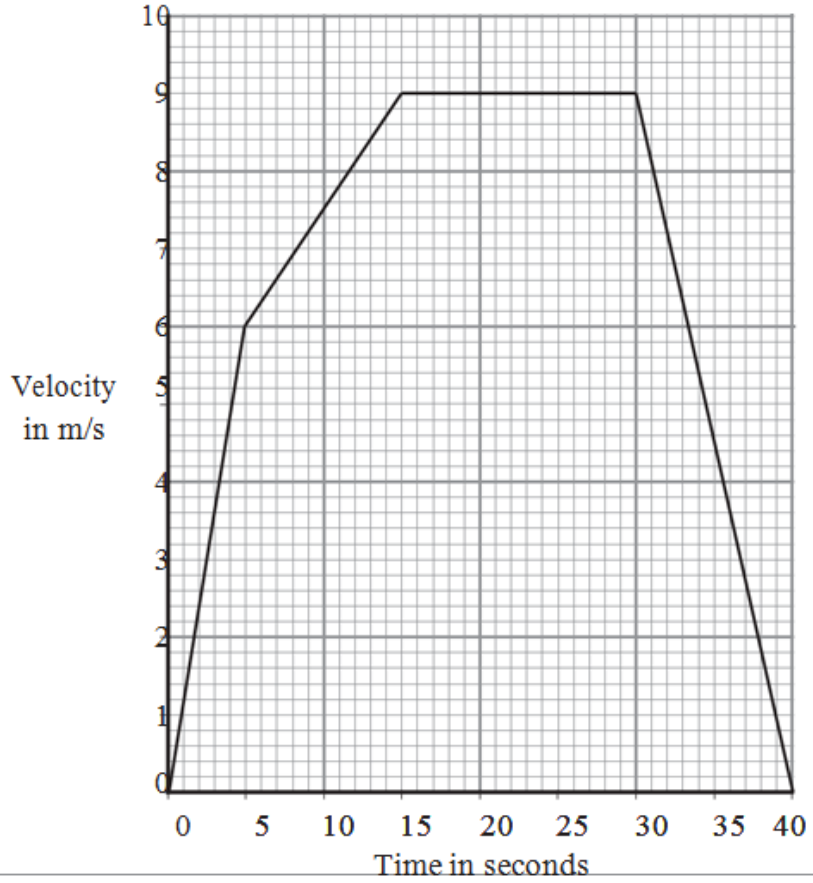
_____

_____

Resultant force _____

(3 marks)

(b) The graph shows how the velocity of the cyclist changes with time.



(b)(i) Complete the following sentence.

The velocity includes both the speed and the _____ of the cyclist.

(1 mark)

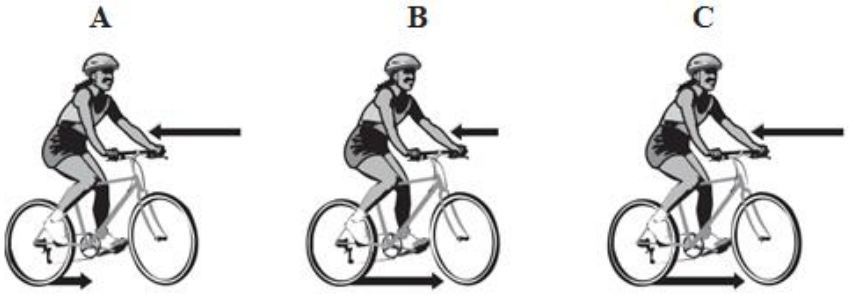
(b)(ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

_____

_____

(1 mark)

(b)(iii) The diagrams show the horizontal forces acting on the cyclist at three different speeds. The length of an arrow represents the size of the force.



Which one of the diagrams, A, B or C, represents the forces acting when the cyclist is travelling at a constant 9 m/s?

_____

Explain the reason for your choice.

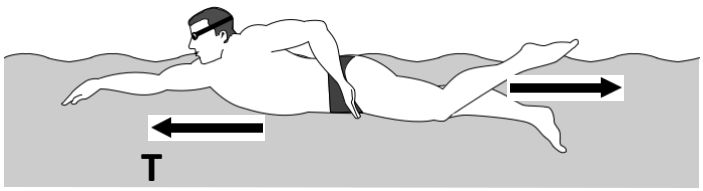
_____

_____

_____

(3 marks)

Q:3 The diagram shows the horizontal forces acting on a swimmer.



D

(a) (i) The swimmer is moving at constant speed.

T is 120 N. What is the size of force D?

_____ N

(1 mark)

(a) (ii) By increasing force T to 140 N, the swimmer accelerates to a higher speed.

Calculate the size of the initial resultant force acting on the swimmer.

_____

_____

Initial resultant force = _____ N

(1 mark)

(a) (iii) Even though the swimmer keeps the force T constant at 140 N, the resultant force on the swimmer decreases to zero.

Explain why.

_____

_____

_____

_____

(3 marks)

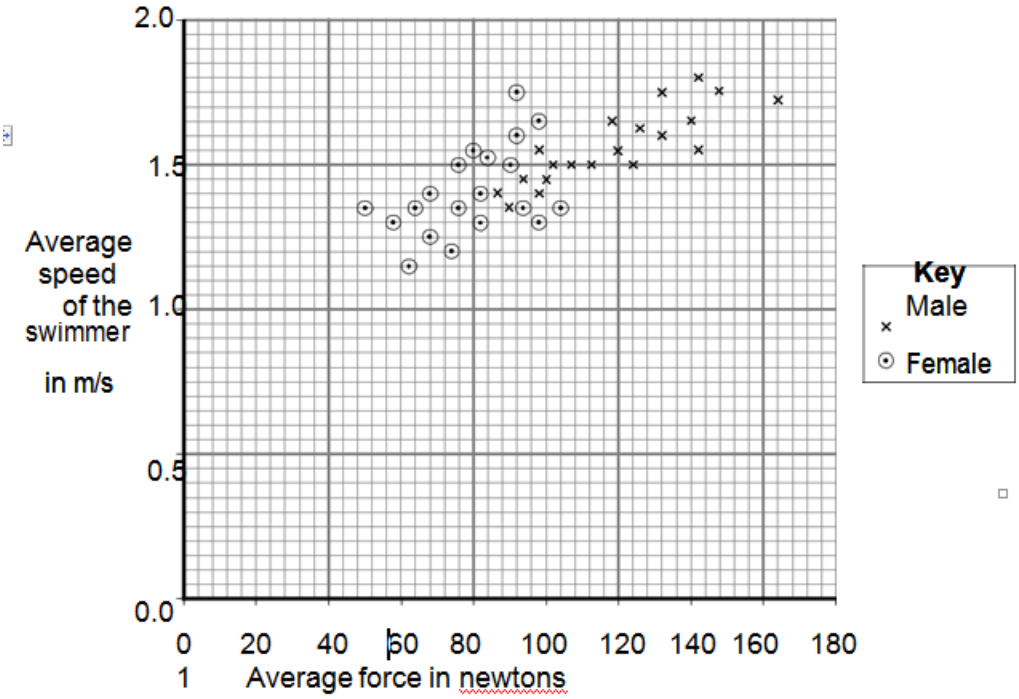
(b) A sports scientist investigated how the force exerted by a swimmer's hands against the water affects the swimmer's speed.

The investigation involved 20 males and 20 females swimming a fixed distance. Sensors placed on each swimmer's hands measured the force 85 times every second over the last 10 metres of the swim.

The measurements were used to calculate an average force.

The average speed of each swimmer over the last 10 metres of the swim was also measured.

The data from the investigation is displayed the graph.



(b) (i) What was the dependent variable in this investigation?

_____

(1 mark)

(b) (ii) Explain one advantage of measuring the force 85 times every second rather than just once or twice every second.

_____

_____

_____

(2 marks)

(b) (iii) Give one way in which the data for the male swimmers is different from the data for the female swimmers.

_____

_____

(1 mark)

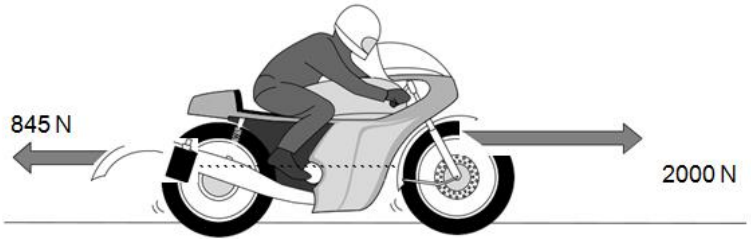
(b) (iv) Considering only the data from this investigation, what advice should a swimming coach give to swimmers who want to increase their average speed?

_____

_____

(1 mark)

Q:4 The arrows in the diagram represent the horizontal forces acting on a motorbike at one moment in time.



(a) The mass of the motorbike and rider is 275 kg.

Use the equation in the box to calculate the acceleration of the motorbike at this moment in time.

resultant force = mass × acceleration

Show clearly how you work out your answer.

_____

_____

_____

_____

Acceleration = _____ m/s 2

(3 marks)

(b) A road safety organisation has investigated the causes of motorbike accidents.

The main aim of the investigation was to find out whether there was any evidence that young, inexperienced riders were more likely to be involved in an accident than older, experienced riders.

Data obtained by the organisation from a sample of 1800 police files involving motorbike accidents, is summarised in the table.

Size of motorbike engine	Percentage of all motorbikes sold	Total number in the sample of 1800 accident files
up to 125 cc	36	774
126 to 350 cc	7	126
351 to 500 cc	7	162
over 500 cc	50	738

Most of the motorbikes with engines up to 125 cc were ridden by young people. The motorbikes with engines over 500 cc were ridden by older, more experienced riders.

(b) (i) In terms of the main aim of the investigation, is this data valid?

Draw a ring around your answer. NO YES

Explain the reason for your answer.

_____

_____

_____

(2 marks)

(b) (ii) The organisation concluded that:

"Young, inexperienced riders are more likely to be involved in a motorbike accident than older, experienced riders".

Explain how the data supports this conclusion.

_____

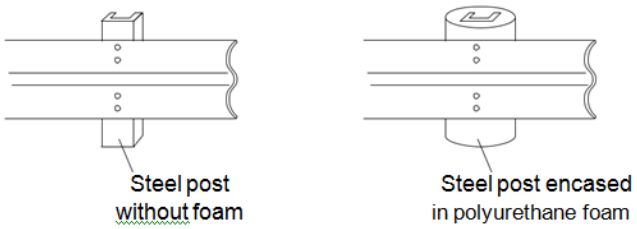
_____

_____

(2 marks)

(c) Of particular concern to motorbike riders is the design of steel crash barriers. Riders falling off and sliding at high speed into a steel support post are often seriously injured.

One way to reduce the risk of serious injury is to cover the post in a thick layer of high impact polyurethane foam.



(c) (i) Use the ideas of momentum to explain how the layer of foam reduces the risk of serious injury to a motorbike rider sliding at high speed into the support post.

_____

_____

_____

(3 marks)

(c) (ii) Crash barrier tests use dummies that collide at 17 m/s with the barrier. Each test costs about £12 000. New safety devices for crash barriers are tested many times to make sure that they will improve safety.

Do you think that the cost of developing the new safety devices is justified?

Draw a ring around your answer. NO YES

Give a reason for your answer.

_____

_____

_____ (1 mark)

TOTAL MARKS=36