

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.5.1.1 SCALAR AND VECTOR QUANTITIES (PACK 2)

SCORE

/78

PERCENTAGE

%

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Q1.

Figure 1 shows a boat floating on the sea. The boat is stationary.

Figure 1



(a) **Figure 2** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

Figure 2



(2)

(b) Calculate the mass of the boat.

Use the information given in **Figure 2**.

gravitational field strength = 9.8 N/kg

Give your answer to **two** significant figures.

Mass = _____ kg

(4)

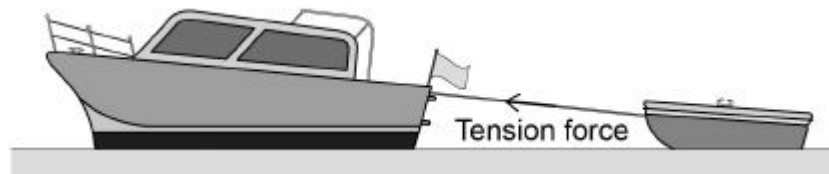
- (c) When the boat propeller pushes water backwards, the boat moves forwards.
The force on the water causes an equal and opposite force to act on the boat.

Which law is this an example of?

(1)

- (d) **Figure 3** shows the boat towing a small dinghy.

Figure 3



The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

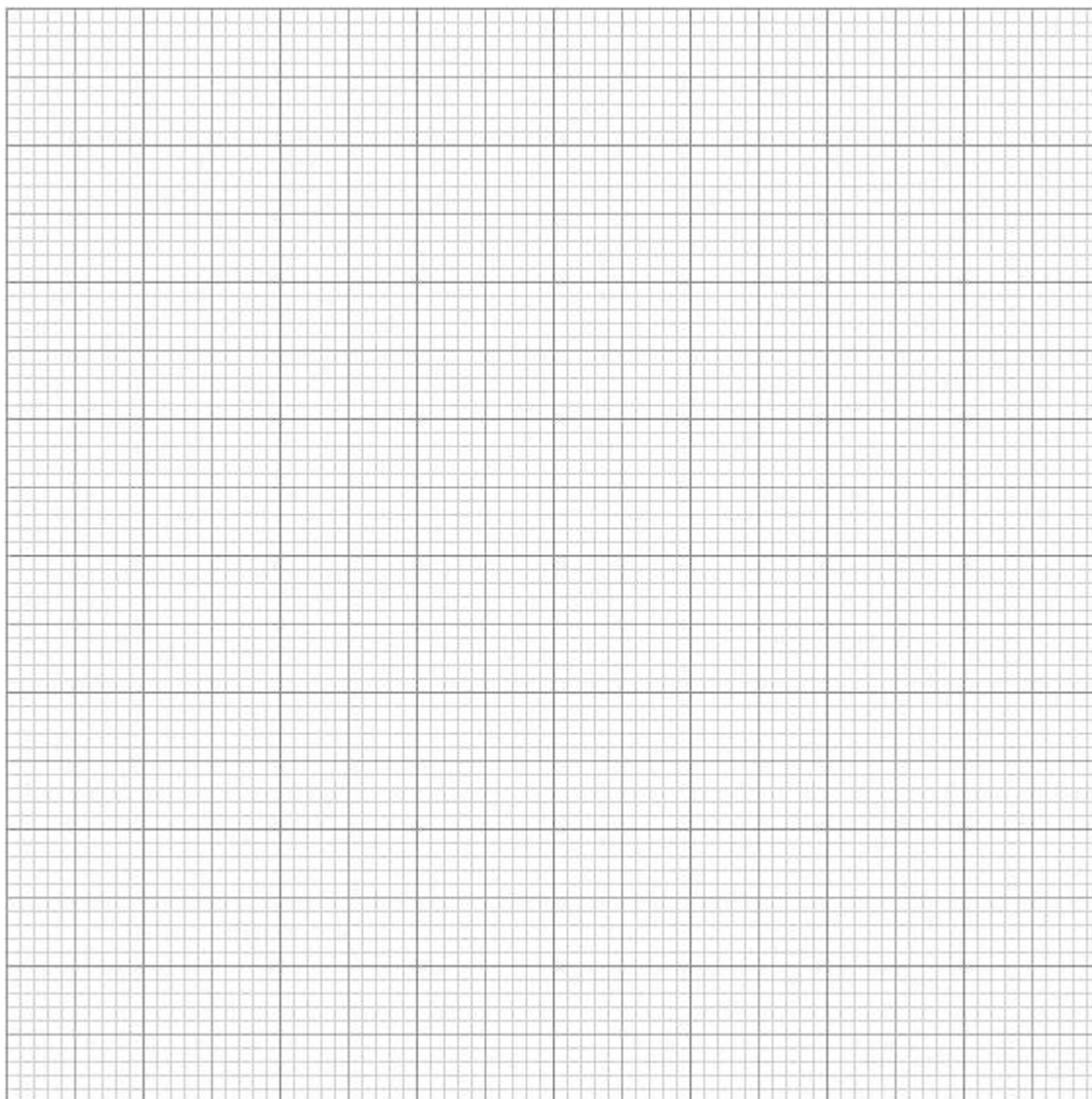
horizontal force forwards = 150 N

vertical force upwards = 50 N

Figure 4 shows a grid.

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.

Figure 4



Magnitude of the tension force in the tow rope = _____ N

Direction of the force on the dinghy caused
by the tension force in the tow rope = _____

(4)

(Total 11 marks)

Q2.

Momentum is a vector quantity.

- (a) How is a vector quantity different to a scalar quantity?

(1)

- (b) Name another vector quantity.

(1)

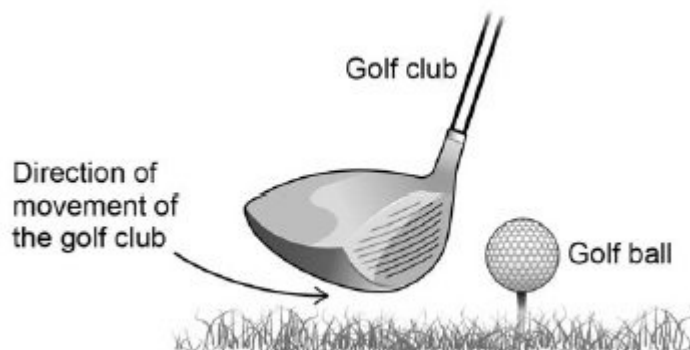
- (c) Give the definition of momentum.

(1)

- (d) What is the unit of momentum?

(1)

- (e) The image shows a golf club about to hit a stationary golf ball.



The golf club is in contact with the golf ball for 1.8 ms and exerts a force of 1500 N on the golf ball.

The mass of the golf ball is 0.045kg

Calculate the velocity of the golf ball as it leaves the golf club.

Velocity = _____ m/s

(4)

- (f) When hitting the golf ball the golfer swings the golf club to keep it in contact with the golf ball for as long as possible.

The force acting on the golf ball is constant during this time.

Explain the effect that the time of contact between the golf club and the golf ball has on the distance the golf ball travels.

(4)
(Total 12 marks)

Q3.

- (a) **Figure 1** shows an aircraft flying at a constant velocity and at a constant height above the ground.

Figure 1



Complete the free body diagram in **Figure 2** to show the other two forces acting on the aircraft.

Figure 2



(2)

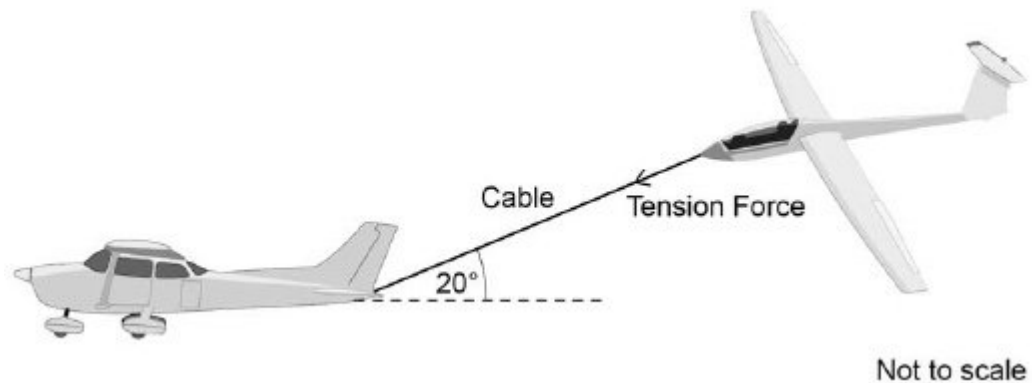
- (b) A small aircraft accelerated down a runway at 4.0 m/s^2
The aircraft started from rest and reached a speed of 34 m/s just before take-off.
Calculate the distance the aircraft travelled while accelerating.
Give your answer to 2 significant figures.

Distance = _____ m

(4)

- (c) **Figure 3** shows the small aircraft being used to tow a glider.

Figure 3



The tension force in the cable can be resolved into a horizontal component and a vertical component.

The tension in the cable is 2000 N

The cable makes an angle of 20° with the horizontal.

Draw a vector diagram to determine the magnitude of the two components of the tension force in the cable.

Magnitude of the horizontal component = _____ N

Magnitude of the vertical component = _____ N

(1)

(Total 10 marks)

Q4.

Quantities in physics are either scalars or vectors.

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

acceleration	direction	distance	speed	time
--------------	-----------	----------	-------	------

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.

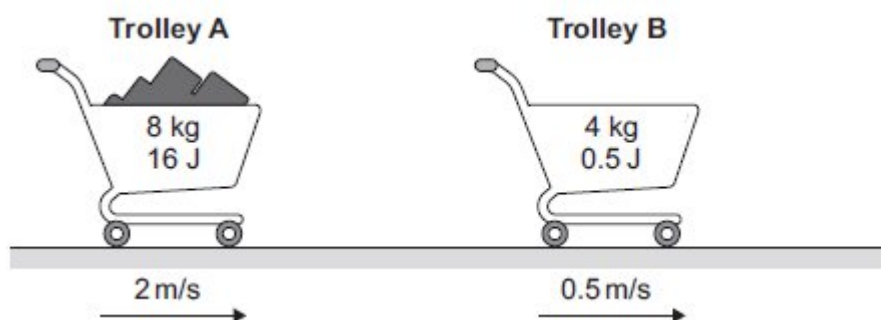
Quantity	Scalar	Vector
Momentum		✓
Acceleration		
Distance		
Force		
Time		

(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.

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.

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.

Total momentum = _____

Total kinetic energy = _____ J

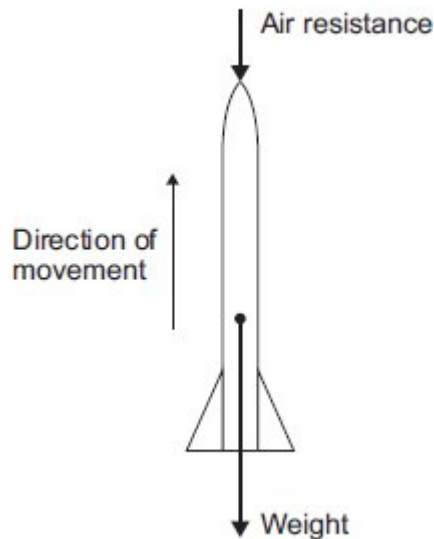
(2)

(Total 14 marks)

Q5.

- (a) **Figure 1** shows the forces acting on a model air-powered rocket just after it has been launched vertically upwards.

Figure 1



- (i) How does the velocity of the rocket change as the rocket moves **upwards**?

Give a reason for your answer.

(2)

- (ii) The velocity of the rocket is not the same as the speed of the rocket.

What is the difference between the velocity of an object and the speed of an object?

(1)

- (b) The speed of the rocket just after being launched is 12 m / s .
The mass of the rocket is 0.05 kg .

- (i) Calculate the kinetic energy of the rocket just after being launched.

Kinetic energy = _____ J

(2)

- (ii) As the rocket moves upwards, it gains gravitational potential energy.

State the maximum gravitational potential energy gained by the rocket.

Ignore the effect of air resistance.

Maximum gravitational potential energy = _____ J

(1)

(iii) Calculate the maximum height the rocket will reach.

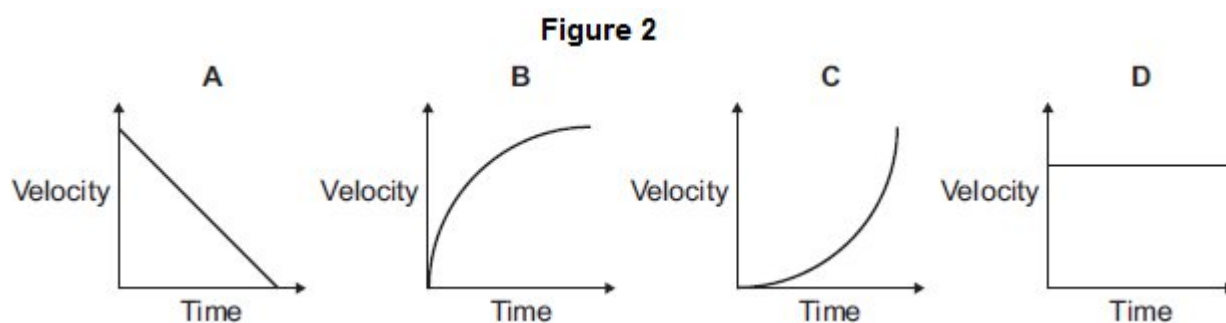
Ignore the effect of air resistance.

Gravitational field strength = 10 N/kg.

Maximum height = _____ m

(2)

(iv) **Figure 2** shows four velocity–time graphs.



Taking air resistance into account, which graph, **A**, **B**, **C** or **D**, shows how the velocity of the rocket changes as it **falls** from the maximum height it reached until it just hits the ground?

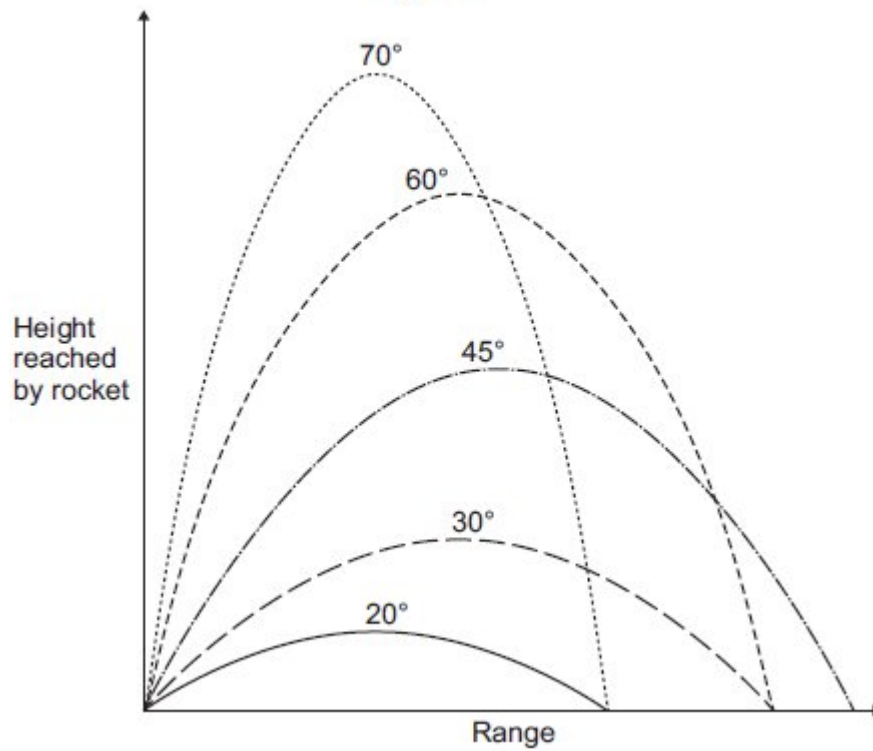
Write the correct answer in the box.

(1)

- (c) The rocket can be launched at different angles to the horizontal.
The horizontal distance the rocket travels is called the range.

Figure 3 shows the paths taken by the rocket when launched at different angles.
Air resistance has been ignored.

Figure 3



What pattern links the angle at which the rocket is launched and the range of the rocket?

(2)

(Total 11 marks)

Q6.

The London Eye is one of the largest observation wheels in the world.



© Angelo Ferraris/Shutterstock

The passengers ride in capsules. Each capsule moves in a circular path and accelerates.

- (a) Explain how the wheel can move at a steady speed and the capsules accelerate at the same time.

(2)

- (b) In which direction is the resultant force on each capsule?

(1)

- (c) The designers of the London Eye had to consider **three** factors which affect the resultant force described in part (b).

Two factors that increase the resultant force are:

- an increase in the speed of rotation
- an increase in the total mass of the wheel, the capsules and the passengers.

Name the other factor that affects the resultant force and state what effect it has on the resultant force.

(1)

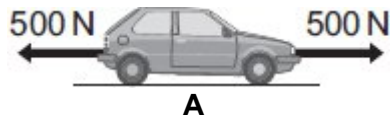
(Total 4 marks)

Q7.

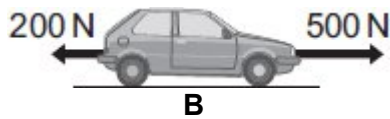
- (a) The diagrams, **A**, **B** and **C**, show the horizontal forces acting on a **moving** car.

Draw a line to link each diagram to the description of the car's motion at the moment when the forces act.

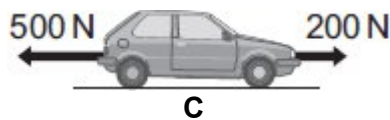
Draw only **three** lines.



stationary



constant speed

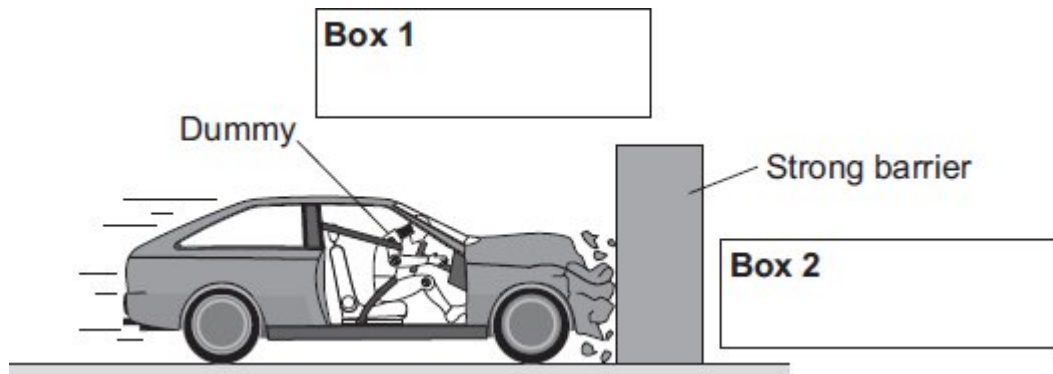


slowing down

accelerating forwards

(3)

- (b) The front crumple zone of a car is tested at a road traffic laboratory. This is done by using a remote control device to drive the car into a strong barrier. Electronic sensors are attached to a dummy inside the car.



- (i) Draw an arrow in **Box 1** to show the direction of the force that the car exerts on the barrier.

(1)

- (ii) Draw an arrow in **Box 2** to show the direction of the force that the barrier exerts on the car.

(1)

- (iii) Complete the following by drawing a ring around the correct line in the box.

The car exerts a force of 5000 N on the barrier. The barrier does not move.

The force exerted by the barrier on the car will be

more than

equal to

less than

5000 N.

(1)

- (iv) Which **one** of the following gives the most likely reason for attaching electronic sensors to the dummy?

Put a tick (✓) in the box next to your answer.

To measure the speed of the car just before the impact.

☐

To measure the forces exerted on the dummy during the impact.

☐

To measure the distance the car travels during the impact.

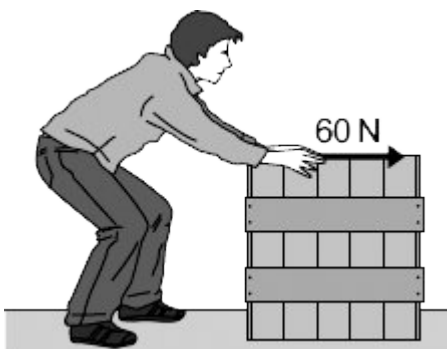
☐

(1)

(Total 7 marks)

Q8.

The diagram shows a worker using a constant force of 60 N to push a crate across the floor.



My Revision Notes AQA GCSE Physics for A* – C,
Steve Witney, © Philip Allan UK

- (a) The crate moves at a constant speed in a straight line

- (i) Draw an arrow on the diagram to show the direction of the friction force acting on the moving crate.

(1)

- (ii) State the size of the friction force acting on the moving crate.

_____ N

Give the reason for your answer.

(2)

- (b) Calculate the work done by the worker to push the crate 28 metres.

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

Choose the unit from the list below.

joule

newton

watt

Work done = _____

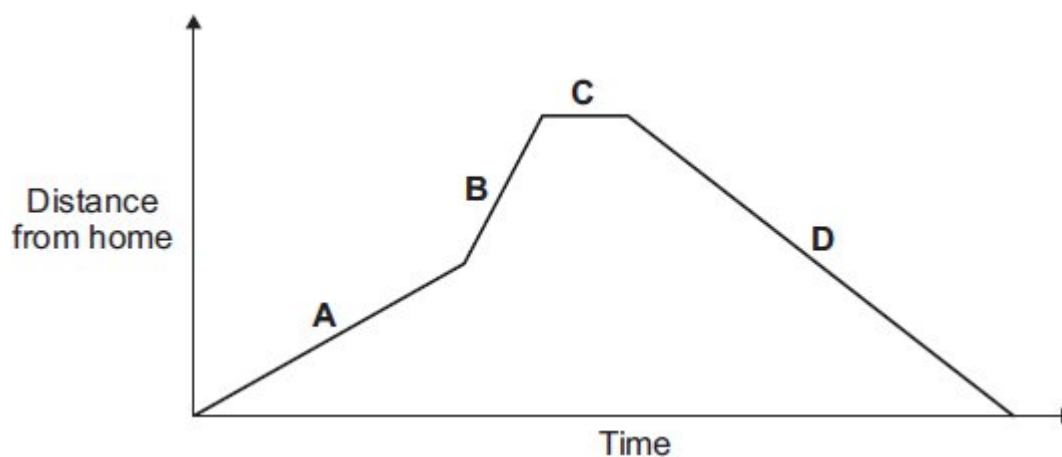
(3)

(Total 6 marks)

Q9.

- (a) A person takes their dog for a walk.

The graph shows how the distance from their home changes with time.



Which part of the graph, **A**, **B**, **C** or **D**, shows them walking the fastest?

Write your answer in the box.

Give the reason for your answer.

(2)

- (b) During the walk, both the speed and the velocity of the person and the dog change.

How is *velocity* different from *speed*?

(1)

(Total 3 marks)

Mark schemes

Q1.

- (a) arrow of equal size pointing vertically upwards

judged by eye
ignore horizontal arrows if equal and opposite
horizontal arrows of unequal length negates this mark

1

labelled 'upthrust'

ignore buoyancy
ignore 25 kN

1

- (b) weight = 25 kN

allow 24 to 25 kN inclusive

1

$$25\,000 = \text{mass} \times 9.8$$

or

$$m = \frac{25000}{9.8}$$

allow their W correctly converted and substituted

1

$$m = 2551 \text{ kg}$$

allow correctly calculated value using their converted W
allow a value correctly calculated with W in kN

1

$$m = 2600 \text{ kg}$$

allow a calculated answer correctly rounded to 2 significant figures

1

an answer of 2600 scores 4 marks

- (c) Newton's 3rd law (of motion)

1

- (d) vertical force (50 N) drawn
and
 horizontal force (150 N) drawn to the same scale

1

resultant tension force in the correct direction
shown by an arrowhead

1

value of the tension force in the range 156 N–160 N
allow a calculated value of 158

1

value of direction in the range 18°–20° (from the horizontal)

allow 70° to 72° (from the vertical)
allow a bearing in the range 288 to 290

1

[11]

Q2.

- (a) a vector has direction (a scalar does not)

1

- (b) accept any vector quantities eg

- velocity
- force
- weight
- acceleration
- displacement

1

- (c) mass × velocity

do not accept speed for velocity

do not accept symbols

1

- (d) kilogram(s) metre per second

allow kg m/s

1

- (e) 1.8 ms = 0.0018 s

an answer of 60 (m/s) scores 4 marks

1

$$1500 = \frac{0.045 \times v (-0.045 \times 0)}{0.0018}$$

1

$$v = \frac{1500 \times 0.0018}{0.045}$$

1

$$v = 60 \text{ (m/s)}$$

an answer of 60 000 scores 3 marks

1

- (g) longer the time of contact the greater the change of momentum

allow the converse

1

since the mass of the golf ball is constant

1

the velocity of the golf ball must increase

1

increasing the distance the golf ball travels

1

[12]

Q3.

- (a) arrow vertically down – same size as lift – labelled weight
judge by eye

1

arrow to the left – same size as drag - labelled thrust
judge by eye

two correct arrows without labels gains 1 mark

1

- (b) $34^2 - (0^2) = 2 \times 4.0 \times s$

1

$$\frac{34 \times 34}{8} = s$$

1

$$s = 144.5$$

1

$$s = 140 \text{ (2 sig figs)}$$

an answer of 140 scores 4 marks

an answer of 144.5 scores 3 marks

1

- (c) tension force drawn to a suitable scale and in correct direction

1

triangle completed showing correct components

1

scale used to determine both component forces

1

horizontal component = 1900 N

vertical component = 680 N

allow 1850 to 1925 inclusive

allow 660 to 700 inclusive

1

[10]**Q4.**

- (a) speed
must be in correct order

1

direction

1

- (b)

Quantity	Scalar	Vector
Momentum		✓

Acceleration		✓
Distance	✓	
Force		✓
Time	✓	

any three correct scores 2 marks

any two correct scores 1 mark

only one correct scores zero

3

- (c) (i) 16 and 2

16 or 2 scores 2 marks

allow 1 mark for correct substitution, ie

$$8 \times 2$$

or

$$4 \times 0.5$$

3

kg m / s **or** N s

1

- (ii) 1.5 (m / s)

or

their $p_A + p_B = 12 \times v$ correctly calculated

allow 2 marks for correct substitution, ie

$$18 = 12 \times v$$

or

$$\text{their } p_A + p_B = 12 \times v$$

18 or their $p_A + p_B$ scores 1 mark if no other mark awarded

3

- (iii) 14 (kg m / s)

or

their $p_A - p_B$

1

16.5 (J)

1

[14]

Q5.

- (a) (i) decreases (to zero)

1

resultant force acts in opposite direction to motion

accept air resistance and weight for resultant force

accept resultant force acts downwards

*do **not** accept air resistance increases*

1

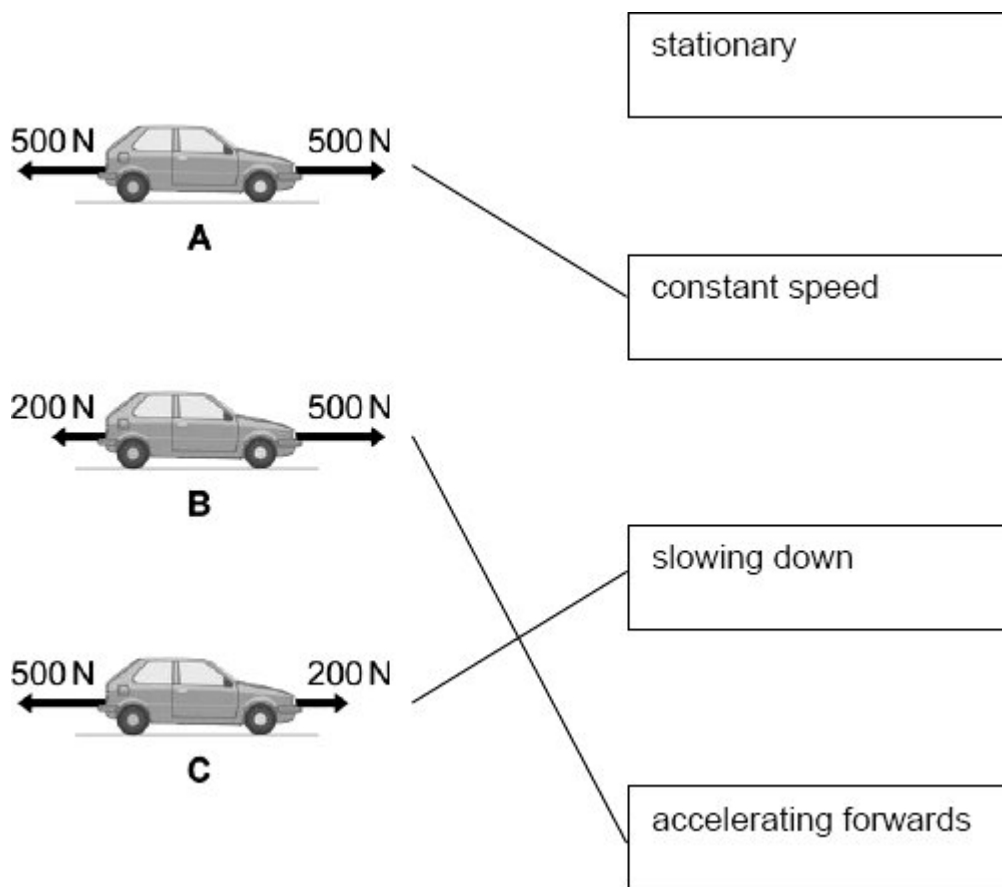
- (ii) velocity includes direction
or
velocity is a vector (quantity) 1
- (b) (i) 3.6
allow 1 mark for correct substitution i.e.
 $\frac{1}{2} \times 0.05 \times 12^2$ provided no subsequent step 2
- (ii) 3.6 **or** their (i) 1
- (iii) 7.2
or
their (ii) $\div 0.5$ correctly calculated
allow 1 mark for correct substitution i.e.
3.6 or their (ii) $= 0.05 \times 10 \times h$ 2
- (iv) **B** 1
- (c) range increases up to 45° 1
- range decreases from 45°
the range is a maximum at 45° gains both marks
for any two angles that add up
to 90° the range is the same gains both marks
the range increases then decreases gains 1 mark 1
- [11]**

Q6.

- (a) any **two** from:
- (acceleration occurs when) the direction (of each capsule) changes
 - velocity has direction
 - acceleration is (rate of) change of velocity
- 2
- (b) to(wards) the centre (of the wheel) 1
- (c) the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)
accept 'the size' for radius
both parts required for the mark 1
- [4]**

Q7.

- (a) 3 lines drawn
all correct
allow 1 mark for each correct line
if two or more lines are drawn from any diagram then all these lines are incorrect



3

- (b) (i) horizontal arrow to the right
judge by eye
accept an arrow drawn outside the box if it is labelled correctly
- (ii) horizontal arrow to the left
judge by eye
accept an arrow drawn outside the box if it is labelled correctly
- (iii) equal to
- (iv) to measure the forces exerted on the dummy during the impact

1

1

1

1

[7]

Q8.

- (a) (i) horizontal arrow pointing to the left
judge by eye

	<i>drawn anywhere on the diagram</i>	1	
(ii)	60 (N)	1	
	(at steady speed) resultant force must be zero <i>accept forces must balance/are equal</i> <i>accept no acceleration</i> <i>do not accept constant speed</i>	1	
(b)	1680 <i>allow 1 mark for correct substitution, ie 60 x 28 provided no subsequent step shown</i>	2	
	joule <i>accept J</i> <i>do not accept j</i>	1	
			[6]
Q9.			
(a)	B <i>reason only scores if B is chosen</i>	1	
	gradient / slope is the steepest / steeper <i>answers must be comparative</i> <i>accept steepest line</i> <i>ignore greatest speed</i>	1	
(b)	(velocity includes) direction <i>'it' refers to velocity</i>	1	
			[3]