Farr High School

NATIONAL 5 PHYSICS

Unit 3
Dynamics and Space

Exam Questions

Velocity and Displacement – Vectors and Scalars

2011 Int2 1 MC

1. During training an athlete sprints 30 m East and then 40 m West.
Which row shows the distance travelled and the displacement from the starting point? 1

	Distance travelled	*Displacement*
A	10 m	10 m East
B	10 m	10 m West
C	10 m	70 m East
D	70 m	10 m West
E	70 m	10 m East

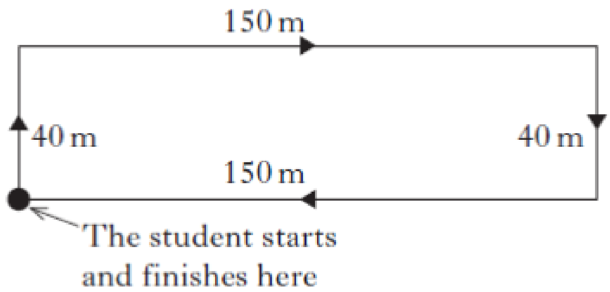
2013 Int2 1 MC

2. Which row contains two scalar quantities and one vector quantity?

A Distance, momentum, velocity
B Speed, mass, momentum
C Distance, weight, momentum
D Speed, weight, momentum
E Velocity, force, mass 1

2013 Int2 2 MC

3. A student follows the route shown in the diagram and arrives back at the starting point.



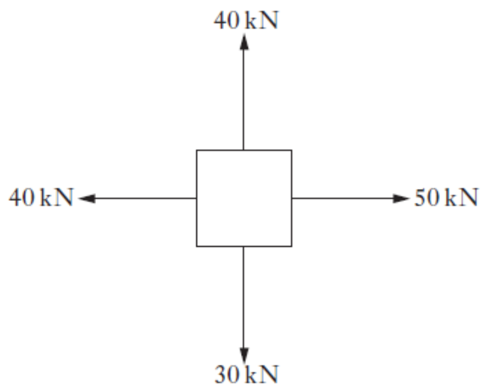
Which row in the table shows the total distance walked and the magnitude of the final displacement?

	Total distance (m)	Final displacement (m)
A	0	80
B	0	380
C	190	0
D	380	0
E	380	380

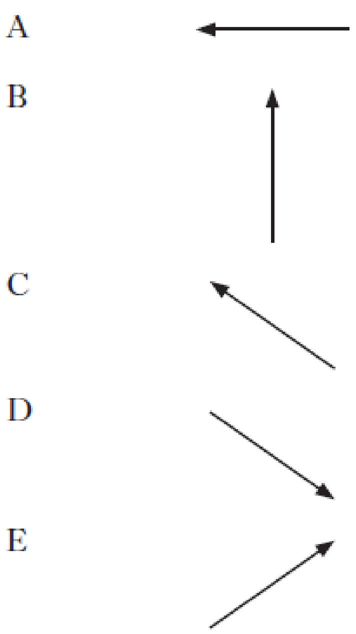
1

2013 Int2 5 MC

4. Four tugs apply forces to an oil-rig in the directions shown.

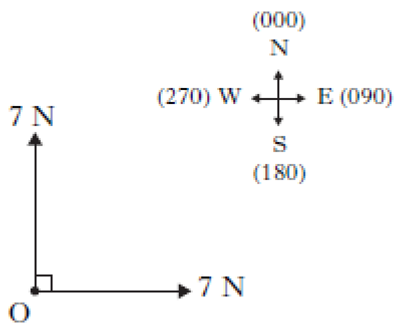


Which of the following could represent the direction of the resultant force? 1



2010 Int2 3 MC

5. Two forces, each of 7N, act on an object O.
The forces act as shown.



The resultant of these two forces is

A 7 N at a bearing of 135
B 9·9 N at a bearing of 045
C 9·9 N at a bearing of 135
D 14 N at a bearing of 045
E 14 N at a bearing of 135. 1

2010 Int2 1 MC

6. Which of the following is a scalar quantity?

A Force
B Acceleration
C Momentum
D Velocity
E Energy 1

2007 Int2 1MC

7. In the following statements X, Y and Z represent physical quantities.

X is the displacement of an object in a given time.

Y is the change in velocity of an object in a given time.

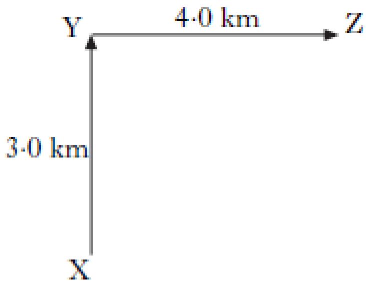
Z is the distance travelled by an object in a given time.

Which row in the table shows the quantities represented by X, Y and Z? 1

	X	Y	Z
A	speed	acceleration	velocity
B	velocity	speed	acceleration
C	acceleration	velocity	speed
D	acceleration	speed	velocity
E	velocity	acceleration	speed

2008 Int2 2 MC

8. A student walks from X to Y and then from Y to Z.



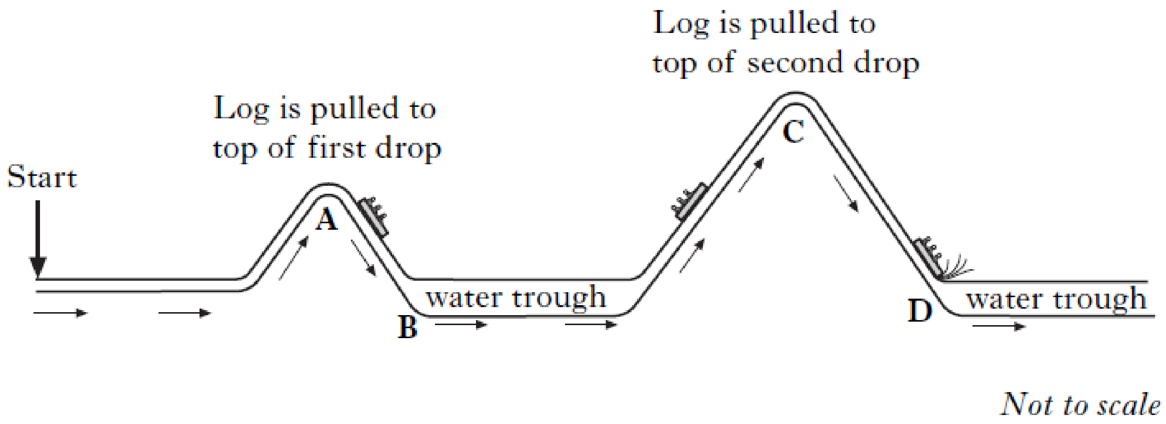
The complete walk takes 2 hours. Which row in the table shows the average speed and the average velocity for the complete walk? 1

	Average speed	Average velocity
A	2.5 km h^{-1}	2.5 km h^{-1} at 053
B	2.5 km h^{-1} at 053	2.5 km h^{-1}
C	3.5 km h^{-1}	2.5 km h^{-1} at 053
D	3.5 km h^{-1} at 053	3.5 km h^{-1}
E	3.5 km h^{-1}	3.5 km h^{-1} at 053

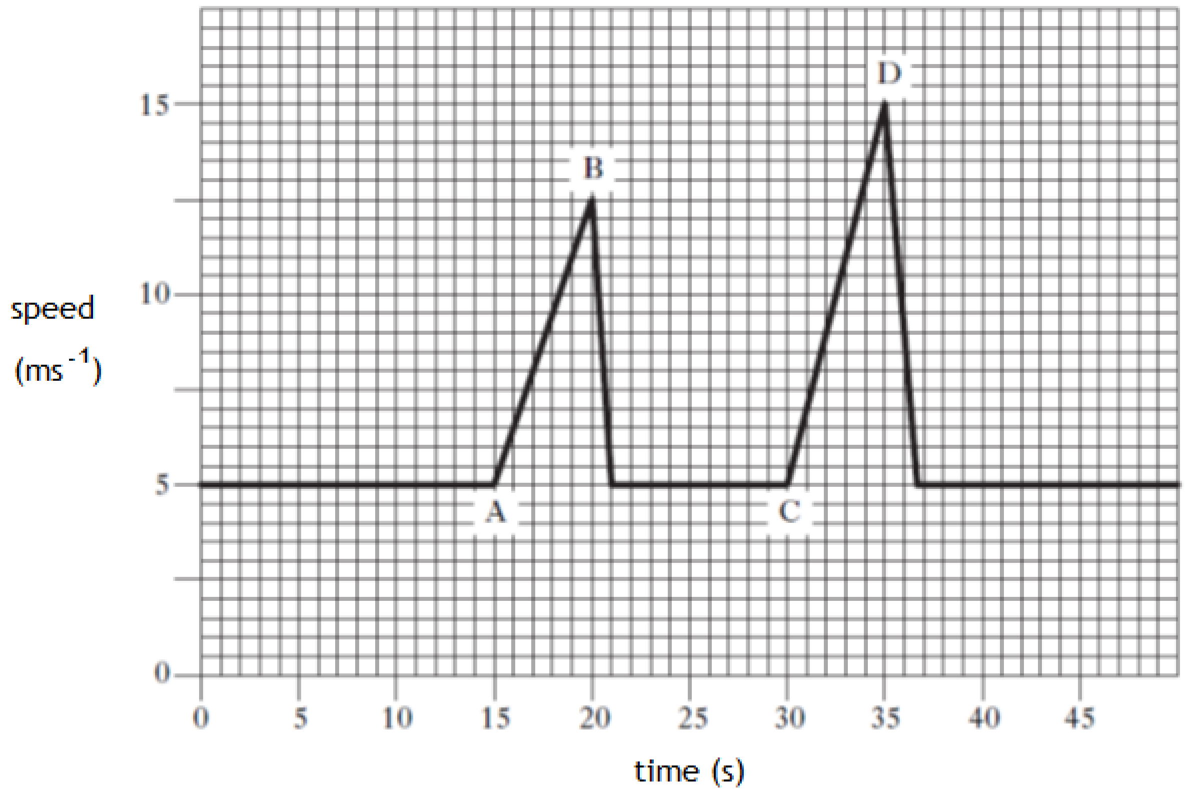
Velocity-Time Graphs

2011 C 9

1. On a visit to a theme park, four students ride the log flume.



The graph shows how the speed of the log varies during the ride.



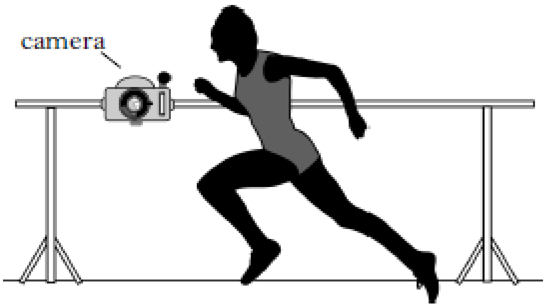
(a) Describe the motion of the log during AB on the graph. 1

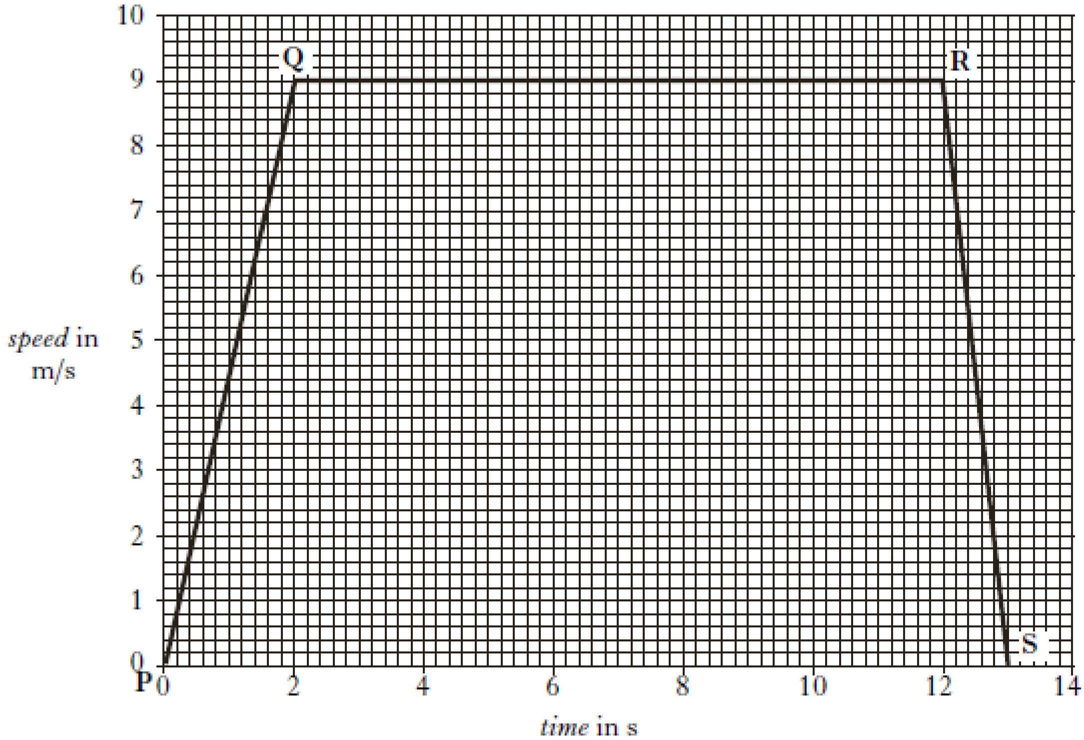
(b) Calculate the distance travelled by the log from the start of the ride to the bottom of the first drop. 3

(c) Calculate the log's acceleration as it goes down the second drop. 3

2008 Int2 21c

2. Athletes in a race are recorded by a TV camera which runs on rails beside the track.





The graph shows the speed of the camera during the race.

How far does the camera travel in the 13 s? 3

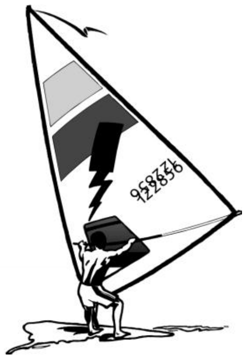
2007 Int2 22bii and iii

3. A cyclist approaches traffic lights at a speed of 8 m/s. He sees the traffic lights turn red and 3 s later he applies the brakes. He comes to rest in a further 2.5 s.

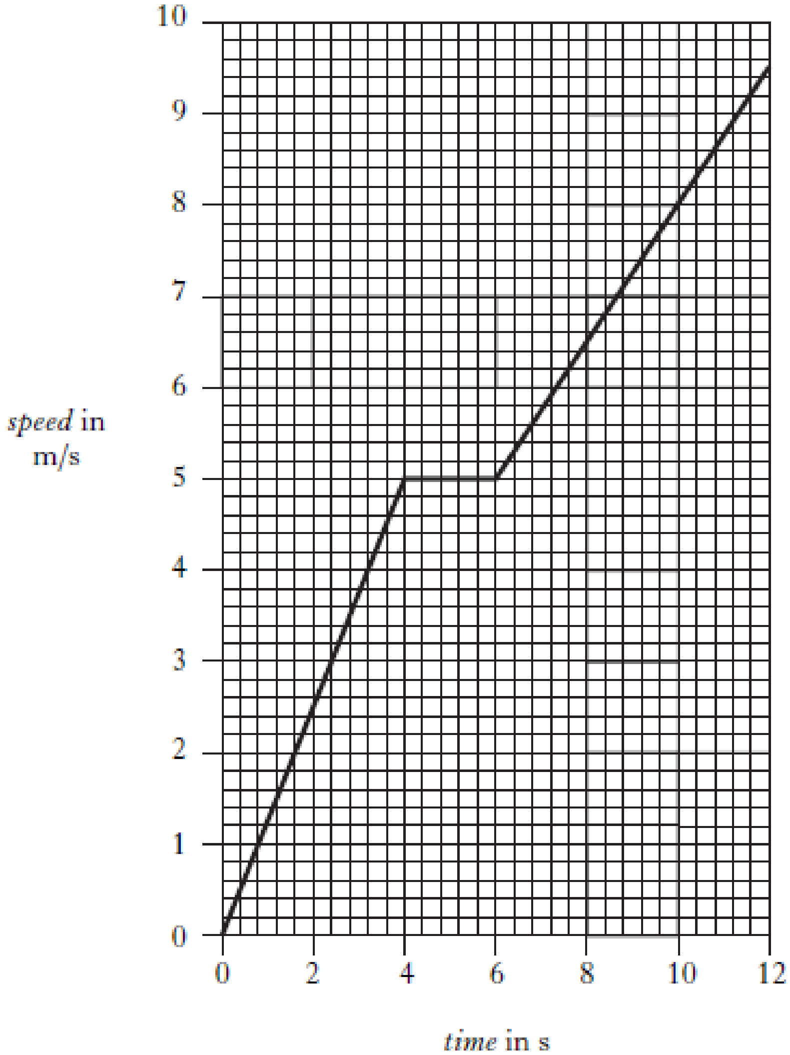
(a) Sketch a speed time graph showing the motion of the cyclist from the moment the lights turn red until he stops at the traffic lights.
Numerical values must be included. 3

(b) Use the graph to calculate the total distance the cyclist travels from the moment the lights turn red until he stops at the traffic lights. 3

4. A windsurfer takes part in a race.



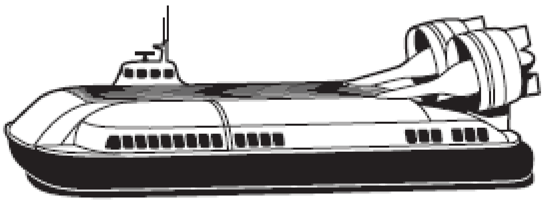
The graph shows how the speed of the windsurfer and board changes with time during part of the race.



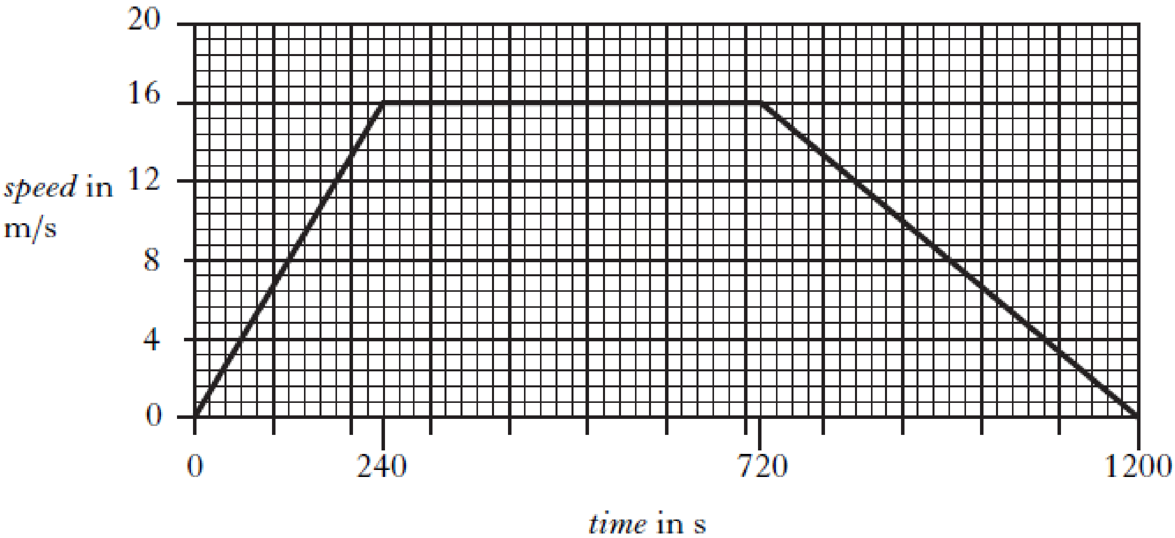
Calculate the total distance travelled by the windsurfer during the 12 s time interval shown on the graph. 3

2009 C 12b

5. A hovercraft service was trialled on the Firth of Forth from Kirkcaldy to Leith.



The graph shows how the speed of the hovercraft varies with time for one journey from Kirkcaldy to Leith.

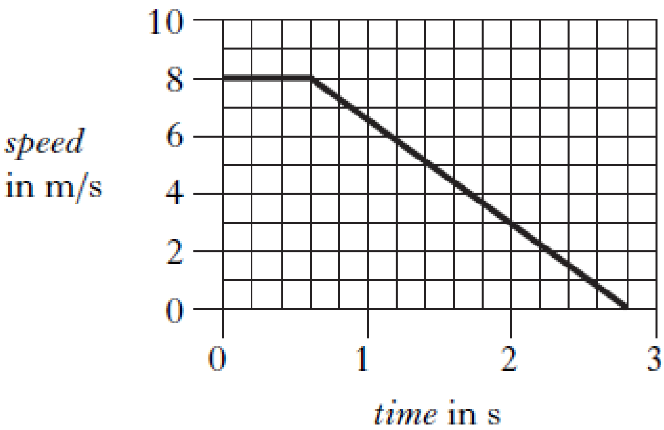


(a) Calculate the total distance travelled during the journey. 3

(b) Calculate the average speed for the whole journey. 3

2010 C 10a

6. A cyclist is approaching traffic lights at a constant speed. The cyclist sees the lights change to red. The graph shows how the speed of the cyclist varies with time from the instant the cyclist sees the lights change to red.



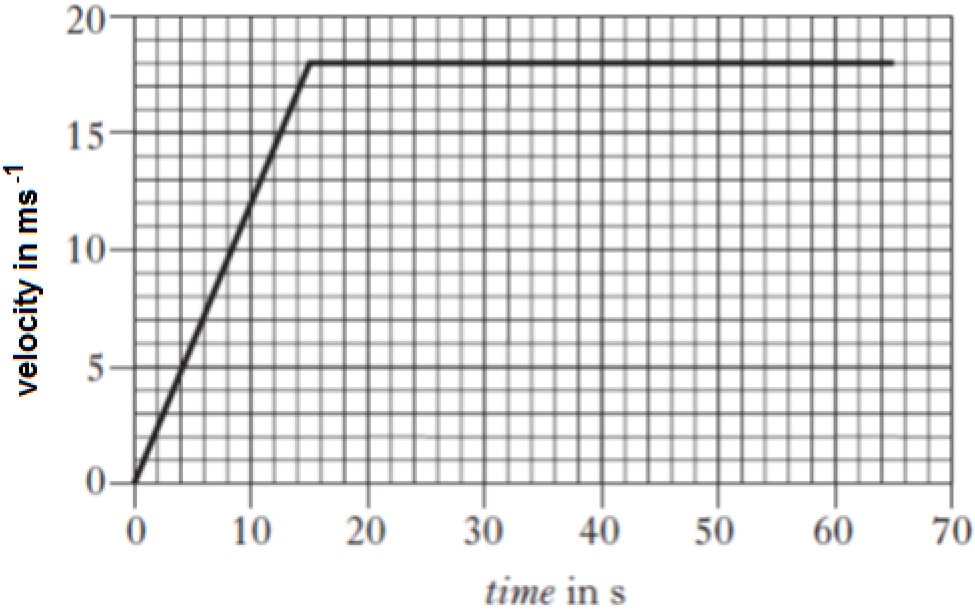
(a) How long did it take for the cyclist to react before applying the brakes? 1

(b) Calculate the distance travelled from the instant the cyclist sees the traffic lights change to red until stationary. 3

Acceleration

2012 C 10

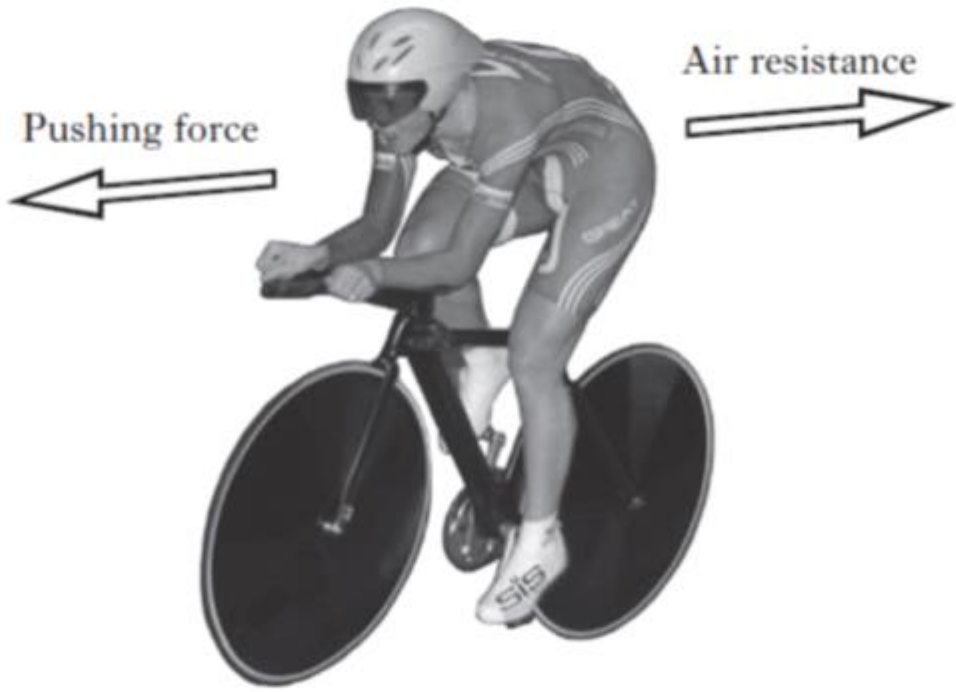
1. A competitor takes part in a cycling event along a straight road.
The cyclist takes 65 s to complete the race.
The graph below shows how the cyclist's velocity changes with time during the race.



(a) Calculate the acceleration of the cyclist during the first 15 s of the race. 3

(b) Calculate the displacement of the cyclist during the race. 3

(c) The diagram shows some of the forces acting on the cyclist during the race.

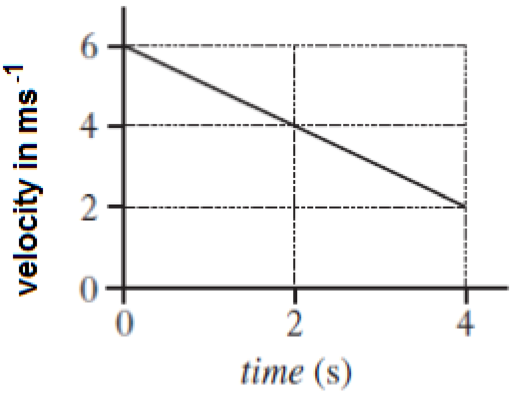


(i) Suggest one way in which the cyclist reduces air resistance. 1

(ii) Suggest one place where the cyclist requires friction. 1

2011 Int2 2 MC

2. The graph shows how the velocity of a ball changes with time.

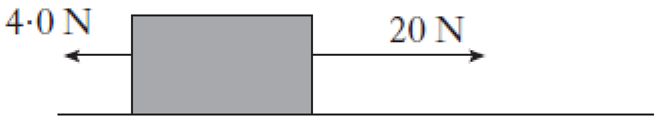


The acceleration of the ball is:

A -8 ms^{-2}
B -1 ms^{-2}
C 1 ms^{-2}
D 8 ms^{-2}
E 24 ms^{-2} 1

2012 Int2 4 MC

3. The diagram shows the horizontal forces acting on a box.



The box accelerates at 1•6 m s^{-2}.
The mass of the box is

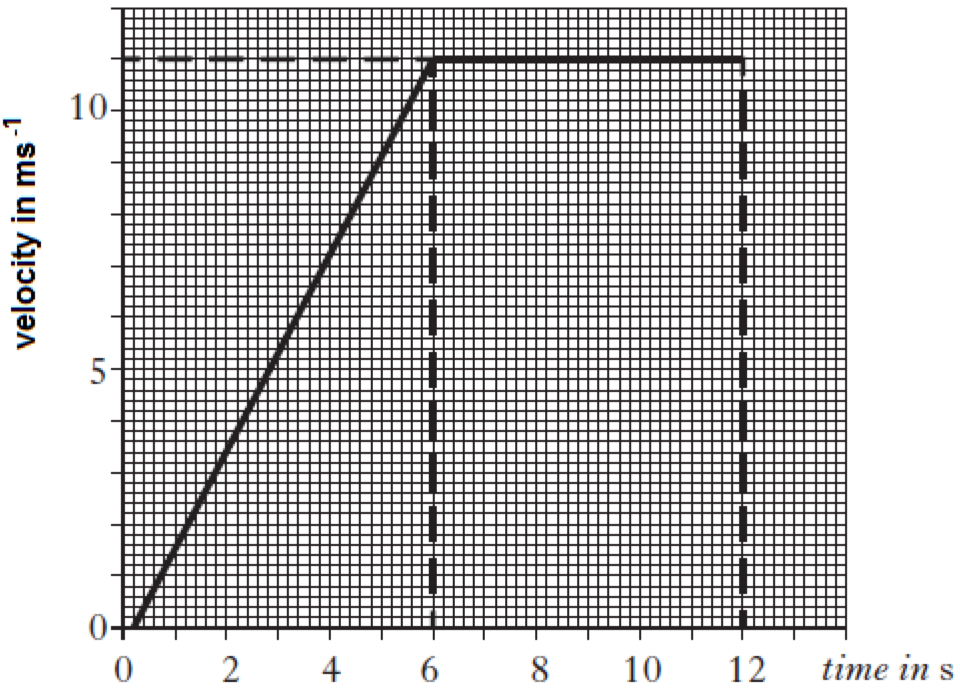
A 0.10 kg
B 10.0 kg
C 15.0 kg
D 25.6 kg
E 38.4 kg 1

2007 Int2 22bi

4. A cyclist approaches traffic lights at a speed of 8 m/s. He sees the traffic lights turn red and he applies the brakes. He comes to rest in 2.5 s.
Calculate the acceleration of the cyclist whilst braking. 3

2013 C 9c

5. The graph shows the motion of a runner in the first 12 s of a race.

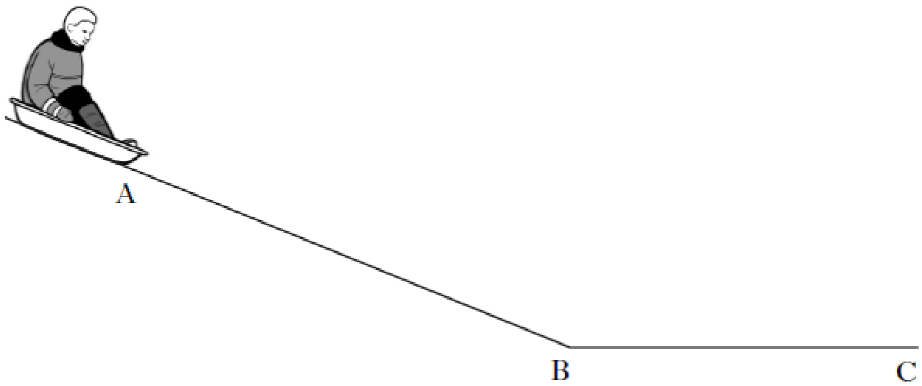


(a) Calculate the acceleration of the runner. 3

(b) Calculate the displacement of the runner in the first 12 s. 3

2009 Int2 22ac

6. A child sledges down a hill.



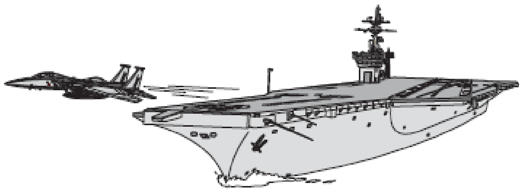
The sledge and child are released from rest at point A. They reach a speed of 3 ms^{-1} at point B.

(a) The sledge and child take 5 s to reach point B.
Calculate the acceleration. 3

(b) After the sledge and child pass point B, they slow down, coming to a halt at point C.
Explain this motion in terms of forces. 2

2007 C 11ai

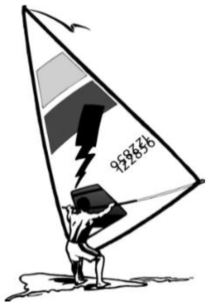
7. An aeroplane on an aircraft carrier must reach a minimum speed of 70 ms^{-1} to safely take off.



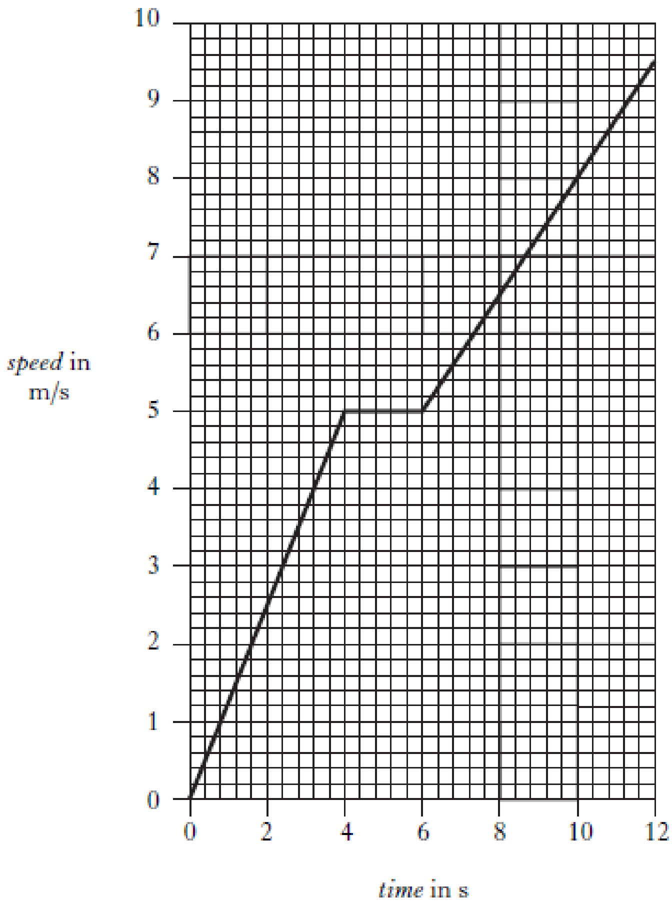
The aeroplane accelerates from rest to its minimum take off speed in 2 s.
Calculate the acceleration of the aeroplane. 3

2008 C 11ai

8. A windsurfer takes part in a race.



The graph shows how the speed of the windsurfer and board changes with time during part of the race.



Calculate the acceleration of the windsurfer and board during the first 4 s of the race. 3

Newton's Laws

2011 C 15

1. The first manned space flights took place 50 years ago. Spacecraft were launched into space using powerful rockets.

(a) The operation of a rocket engine can be explained using Newton's Third Law of Motion.

(i) State Newton's Third Law of Motion. 1

(ii) Explain, in terms of Newton's Third Law, how the rocket engines propel the rocket upwards. 1

(b) At lift-off, one rocket has a total mass of 2.05×10^6 kg. The resultant force acting upwards on the rocket is 8.2×10^6 N.
Calculate the acceleration of the rocket at lift-off. 3

2011 Int2 4 MC

2. An engine applies a force of 2000 N to move a lorry at a constant speed.
The lorry travels 100 m in 16 s.
The power developed by the engine is

A 0.8 W
B 12.5 W
C 320 W
D 12500 W
E 3200000 W 1

2012 Int2 2 MC

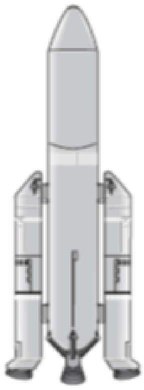
3. Near the Earth's surface, a mass of 6 kg is falling with a constant velocity. The air resistance and the unbalanced force acting on the mass are:

	Air resistance	Unbalanced force
A	60 N upwards	0N
B	10 N upwards	10 N downwards
C	10 N downwards	70 N downwards
D	10 N upwards	0 N
E	60 N upwards	60 N downwards

1

2013 C 13

4. In 2014 the European Space Agency will fly a manned mission to the International Space Station (ISS).



A spacecraft with booster rockets attached will be launched.

(a) On the diagram above draw and label the two forces acting on the spacecraft at lift off. 1

(b) The combined mass of the spacecraft and booster rockets is 3.08×10^5 kg and the initial thrust on the rocket at lift off is 3352 kN. The frictional forces acting on the rocket at lift off are negligible.

(i) Calculate the weight of the spacecraft and booster rockets at lift off. 3

(ii) Calculate the acceleration of the spacecraft and booster rockets at lift off. 4

(c) The ISS orbits at a height of approximately 360 km above the Earth. Explain why the ISS stays in orbit around the Earth. 2

(d) An astronaut on board the ISS takes part in a video link-up with a group of students. The students see the astronaut floating.

(i) Explain why the astronaut appears to float. 1

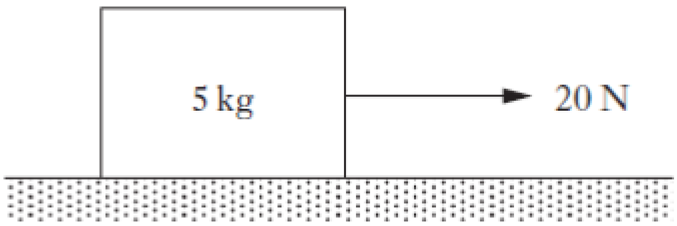
(ii) The astronaut then pushes against a wall and moves off.
Explain in terms of Newton's Third Law why the astronaut moves. 1

2013 Int2 3 MC

5. A space probe has a mass of 60 kg. The weight of the space probe at the surface of a planet in our solar system is 660 N.
The planet is
A Venus
B Mars
C Jupiter
D Saturn
E Neptune 1

2013 Int2 4 MC

6. A block is pulled across a horizontal surface as shown.



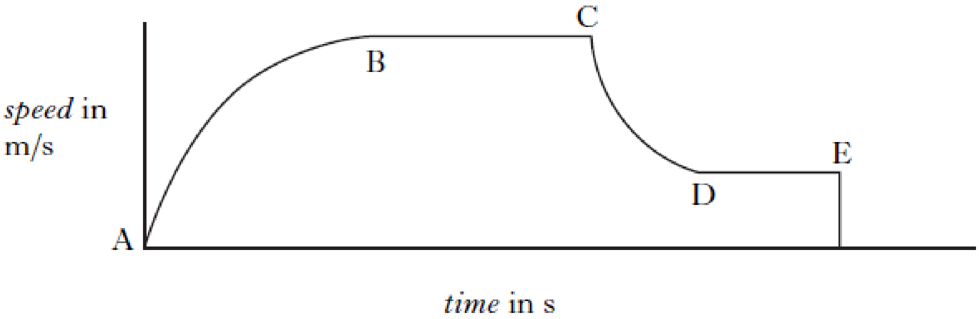
The mass of the block is 5 kg. The block is travelling at a constant speed.
The force of friction acting on the block is
A 0 N
B 4 N
C 15 N
D 20 N
E 25 N 1

2010 Int2 6 MC

7. A crate of mass 200 kg is pushed a distance of 20 m across a level floor.
The crate is pushed with a force of 150N.
The force of friction acting on the crate is 50N.
The work done in pushing the crate across the floor is
A 1000 J
B 2000 J
C 3000 J
D 4000 J
E 20 000 J 1

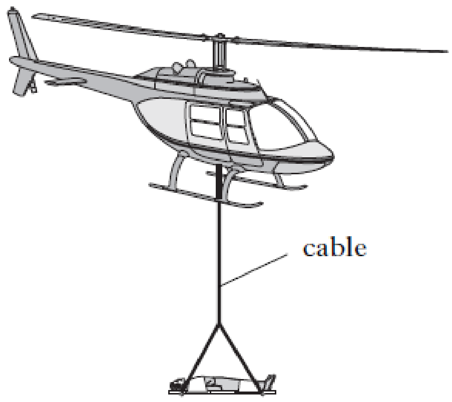
8. A parachutist jumps out of an aircraft. Sometime later, the parachute is opened.

The graph shows the motion of the parachutist from leaving the aircraft until landing.



(*a*) Which parts of the graph show when the forces acting on the parachutist are balanced? 1

(b) The parachutist lands badly and is airlifted to hospital by helicopter.
The stretcher and parachutist have a total mass of 90·0 kg.

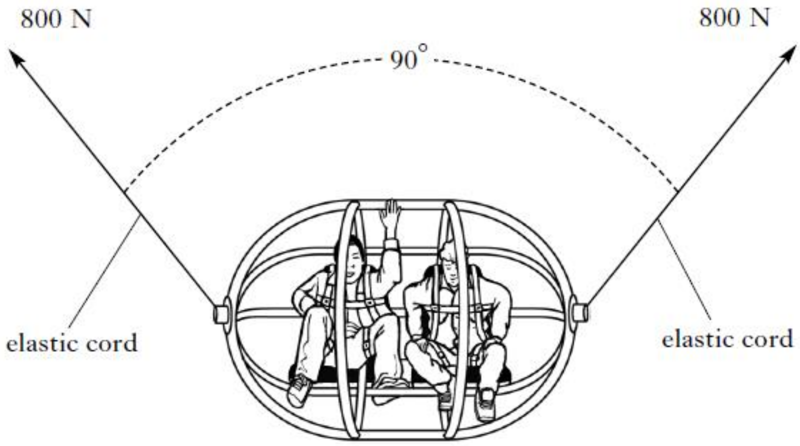


(i) Calculate the weight of the stretcher and parachutist. 3

(ii) The helicopter cable provides an upward force of 958·5 N to lift the stretcher and parachutist.
Calculate the acceleration of the stretcher and parachutist. 5

2008 Int2 22

9. A fairground ride uses a giant catapult to launch people upwards using elastic cords.



(a) Each cord applies a force of 800N and the cords are at 90° as shown.
Using a scale diagram, or otherwise, find the size of the resultant of these two forces. 2

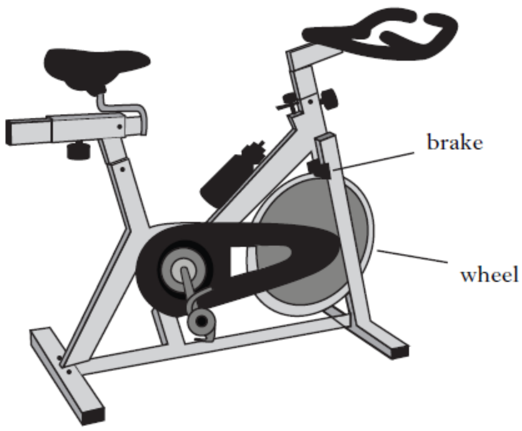
(b) The cage is now pulled further down before release. The cords provide an upward resultant force of 2700N. The cage and its occupants have a total mass of 180 kg.

(i) Calculate the weight of the cage and occupants. 3

(ii) Calculate the acceleration of the cage and occupants when released. 3

2008 Int2 23ai

10. One type of exercise machine is shown below.



(*a*) A person using this machine pedals against friction forces applied to the wheel by the brake. A friction force of 300N is applied at the edge of the wheel, which has a circumference of 1.5m.

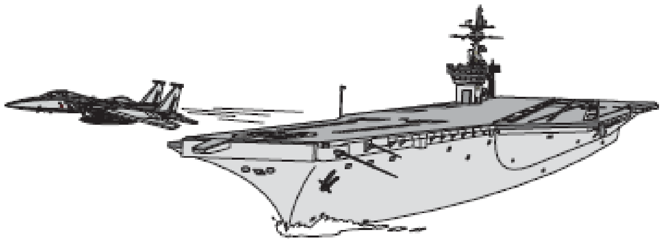
(i) How much work is done by friction in one turn of the wheel?

2010 C 10b

11. A cyclist is waiting at a red traffic light. She sees the traffic lights change to green and accelerates away from the lights. The combined mass of the cycle and cyclist is 75 kg. An unbalanced force of 150 N acts on this combined mass.
Calculate the acceleration. 3

2007 C 11a

12. An aeroplane on an aircraft carrier must reach a minimum speed of 70 ms^{-1} to safely take off. The mass of the aeroplane is 28 000 kg.



The aeroplane accelerates from rest to its minimum take off speed in 2 s.

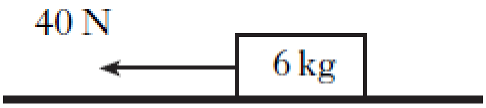
(a) Calculate the acceleration of the aeroplane. 3

(b) Calculate the force required to produce this acceleration. 3

(c) The aeroplane's engines provide a total thrust of 240 kN. An additional force is supplied by a catapult to produce the acceleration required. Calculate the force supplied by the catapult. 2

2007 Int2 6 MC

13. A block of mass 6 kg is pulled across a horizontal bench by a force of 40 N as shown below.



The block accelerates at 4 ms^{-2}.
The force of friction between the block and the bench is
A zero
B 16N
C 24N
D 40N
E 64N.

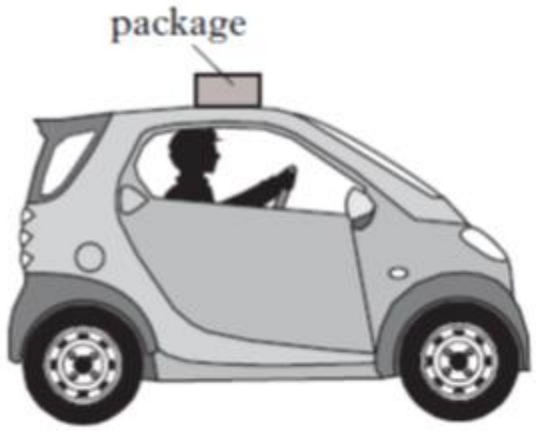
2007 Int2 27b

14. As a raindrop falls it reaches a steady speed.
Using Newton's laws of motion, explain why it falls at a steady speed. 2

Projectile Motion

2011 C 13

1. A car driver exits a car park having accidentally left a package resting on the roof of the car. The car is travelling at a constant velocity of 15 m s^{-1} when the driver brakes suddenly and the car stops. The package continues to move forward.



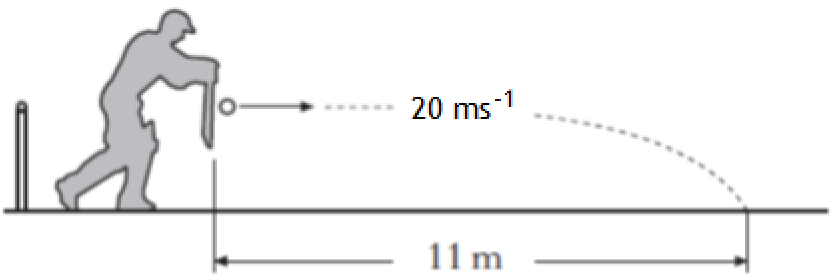
(a) (i) On the above diagram sketch the path taken by the package. 1

(ii) Explain why the package follows this path. 2

(b) The package takes 0.55 s to fall to the ground.
Calculate its vertical velocity as it reaches the ground. 4

2011 Int2 21

2. A cricketer strikes a ball. The ball leaves the bat horizontally at 20 m s^{-1}.
It hits the ground at a horizontal displacement of 11 m from the point where it was struck.



Assume that air resistance is negligible.

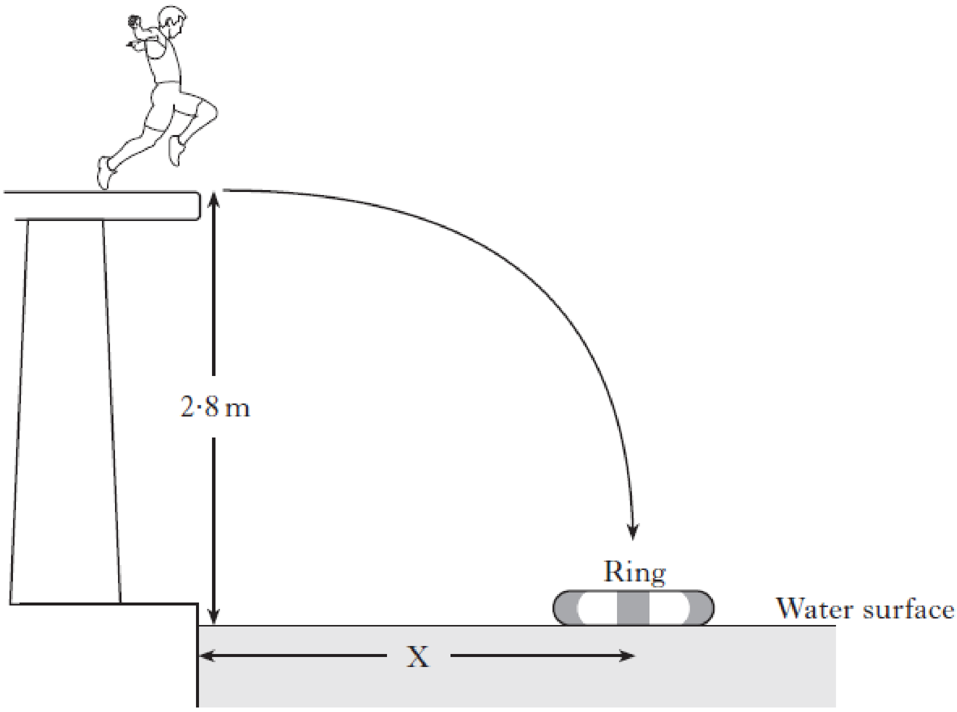
(a) Calculate the time of flight of the ball. 3

(b) Calculate the vertical velocity of the ball as it reaches the ground. 3

(c) Sketch a graph of vertical velocity against time for the ball.
Numerical values are required on both axes. 2

(d) Calculate the vertical displacement of the ball during its flight. 3

3. In a TV game show contestants are challenged to run off a horizontal platform and land in a rubber ring floating in a swimming pool.
The platform is 2.8 m above the water surface.



(a) A contestant has a mass of 60 kg.
He runs off the platform with a horizontal velocity of 2 m s^{-1}.
He takes 0•76 s to reach the water surface in the centre of the ring.

(i) Calculate the horizontal displacement X from the poolside to the centre of the ring. 3

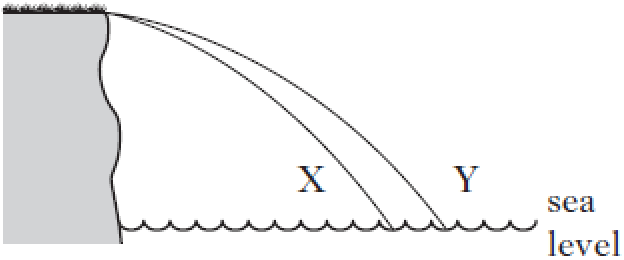
(ii) Calculate the vertical velocity of the contestant as he reaches the water surface. 3

(b) Another contestant has a mass of 80 kg.

(i) State if she will need to run faster, slower or at the same horizontal velocity as the first contestant to land in the ring. 1

(ii) You must explain your answer to (b) (i). 1

4. Two identical balls X and Y are projected horizontally from the edge of a cliff.
The path taken by each ball is shown.



A student makes the following statements about the motion of the two balls.

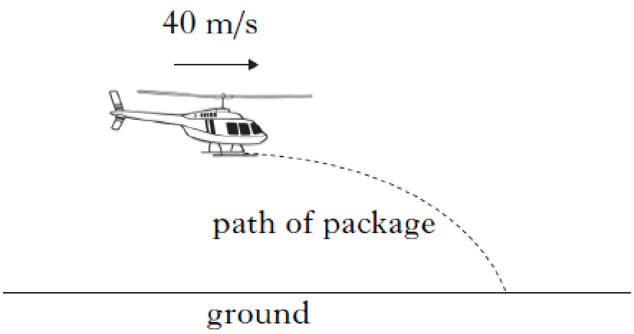
I They take the same time to reach sea level.
II They have the same vertical acceleration.
III They have the same horizontal velocity.

Which of these statements is/are correct?

A I only
B II only
C I and II only
D I and III only
E II and III only

2010 Int2 4 MC

5. A package is released from a helicopter flying horizontally at a constant speed of 40 ms^{-1}.



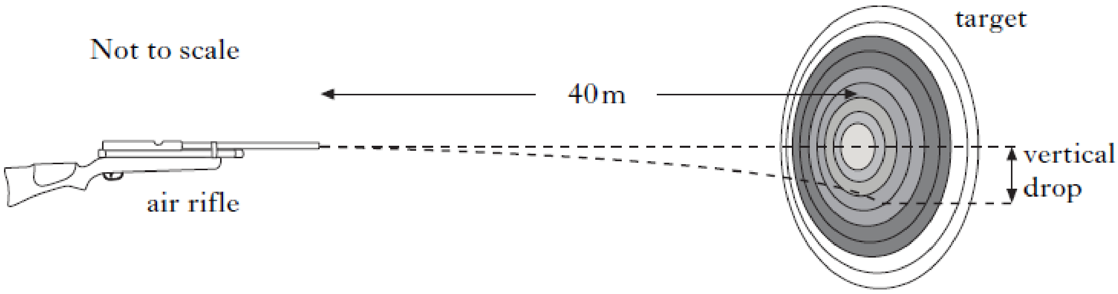
The package takes 3.0 s to reach the ground.
The effects of air resistance can be ignored.
Which row in the table shows the horizontal speed and vertical speed of the package just before it hits the ground?

	Horizontal speed (ms^{-1})	Vertical speed (ms^{-1})
A	0	30
B	30	30
C	30	40
D	40	30
E	40	40

1

2009 Int2 23ci

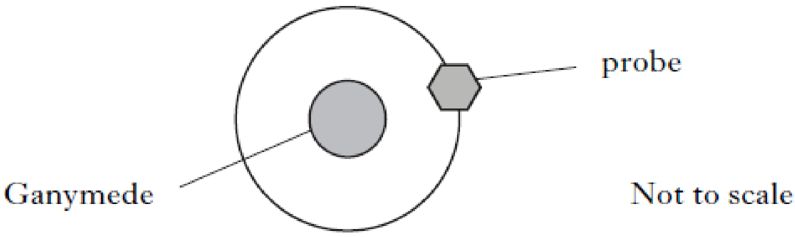
6. At a firing range a pellet is fired horizontally at a target 40 m away. It takes 0.20 s to reach the target.



Calculate the **vertical** velocity of the pellet on reaching the target. 3

2009 C 15cd

7. A space probe is in orbit around Ganymede, a moon of Jupiter.

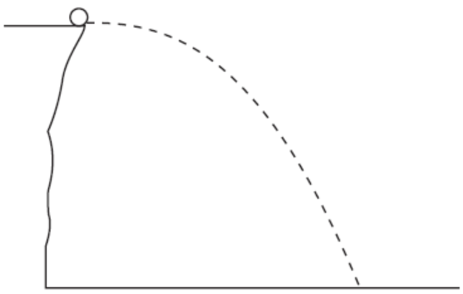


(a) Explain why the probe follows a circular path while in orbit. 2

(b) The probe has gas thrusters that fire to slow it down in order to land on Ganymede. In terms of Newton's laws, explain how these thrusters achieve this task. 2

2009 Int2 4 MC

8. A ball is thrown horizontally from a cliff as shown.



The effect of air resistance is negligible.
A student makes the following statements about the ball.

I The vertical speed of the ball increases as it falls.
II The vertical acceleration of the ball increases as it falls.
III The vertical force on the ball increases as it falls.

Which of the statements is/are correct?

A I only
B II only
C I and II only
D II and III only
E I, II and III 1

2007 C 15b

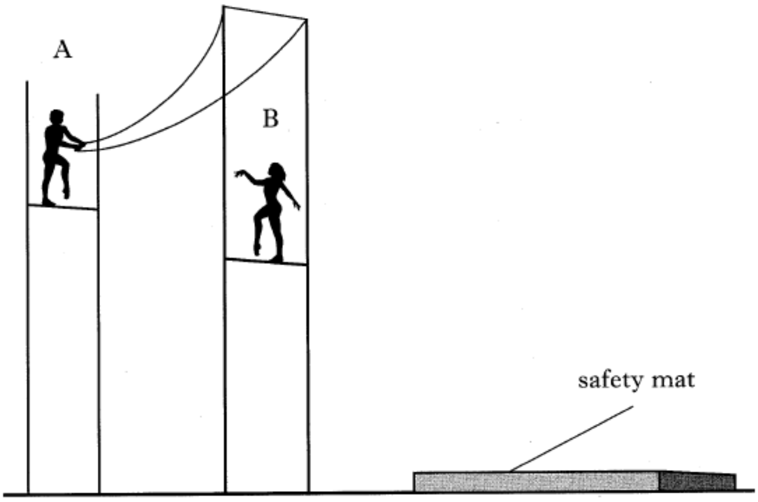
9. In June 2005, a space vehicle called Mars Lander was sent to the planet Mars. The Mars Lander released a rover exploration vehicle on to the surface of Mars. To collect data from the bottom of a large crater, the rover launched a probe horizontally at 30 ms^{-1}. The probe took 6 s to reach the bottom of the crater. (The gravitational field strength on the surface of Mars is 4 N kg^{-1}.)

(a) Calculate the horizontal distance travelled by the probe. 3

(b) Calculate the vertical speed of the probe as it reached the bottom of the crater. 3

2006 Int2 23c

10. In a circus trapeze act, gymnast A swings down on the trapeze and collides with gymnast B. At the point of the collision, gymnast A lets go of the trapeze and the two gymnasts move off together with a horizontal velocity of 4.8 ms^{-1}. They fall together for 0.65 s until they land on a safety mat.



(a) Calculate the horizontal distance they travel until they reach the mat. 3

(b) Calculate the **vertical** speed with which they strike the mat. 3

2005 Int2 3 MC

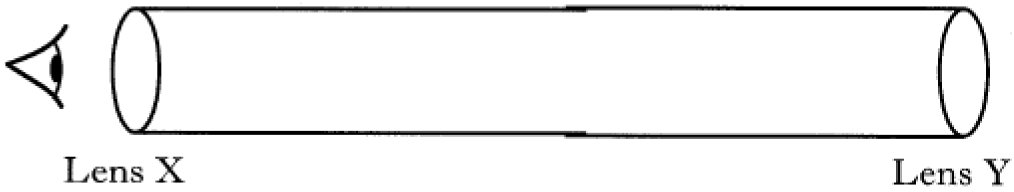
11. A seagull, flying horizontally at 8 ms^{-1} drops a piece of food. What will be the horizontal and vertical speeds of the food when it hits the ground 2.5 s later. Air resistance should be ignored. 1

	Horizontal speed (ms^{-1})	Vertical speed (ms^{-1})
A	0	8
B	8	20
C	8	25
D	25	25
E	33	50

Space Exploration

2001 G 16b

1. A telescope consists of two lenses, X and Y, in a light tube.



Complete the following statements about the lenses in this telescope, using the words or phrases from the list.

eyepiece objective magnify collect light

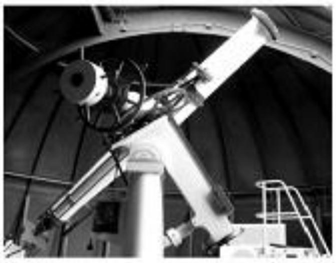
(a) Lens X is called the ………….. lens. Its purpose is to …………….. 1

(b) Lens Y is called the ………….. lens. Its purpose is to ……………… and produce an image of the object. 1

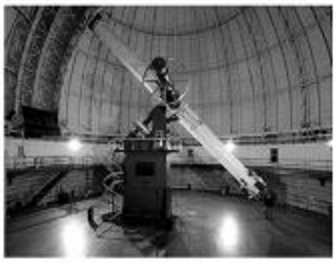
Cosmology

2012 C 14

1. The Mills Observatory in Dundee and the Yerkes Observatory in Wisconsin, USA both have refracting telescopes.



Mills Observatory Telescope



Yerkes Observatory Telescope

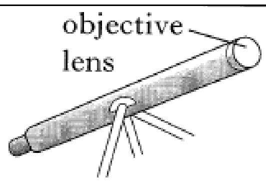
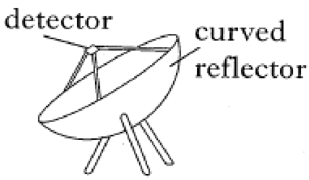
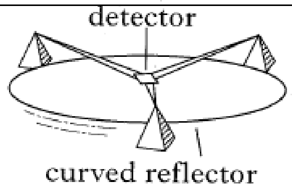
Astronomers in both observatories are studying the Andromeda galaxy which is approximately 2.2 million light years away.

(a) A light year is defined as "the distance that light travels in one year". Show by calculation that 1 light year = 9.4608×10^{15} m. 3

(b) Not all telescopes detect visible light. Why are different kinds of telescope used to detect signals from space? 1

2004 C 13

2. The table below has information about three telescopes used to detect radiation from space.

	Refracting telescope in Edinburgh, with a 150 mm diameter objective lens.
	Radio telescope at Jodrell Bank, with a curved reflector of diameter 76 m.
	Radio telescope at Arecibo, Puerto Rico, with a curved reflector of diameter 300 m.

(a) What type of radiation is detected by a refracting telescope? 1

(b) Why are different types of telescope used to detect radiation from space? 1

(c) In a radio telescope, where is the detector placed in relation to the curved reflector? 1

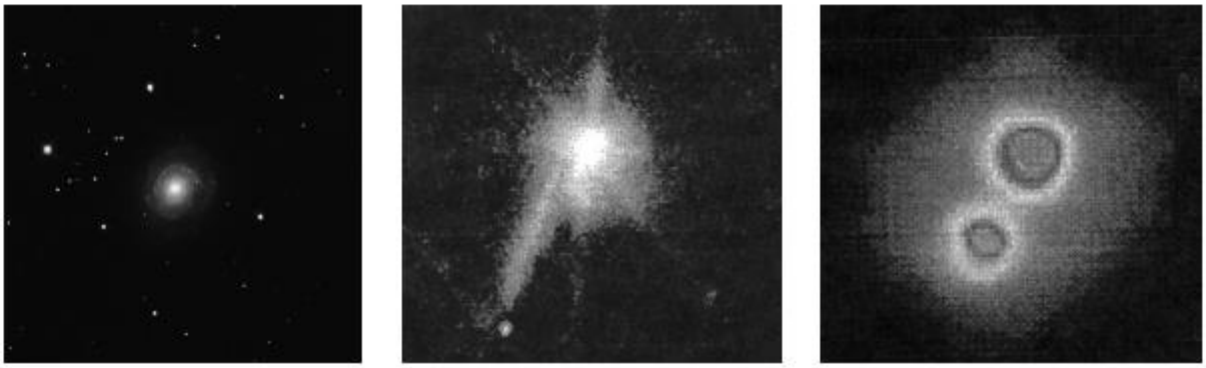
(d) Explain which of the three telescopes above is best for detecting very weak radio signals from deep space. 2

2008 C 14ab

3. A team of astronomers observes a star 200 light-years away.

(a) State what is meant by the term "light-year". 1

(b) Images of the star are taken with three different types of telescope as shown.



Telescope A visible light | Telescope B infrared | Telescope C X-ray

(i) Explain why different types of telescope are used to detect signals from space. 2

(ii) Place the telescopes in order of the increasing wavelength of the radiation which they detect. 1

(iii) State a detector that could be used in telescope C. 1

2009 C 16b

4. Radio waves emitted by galaxies are detected and used to provide images of the galaxies.

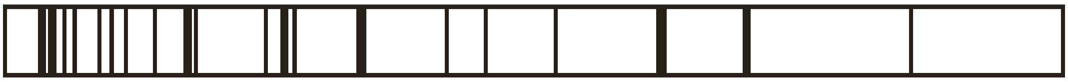
(a) How does the wavelength of radio waves compare with the wavelength of light? 1

(b) Name a detector for radio waves. 1

(c) Why are different kinds of telescope used to detect signals from space? 1

2011 C 14b

5. Some spectral lines of radiation from a distant star are shown below.



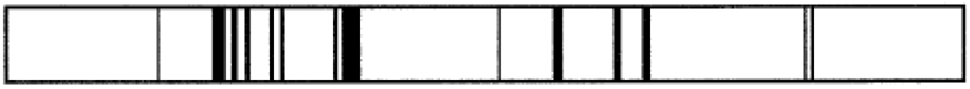
Spectral lines of radiation from distant star

The spectral lines of a number of elements are also shown.

Use the spectral lines of the elements shown above to identify which of these elements are present in the distant star. 2

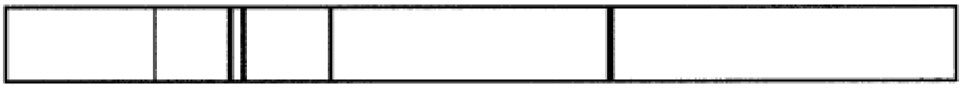
2006 C 13biii

6. Early in 2005, a probe was released from a spacecraft which was orbiting Titan, a moon of Saturn.
The probe carried equipment to analyse the spectral lines of radiation from gases in the atmosphere of Titan. These lines are shown below.

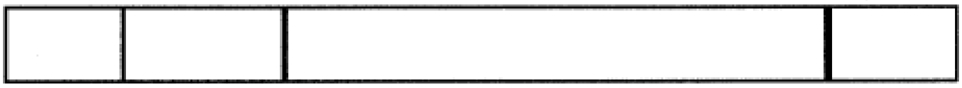


Spectral lines from gases in Titan's atmosphere

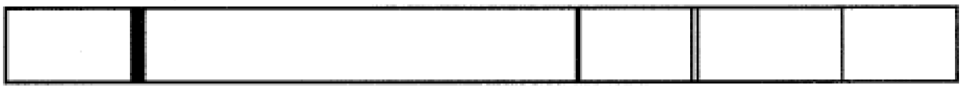
The spectral lines of a number of elements are also shown.



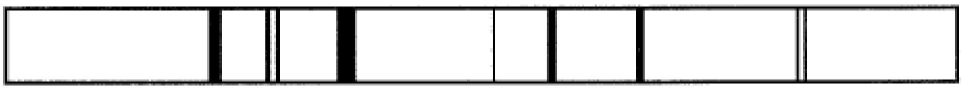
Helium



Hydrogen



Mercury



Nitrogen

Use the spectral lines of the elements to identify which elements are present in the atmosphere of Titan. 1

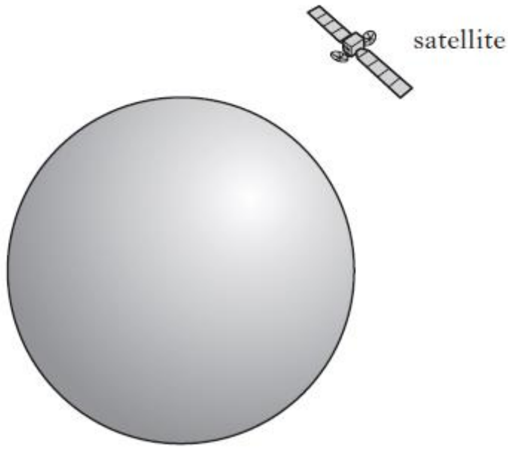
2008 G 20b

7. Light from a star produces a line spectrum.
What information is obtained about the star from this spectrum? 1

Various

2011 Int2 22

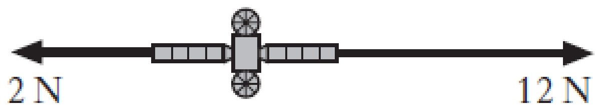
1. A satellite moves in a circular orbit around a planet. The satellite travels at a constant speed whilst accelerating.



(a) (i) State the meaning of the term acceleration. 1

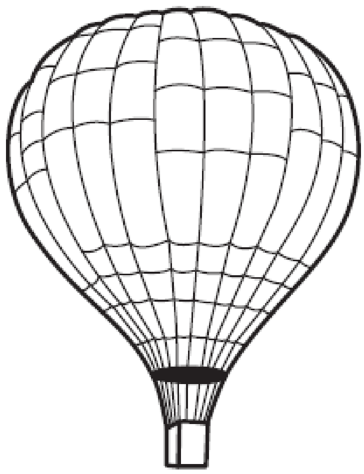
(ii) Explain how the satellite can be accelerating when it is travelling at a constant speed. 1

(b) At one particular point in its orbit the satellite fires two rockets. The forces exerted on the satellite by these rockets are shown on the diagram.

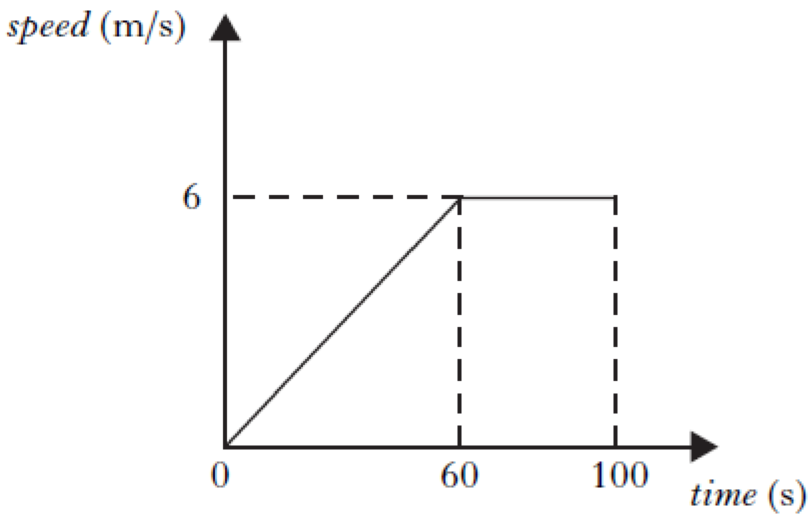


The satellite has a mass of 50 kg.
Calculate the resultant acceleration due to these forces. 4

2. A balloon of mass 400kg rises vertically from the ground.



The graph shows how the vertical speed of the balloon changes during the first 100 s of its upward flight.



(a) Calculate the acceleration of the balloon during the first 60 s. 3

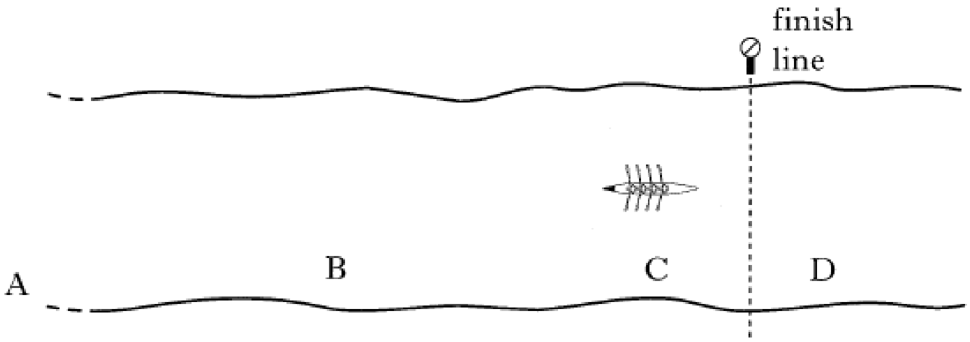
b) Calculate the distance travelled by the balloon in 100 s. 3

(c) Calculate the average speed of the balloon during the first 100 s. 3

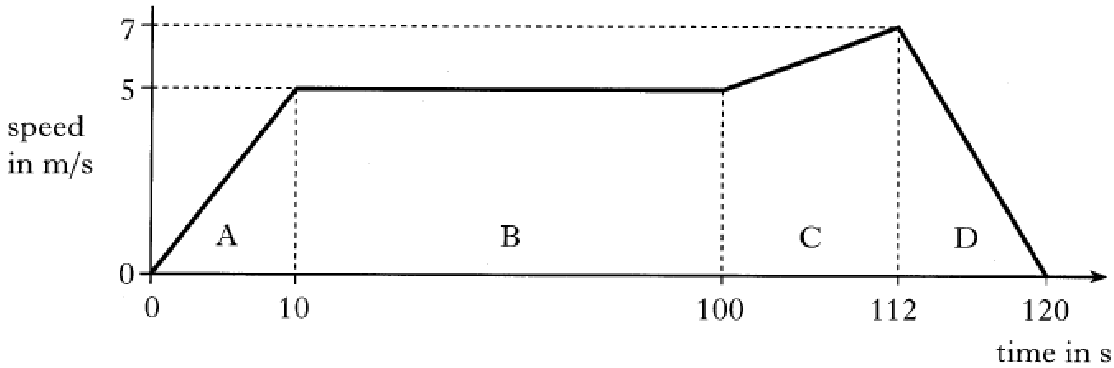
(d) Calculate the weight of the balloon. 3

(e) Calculate the total upward force acting on the balloon during the first 60 s of it's flight. 4

3. A rowing team is taking part in a race on calm water.



The following graph shows how it is predicted that the speed of the boat will vary with time during the stages A, B, C and D of the race.



The prediction assumes that the frictional force on the team's boat remains constant at 800 N during the race.

(a) (i) State the size of the forward force applied by the oars during stage B. 1

(ii) Calculate the acceleration of the boat during stage C. 3

(iii) The total mass of the boat and its crew is 400kg.
Calculate the size of the forward force applied by the oars during stage C. 5

(iv) The boat crosses the finishing line after 112 seconds.
Calculate the distance the boat travels **from the instant it crosses the line until it comes to rest.** 3

(b) The frictional force acting on the boat during stage D actually becomes smaller as the speed decreases.

(i) What will be the effect of this smaller frictional force on the time taken for the boat to come to rest? 1

(ii) Sketch a graph of speed against time for stage D, assuming that the frictional force becomes smaller as the speed decreases. 1