National 5 Physics

Dynamics and Space

Questions by Topic

Based on Past SQA Papers 2000 - 2008

Contents

Velocity and Displacement - Vectors and Scalars

2000 Int 2

1. Which of the following is a vector quantity?

A Speed

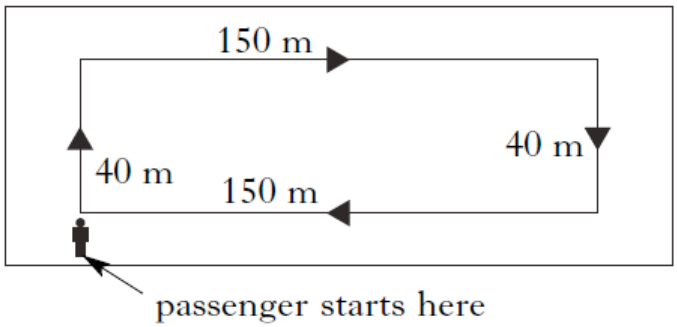
B Distance

C Velocity

D Time

E Energy

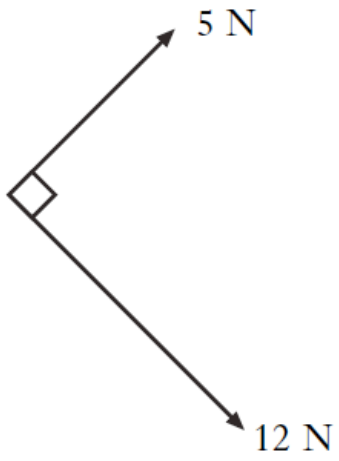
2. At an airport a passenger starts at the entrance to the terminal building, walks around inside the building as shown below and arrives back at the entrance.



Which of the following correctly shows the total distance walked and the size of the final displacement?

	Total distance in m	*Final displacement in* m
A	0	155
B	0	380
C	190	155
D	380	0
E	380	380

4. Two forces act at right angles as shown below.



The size of the resultant force is

A 7 N

B 13 N

C 17 N

D 60 N

E 169 N.

2001 Int 2

1. Which of the following pairs contain two scalar quantities?

A Force and mass

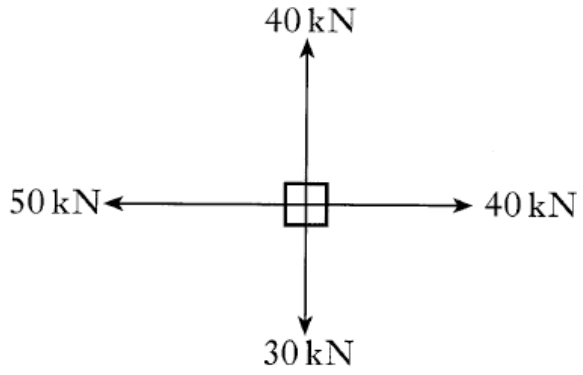
B Weight and mass

C Displacement and speed

D Distance and speed

E Displacement and velocity

2. Four tugs apply forces to an oil-rig as shown.



Which of the following could represent the resultant force?

A 

B 

C 

D 

E 

2002 Int 2

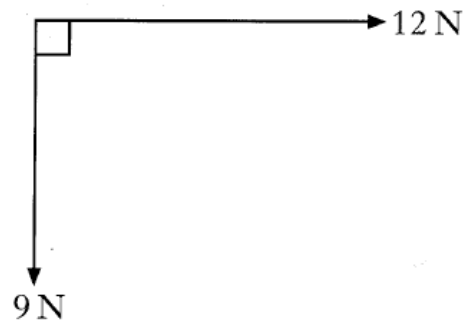
2. An athlete runs 30 m East and then 40 m West.

Which row correctly shows the distance gone and the displacement from the starting point?

	Distance	*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

2003 Int 2

2. The diagram represents two forces acting on an object.



The magnitude of the resultant force is

A 3 N

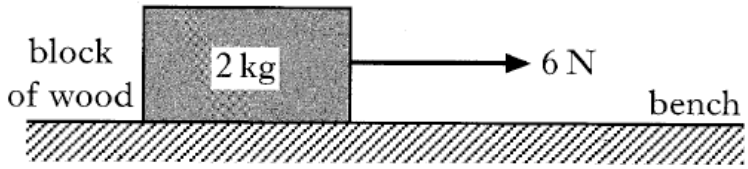
B 10 N

C 11 N

D 15 N

E 21 N.

4. A block of wood of mass 2 kg is pulled along a bench by a horizontal force of 6 N.



A constant frictional force of 2 N acts on the block.

The acceleration of the block is

A $0{\cdot}25\ m/s^2$

B $0{\cdot}5\ m/s^2$

C $2\ m/s^2$

D $3\ m/s^2$

E $4\ m/s^2$.

2005 Int 2

1. Which of the following is a scalar quantity?

A Velocity

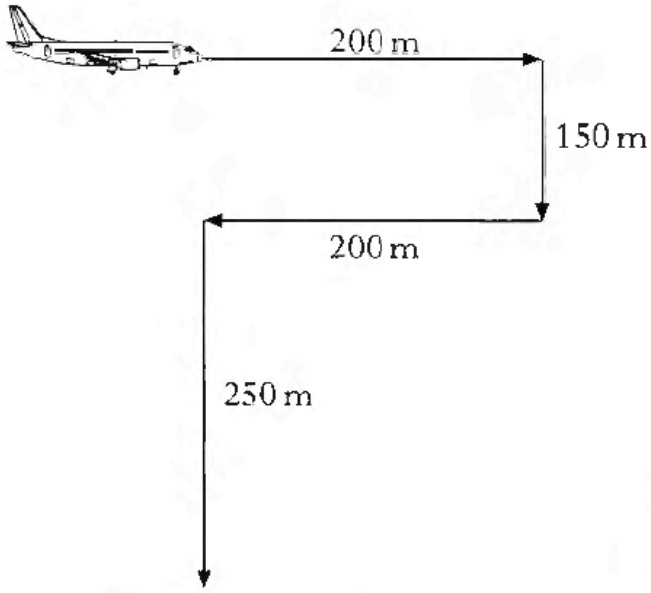
B Displacement

C Acceleration

D Force

E Speed

2. At an airport an aircraft moves from the terminal building to the end of the runway.

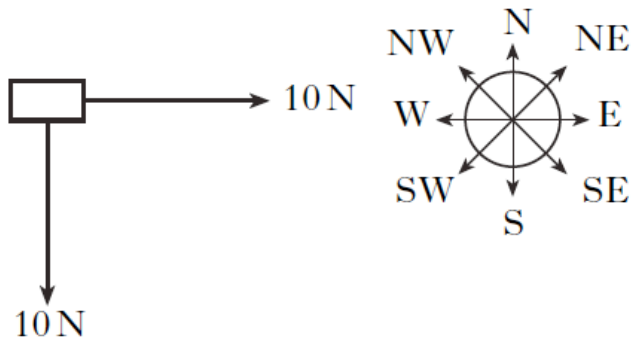


Which row shows the total distance travelled and the size of the displacement of the aircraft?

	Total distanced travelled (m)	*Size of displacement* (m)
A	400	800
B	450	200
C	450	400
D	800	400
E	800	800

2007 Int 2

2. Two forces act on an object as shown.



The angle between the forces is 90°.

The resultant force is

A zero

B 14 N SE

C 14 N NE

D 20 N SE

E 20 N NE.

2008 Int 2

1. Which of the following is a vector quantity?

A Distance

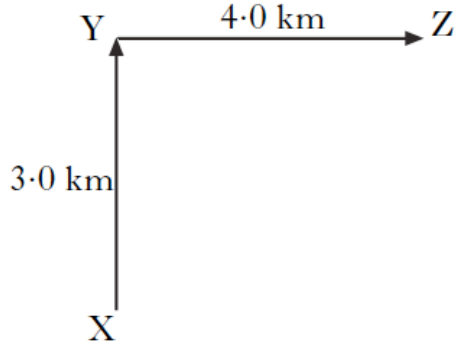
B Energy

C Speed

D Time

E Velocity

2. 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?

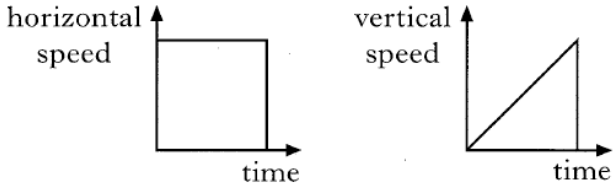
	Average speed	*Average velocity*
A	2·5 km/h	2·5 km/h at 053
B	2·5 km/h at 053	2·5 km/h
C	3·5 km/h	2·5 km/h at 053
D	3·5 km/h at 053	3·5 km/h
E	3·5 km/h	3·5 km/h at 053

Velocity-time graphs

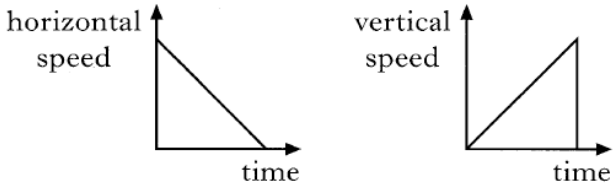
2003 Int 2

5. A ball is kicked horizontally off the edge of a cliff and lands in the sea. Which pair of graphs shows the horizontal and vertical speeds of the ball during its flight? The effect of air friction should be ignored.

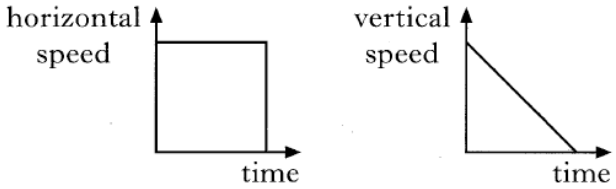
A



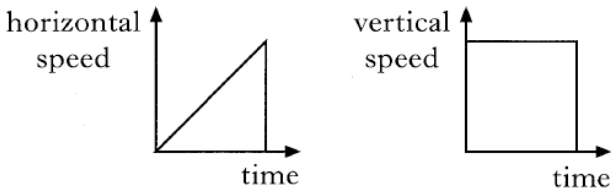
B



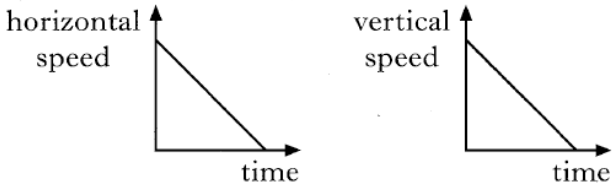
C



D

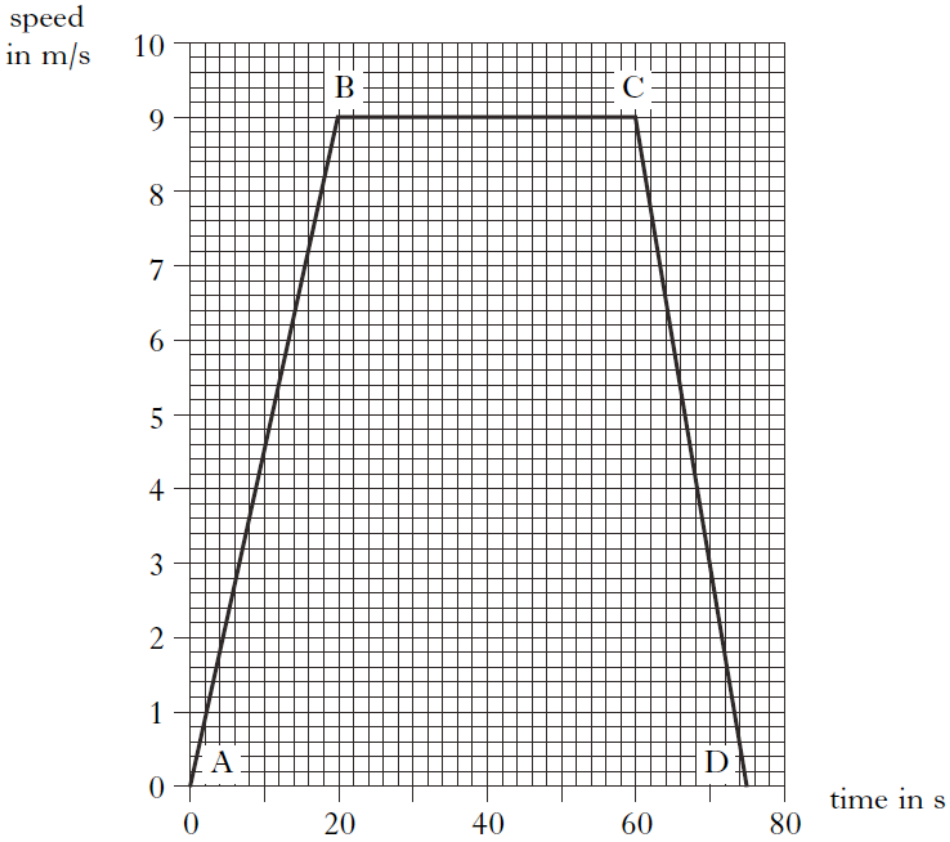


E



2000 Int 2

21. The graph below represents the motion of a cyclist travelling between two sets of traffic lights.



(*a*) Describe the motion of the cyclist

(i) between B and C

(ii) between C and D. **2**

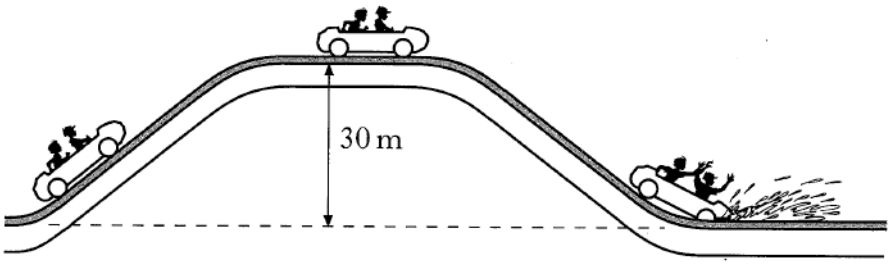
(*b*) Calculate the acceleration between A and B. **2**

(*c*) Calculate the distance between the two sets of traffic lights. **3**

(*d*) Later in the journey the cyclist free-wheels down a hill at constant speed. Explain this motion in terms of the forces acting on the cyclist. **2**

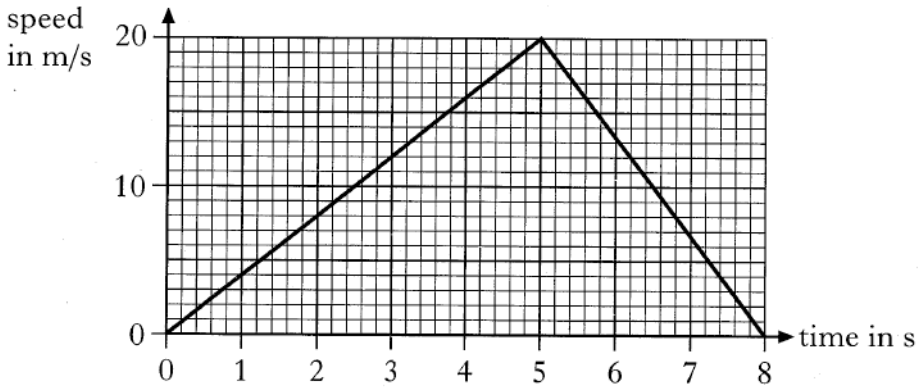
(9)

21. A theme park has a water splash ride. A carriage loaded with passengers is raised through a height of 30 m to the top of the ride. The combined mass of the carriage and the passengers is 1400 kg.



(*a*) Calculate the gain in gravitational potential energy of the carriage and passengers when it is taken to the top of the ride. **2**

(*b*) The carriage and passengers stop briefly before being released at the top of the ride. A speed-time graph of the motion of the carriage from the top of the ride is shown below.



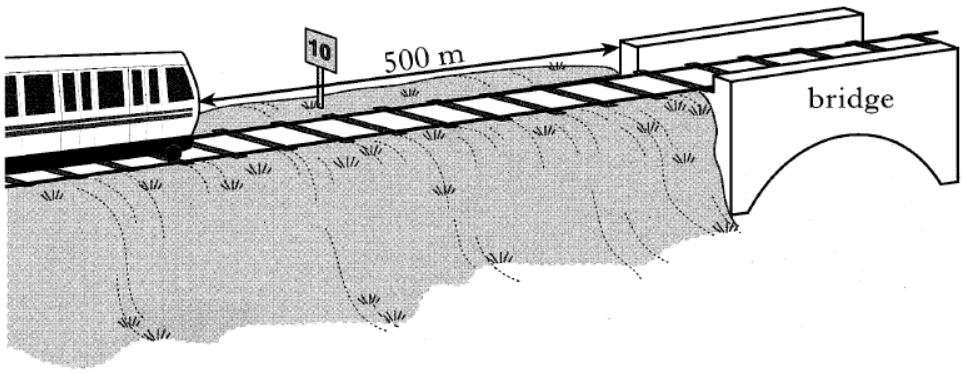
(i) Calculate the acceleration of the carriage from the top of the ride to the point where it reaches the water. **2**

(ii) Calculate the distance travelled by the carriage from the top of the ride to the point where it comes to rest. **2**

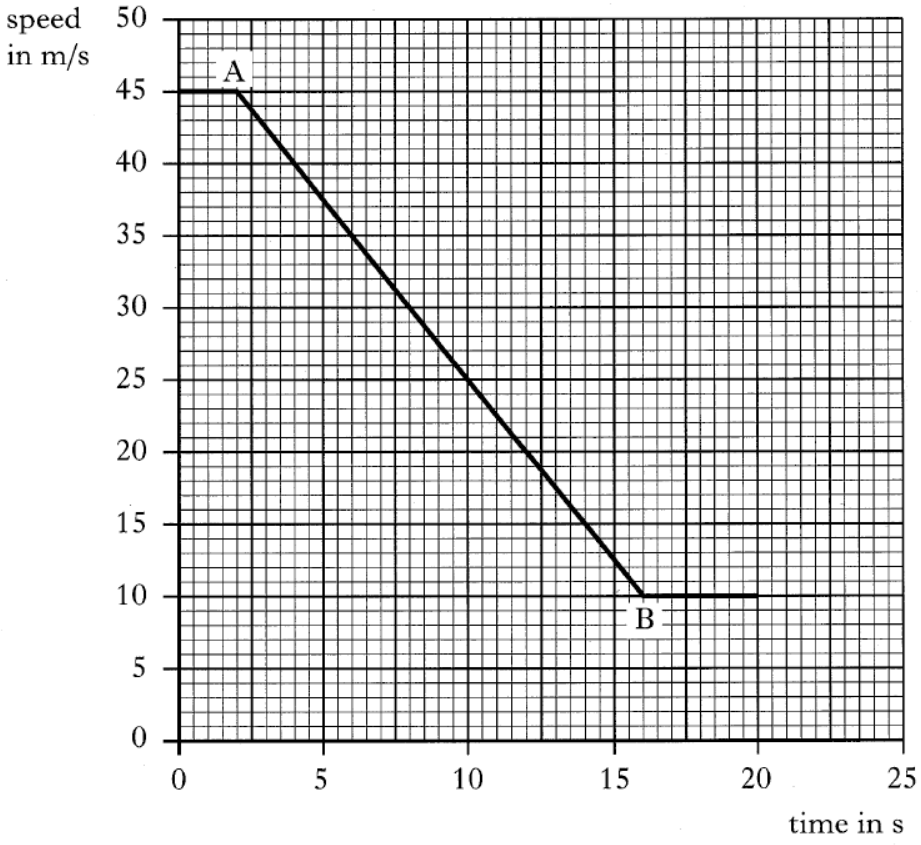
(iii) A test run is carried out without any water in the ride. The carriage travels a longer distance before it comes to rest. Explain why this happens. **1**

(7)

22. The driver of a train travelling at 45 m/s sees a sign indicating that there is a speed limit of 10 m/s on a bridge on the track ahead. At this point the distance from the train to the bridge is 500 m.



The speed-time graph of the train's motion, from the moment the driver sees the sign, is shown below.



(*a*) (i) State the time at which the driver starts to apply the brakes. **1**

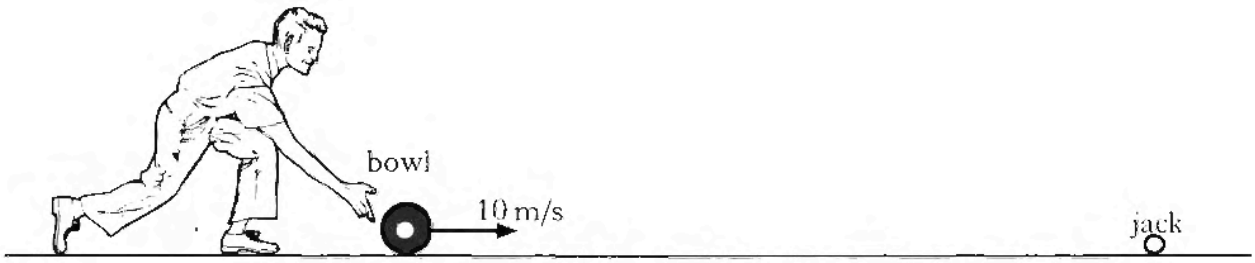
(ii) Explain your answer. **1**

(*b*) Calculate the acceleration of the train between A and B. **2**

(*c*) Is the train travelling at 10 m/s when it reaches the bridge?
You **must** justify your answer by calculation. **3**

(7)

21. In a game of bowls, a bowler moves a bowl through a horizontal distance of 1·5 m from rest before releasing it with a velocity of 10 m/s.



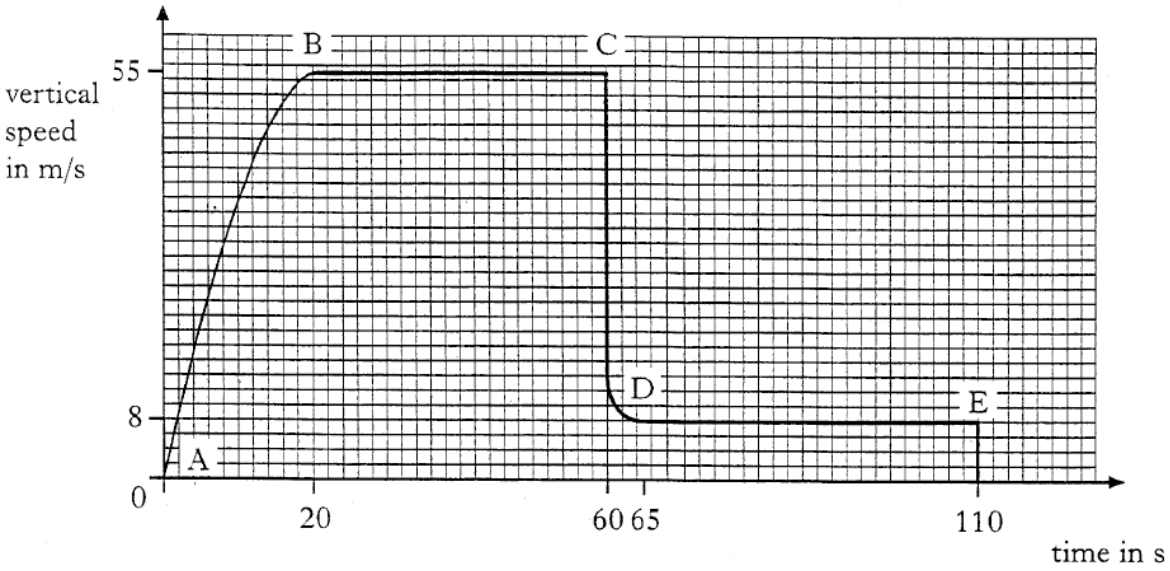
Mass of bowl = 1·5 kg
Mass of jack = 0·25 kg

(*d*) Describe a method to find the average speed of the bowl from the moment it is released until it hits the jack.

Your answer should include:

- the apparatus required
- the measurements taken
- how the average speed is calculated. **3**

22. A sky-diver of mass 90 kg drops from a stationary balloon. The speed-time graph shows how the vertical speed of the sky-diver varies until she reaches the ground. She falls 3000 m before opening her parachute.



(*a*) At what point does the sky-diver:

(i) open her parachute; **1**

(ii) reach the ground? **1**

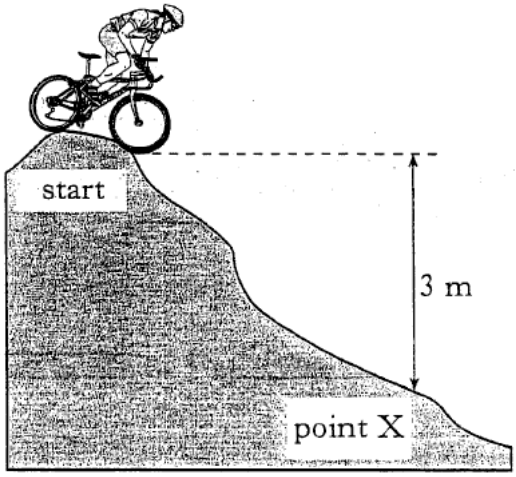
(*b*) Sketch a diagram showing the forces acting on the sky-diver between B and C.

You must name these forces and show their directions. **2**

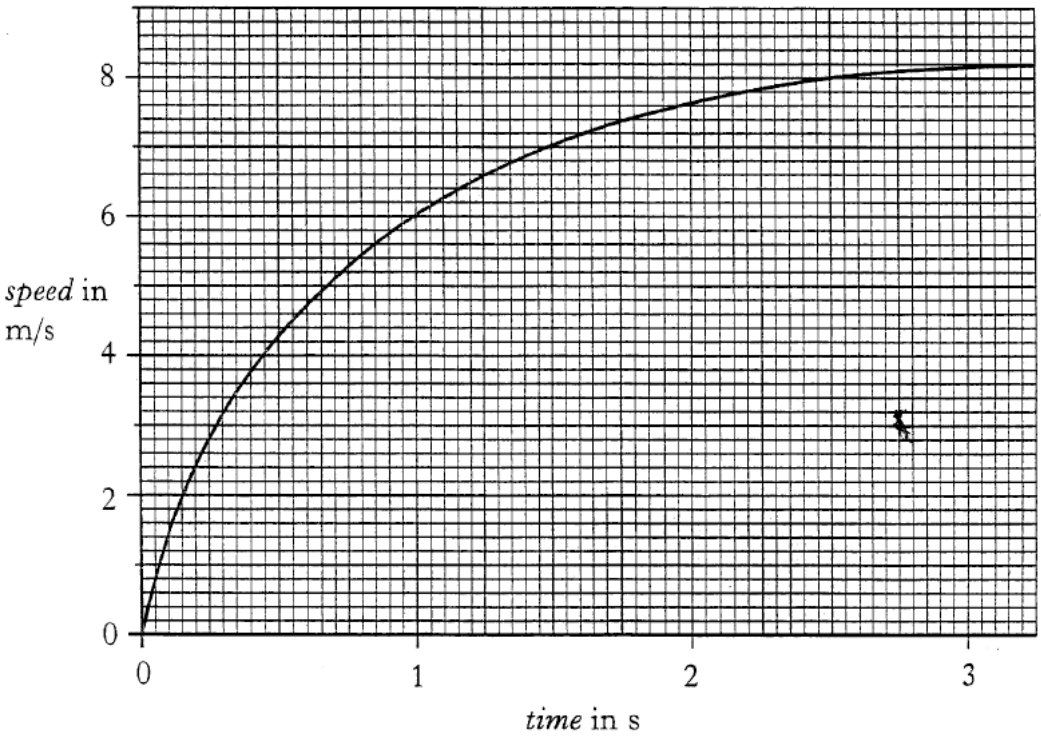
(*c*) Calculate the force of friction acting on the sky-diver between B and C. **3**

(7)

21. In a mountain-bike competition, a competitor starts from rest at the top of a hill. He pedals downhill and after 2·5 s he passes point X which is 3 m lower than the start. The total mass of the bike and competitor is 90 kg.



A speed time graph for this part of the competitor's journey is shown below.



(*a*) Calculate the decrease in gravitational potential energy of the competitor and bike between the start and point X. **2**

(*b*) Calculate the kinetic energy of the competitor and bike at point X. **2**

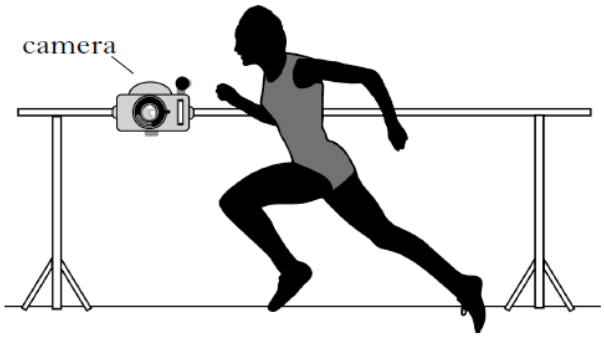
(*c*) Explain the difference between your answers to (*a*) and (*b*). **2**

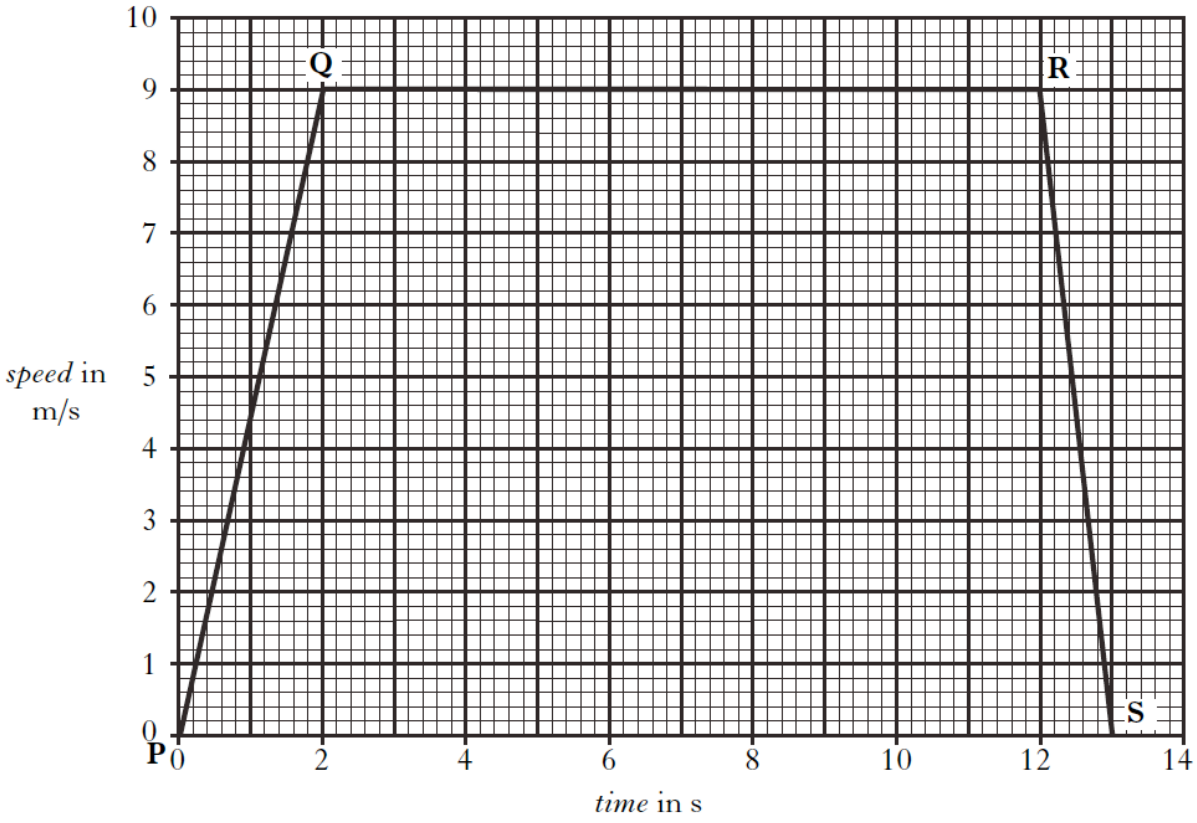
(*d*) (i) What happens to the acceleration of the competitor during the first 2·5 s? **1**

(ii) Explain, in terms of forces, why this happens. **1**

(8)

21. 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.

(*a*) Calculate the acceleration of the camera between **P** and **Q**. **2**

(*b*) The mass of the camera is 15 kg.

Calculate the unbalanced force needed to produce the acceleration between **P** and **Q**. **2**

(*c*) How far does the camera travel in the 13 s? **2**

Acceleration

2002 Int 2

1. A car accelerates from 4·0 m/s to 20 m/s in 5·0 s. The acceleration of the car is

A $0{\cdot}5\ m/s^2$

B $3{\cdot}2\ m/s^2$

C $4{\cdot}0\ m/s^2$

D $4{\cdot}8\ m/s^2$

E $16\ m/s^2$.

2004 Int 2

3. The table gives information about the velocities of three objects **X**, **Y** and **Z** for a time interval of 3 seconds. Each object is moving in a straight line.

Time (s)	0	1	2	3
Velocity of X (m/s)	2	4	6	8
Velocity of Y (m/s)	0	1	2	3
Velocity of Z (m/s)	0	2	5	9

Which of the following statements is/are correct?

I X moves with constant velocity.

II Y moves with constant acceleration.

III Z moves with constant acceleration.

A I only

B II only

C I and II only

D I and III only

E II and III only

2006 Int 2

1. A car travels with an initial speed of 10 m/s. It now accelerates steadily to 30 m/s in 5 s.

Which row shows the car's acceleration and average speed during this time?

	Acceleration (m/s^2)	*Average Speed* (m/s)
A	2	10
B	2	20
C	4	20
D	4	30
E	8	30

2007 Int 2

1. 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?

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

2008 Int 2

3. A car travelling in a straight line decelerates uniformly from 20 m/s to 12 m/s in 4 seconds. The displacement of the car in this time is

A 32 m

B 48 m

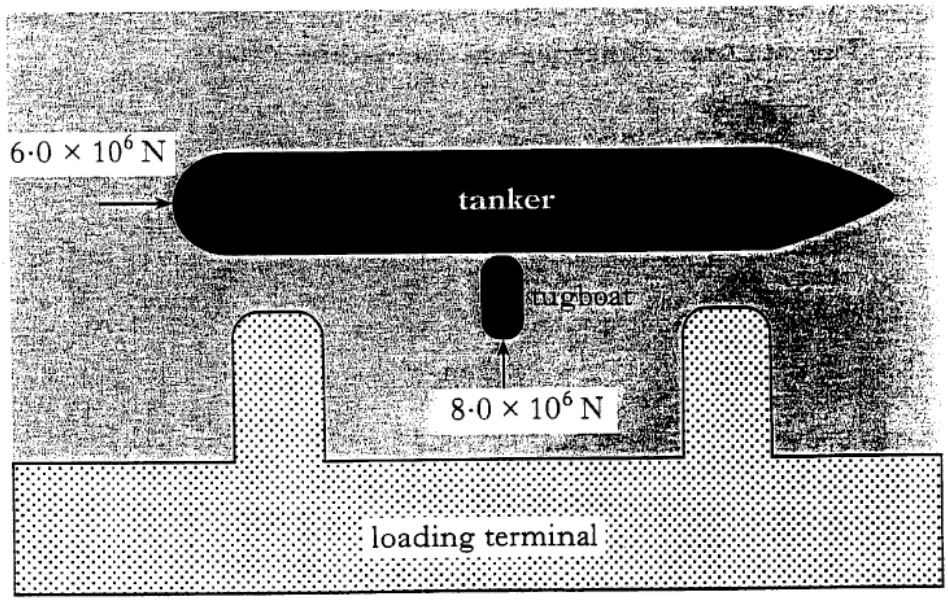
C 64 m

D 80 m

E 128 m.

22. A fully laden oil tanker of mass $7{\cdot}5 \times 10^8$ kg leaves a loading terminal.

Its engine and propellers produce a forward force of $6{\cdot}0 \times 10^6$ N. A tugboat pushes against one side of the tanker as shown. The tug applies a pushing force of $8{\cdot}0 \times 10^6$ N.



(*a*) Using a scale diagram or otherwise, find the size of the resultant of these two forces. 2

(*b*) Calculate the initial acceleration of the tanker. 2

22. A cyclist rides along a road.

(*a*) Describe a method by which the average speed of the cyclist could be measured.

Your description must include the following

- Measurements made
- Equipment used
- Any necessary calculations. **3**

(*b*) The 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.

(i) Calculate the acceleration of the cyclist whilst braking. **2**

(ii) 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. **2**

(iii) Calculate the total distance the cyclist travels from the moment the lights turn red until he stops at the traffic lights. **2**

(9)

Newton's Laws

2000 Int 2

3. One newton is the force required to give

A a mass of 1 g an acceleration of $1\ mm/s^2$

B a mass of 1 g an acceleration of $1\ m/s^2$

C a mass of 1 kg an acceleration of $1\ mm/s^2$

D a mass of 1 kg an acceleration of $1\ m/s^2$

E a mass of 1 kg an acceleration of $10\ m/s^2$.

7. An engine applies a force of 2000 N to move a lorry at a constant speed.

The lorry travels a distance of 100 m in a time of 16 s.

The power developed by the engine is

A 0·8 W

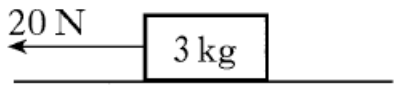
B 12·5 W

C 320 W

D 12 500 W

E 3 200 000 W.

4. A block of mass 3 kg is pulled across a horizontal bench by a force of 20 N as shown below.



The block accelerates at 4 m/s^2.

The force of friction between the block and the bench is

A zero

B 8 N

C 12 N

D 20 N

E 32 N.

7. Which of the following is the unit of gravitational field strength?

A kg m/s

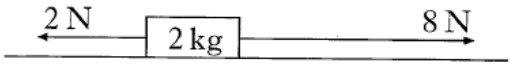
B N m

C N m/s

D kg m/s^2

E N/kg

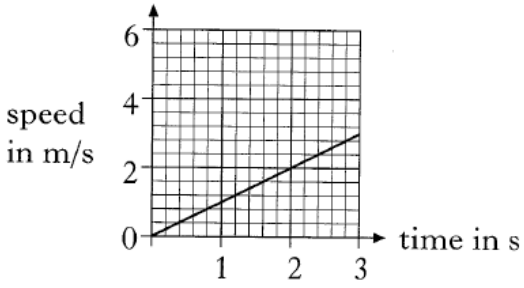
3. Two forces act on a block of mass 2 kg as shown.



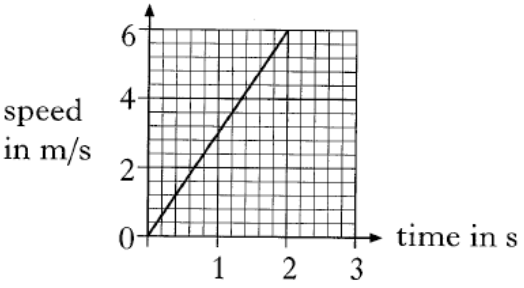
The block is initially at rest.

The speed-time graph for the block is

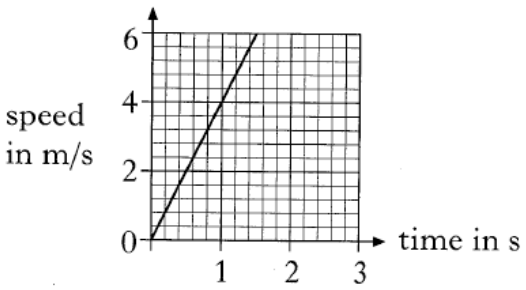
A



B



C



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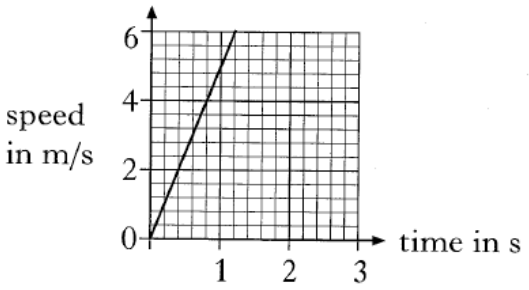
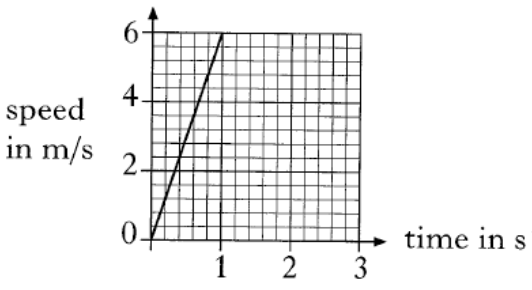


E



2. Near the Earth a mass of 4 kg is falling with a constant velocity.

The air resistance force and the unbalanced force acting on the mass are

	Air resistance force	*Unbalanced force*
A	10 N upwards	10 N downwards
B	10 N downwards	50 N downwards
C	40 N upwards	0 N
D	40 N upwards	40 N downwards
E	10 N upwards	0 N

4. A mass of 1 kg is pulled along a level bench by a horizontal force of 10 N. The acceleration of the mass is 4 m/s^2. The frictional force opposing the motion is

A 0·25 N

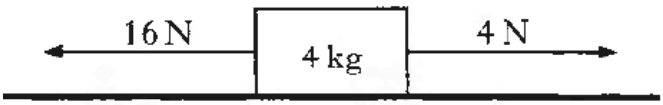
B 0·40 N

C 2·5 N

D 4 N

E 6 N.

4. A block of mass 4 kg is pulled along a horizontal bench by a force of 16 N.



A constant frictional force of 4 N acts on the block.

What is the acceleration of the block?

A $0{\cdot}3\ m/s^2$

B $1{\cdot}0\ m/s^2$

C $3{\cdot}0\ m/s^2$

D $4{\cdot}0\ m/s^2$

E $5{\cdot}0\ m/s^2$

2006 Int 2

4. A person sits on a chair which rests on the Earth. The person exerts a downward force on the chair.

Which of the following is the reaction to this force?

A The force of the person on the Earth

B The force of the person on the chair

C The force of the Earth on the person

D The force of the chair on the Earth

E The force of the chair on the person

2007 Int 2

5. An aircraft engine exerts a force on the air.

Which of the following completes the 'Newton pair' of forces?

A The force of the air on the aircraft engine

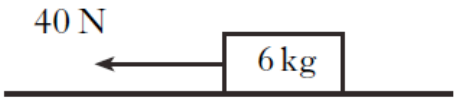
B The force of friction between the aircraft engine and the air

C The force of friction between the aircraft and the aircraft engine

D The force of the Earth on the aircraft engine

E The force of the aircraft engine on the Earth

6. 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 m/s^2.

The force of friction between the block and the bench is

A zero

B 16 N

C 24 N

D 40 N

E 64 N.

2008 Int 2

4. An unbalanced force of one newton will make a

A 0·1 kg mass accelerate at 1 m/s^2

B 1 kg mass accelerate at 1 m/s^2

C 1 kg mass accelerate at 10 m/s^2

D 0·1 kg mass move at a constant speed of 1 m/s

E 1 kg mass move at a constant speed of 10 m/s.

22. An aircraft magazine gives the following information about Concorde.

Mass	185 000 kg
Maximum speed	605 m/s
Take-off speed	112 m/s
Landing speed	83 m/s
Number of engines	4
Force from each engine	170 kN

Concorde

(*a*) (i) Calculate the total force exerted by the engines.

(ii) With all of its engines on, at one point on the runway Concorde has an acceleration of $3{\cdot}20\ m/s^2$.
Calculate the frictional force acting on Concorde at this point. **4**

23. A chairlift at a ski resort carries skiers through a vertical distance of 400 m.

(*a*) One of the skiers has a mass of 90·0 kg.
What is the weight of this skier? **2**

(*b*) (i) The chairlift carries 3000 skiers of average mass 90·0 kg in one hour.
What is the total gravitational potential energy gained by the skiers?

(ii) The chairlift is powered by an electric motor which is 67·5 % efficient.
Calculate the input power to the motor. **5**

(7)

2001 Int 2

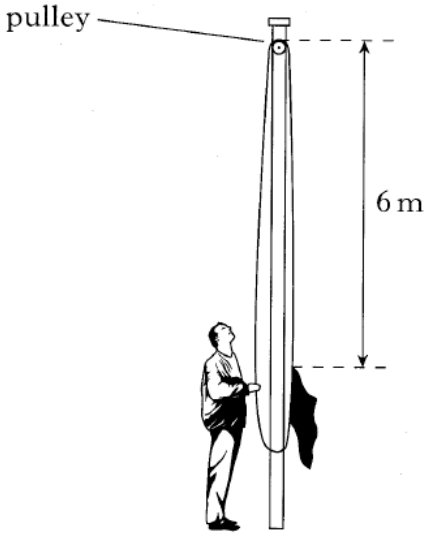
21. A flag is raised at the opening of an athletics competition. The mass of the flag is 0·5 kg and it is raised at constant speed through a height of 6 m.

(*a*) Calculate the gravitational potential energy gained by the flag. **2**

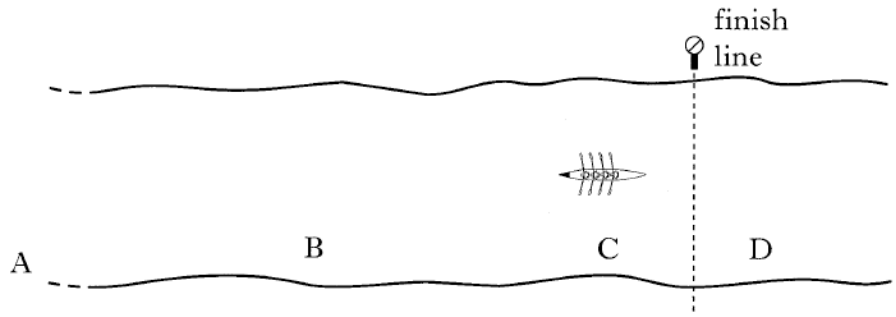
(*b*) A constant force of 7 N is applied to raise the flag.
Calculate the work done raising the flag. **2**

(*c*) Explain why there is a difference between the answers to parts (*a*) and (*b*). **2**

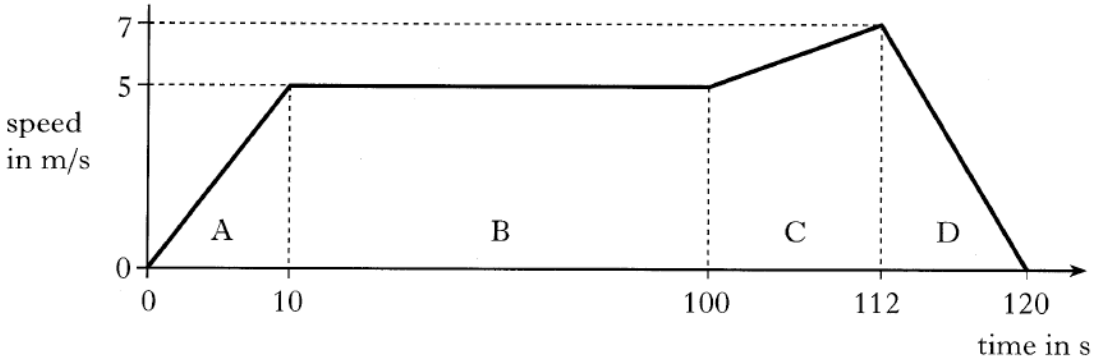
(6)



22. 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. **2**

(iii) The total mass of the boat and its crew is 400 kg.
Calculate the size of the forward force applied by the oars during stage C. **3**

(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. **2**

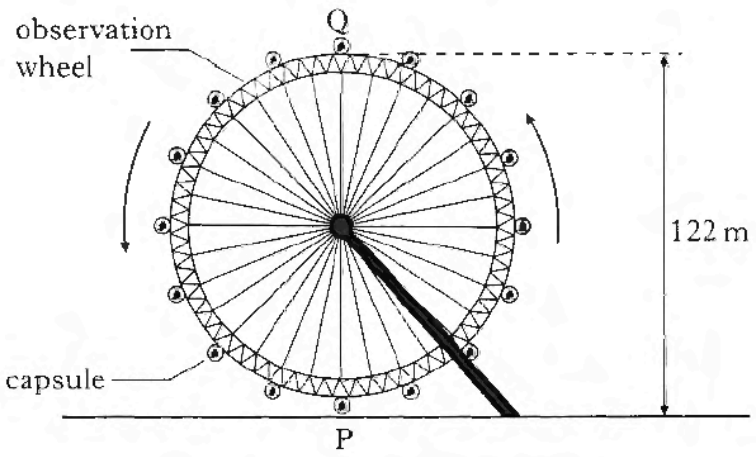
(*b*) The frictional force acting on the boat during stage D actually becomes smaller as the speed decreases.

(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**

(10)

21. An observation wheel rotates slowly and raises passengers to a height where they can see across a large city. The passengers are carried in capsules.

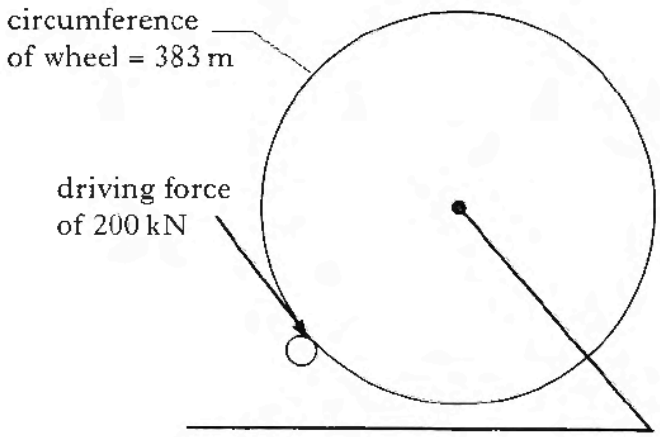


(*a*) Each capsule is raised through a height of 122 m as it moves from P to Q.

Each capsule with passengers has a total mass of 2750 kg.

Calculate the gravitational potential energy gained by a capsule with passengers. 2

(*b*) The wheel is rotated by a driving force of 200 kN.



(i) For one revolution, the driving force is applied through the circumference of the wheel, a distance of 383 m.

Calculate the work done by the driving force for one revolution. 2

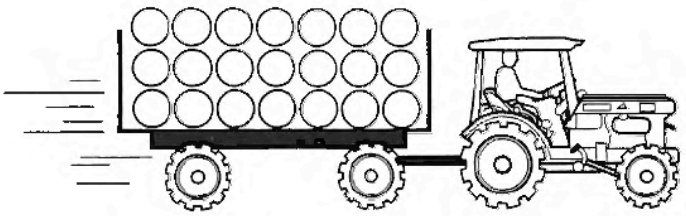
(ii) The observation wheel rotates once every 30 minutes.

Calculate the power delivered to the wheel. 2

(*c*) The driving system does not supply all the gravitational potential energy gained by the upward moving capsules. Explain how these capsules gain the additional energy required. 2

(8)

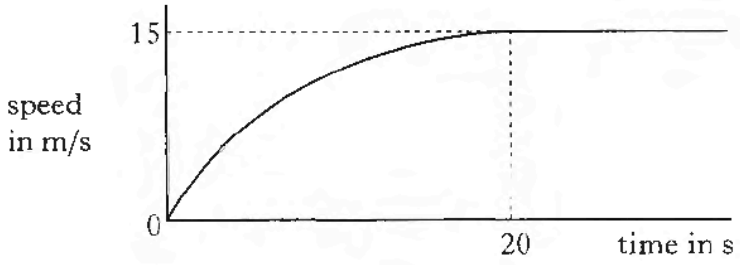
23. A tractor and a loaded trailer have a total mass of 9500 kg.



(*a*) The tractor applies a forward force of 15 250 N. At the instant the tractor and trailer move off the total frictional force is 1000 N.

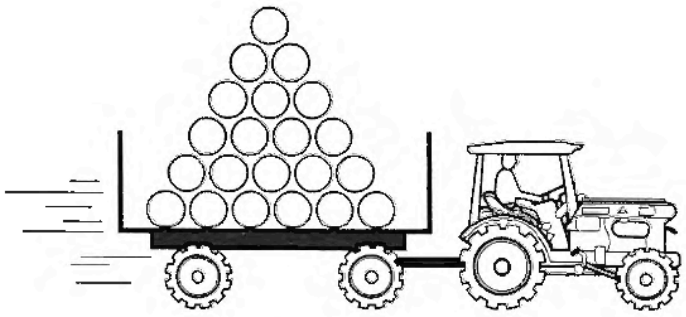
Calculate the initial acceleration of the tractor and trailer. **3**

(*b*) The following graph shows how the speed of the tractor and trailer varies with time.



The tractor continues to apply a forward force of 15 250 N. State the size of the frictional force after 20 s. **1**

(*c*) On a second journey the trailer is loaded in a different way. The total mass of the tractor and trailer is again 9500 kg.



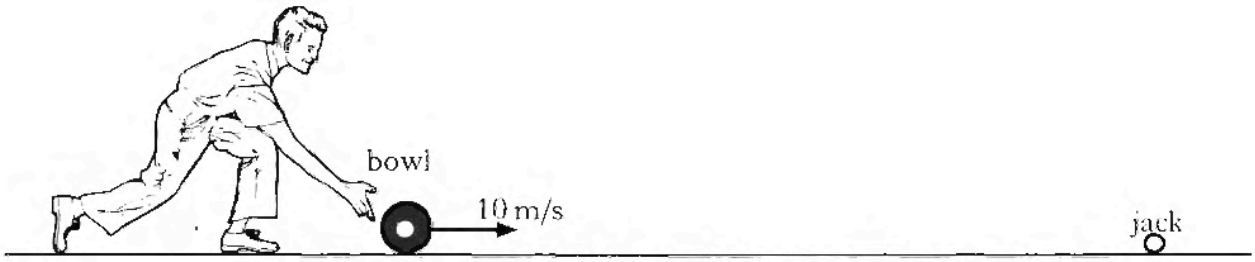
The tractor again applies a forward force of 15 250 N. The maximum speed on this journey is 12 m/s.

Explain, in terms of forces, why the maximum speed on this journey is less than the maximum speed in part (*b*). **2**

(6)

2005 Int 2

21. In a game of bowls, a bowler moves a bowl through a horizontal distance of 1·5 m from rest before releasing it with a velocity of 10 m/s.



Mass of bowl = 1·5 kg
Mass of jack = 0·25 kg

(*a*) Show that the kinetic energy of the bowl when it is released is 75 J. **2**

(*b*) Calculate the force the bowler applies to the bowl. **2**

2006 Int 2

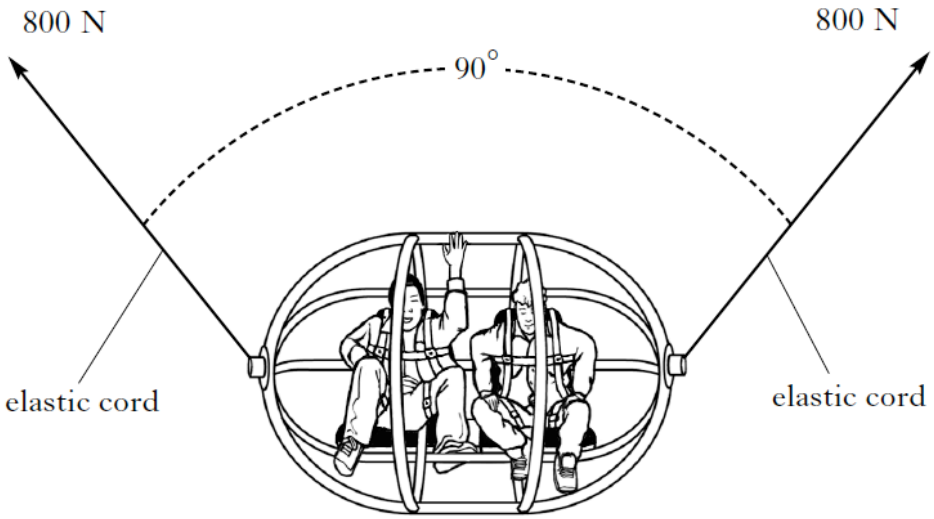
25

(*c*) Over part of the journey the train travels at a steady speed. It covers a distance of 540 m in a time of 15 s.

Calculate the maximum pulling force of the locomotive over this part of the journey. **3**

2008 Int 2

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



(*a*) Each cord applies a force of 800 N 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**

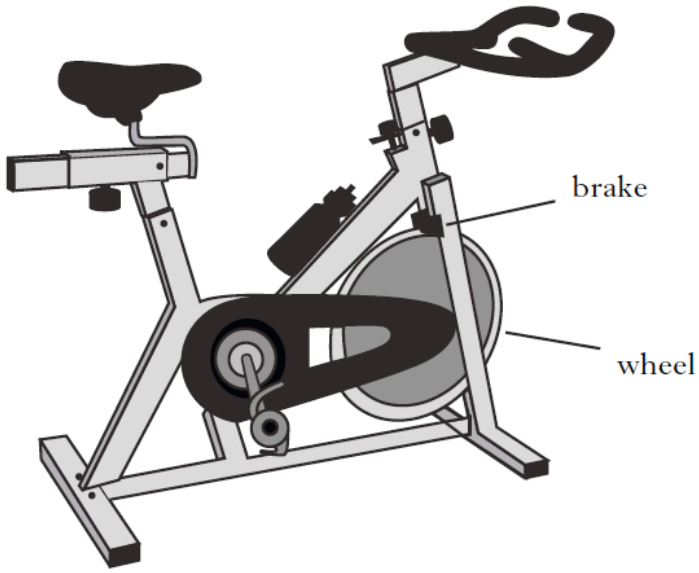
(*b*) The cage is now pulled further down before release. The cords provide an upward resultant force of 2700 N. The cage and its occupants have a total mass of 180 kg.

(i) Calculate the weight of the cage and occupants. **2**

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

(7)

23. 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 300 N is applied at the edge of the wheel, which has a circumference of 1·5 m.

(i) How much work is done by friction in one turn of the wheel? **2**

(ii) The person turns the wheel 500 times in 5 minutes.

Calculate the average power produced. **3**

(*b*) The wheel is a solid aluminium disc of mass 12·0 kg.

(i) All the work done by friction is converted to heat in the disc.

Calculate the temperature rise after 500 turns. **2**

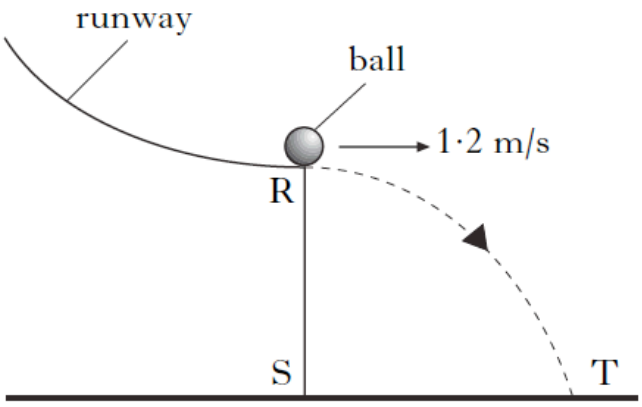
(ii) Explain why the actual temperature rise of the disc is less than calculated in (*b*) (i). **1**

(8)

Projectile Motion

2000 Int 2

5. A ball rolls down a runway and leaves it at point R.



The horizontal speed of the ball at R is 1·2 m/s.

The ball takes 0·4 s to travel from R to T.

The distance ST is

A 0·33 m

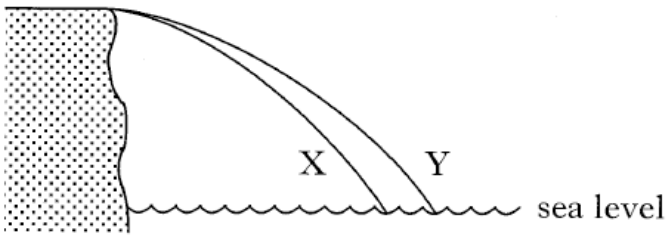
B 0·48 m

C 3·0 m

D 4·8 m

E 12 m.

3. Two identical balls X and Y are projected horizontally from the edge of a cliff. The paths they take are as shown below.



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

I The balls take the same time to reach sea level.

II The balls have the same vertical acceleration.

III The balls have the same horizontal velocity.

Which of these statements is/are correct?

A I only

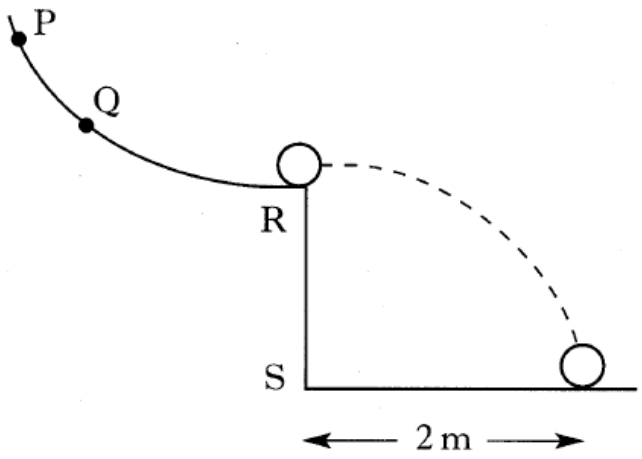
B II only

C I and II only

D I and III only

E II and III only

5. A ball is released from point **Q** on a curved rail, leaves the rail horizontally at **R** and lands 1 s later.



The ball is now released from point **P**.

Which row describes the motion of the ball after leaving the rail?

	Time to land after leaving rail	*Distance from S to landing point*
A	1 s	less than 2 m
B	less than 1 s	more than 2 m
C	1 s	more than 2 m
D	less than 1 s	2 m
E	more than 1 s	more than 2 m

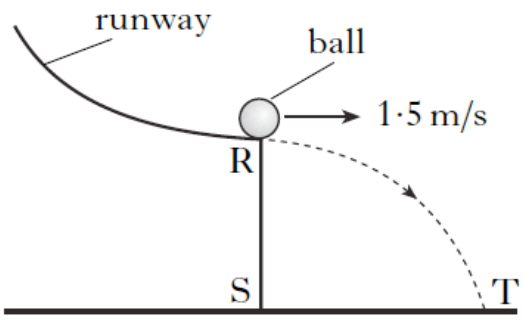
2005 Int 2

3. A seagull, flying horizontally at 8 m/s, 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.

	Horizontal speed (m/s)	*Vertical speed* (m/s)
A	0	8
B	8	20
C	8	25
D	25	25
E	33	50

2007 Int 2

4. A ball rolls down a runway and leaves it at point R.



The horizontal speed of the ball at R is 1·5 m/s.

The ball takes 0·6 s to travel from R to T.

The distance ST is

A 0·40 m

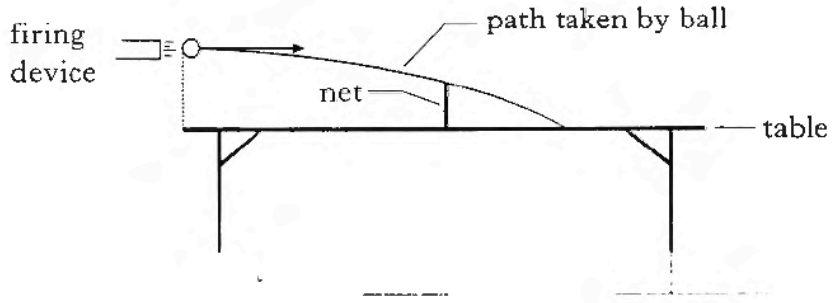
B 0·90 m

C 2·5 m

D 9·0 m

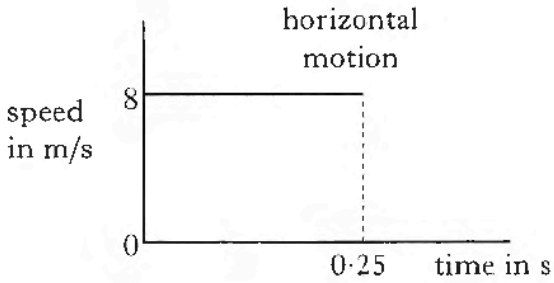
E 15 m.

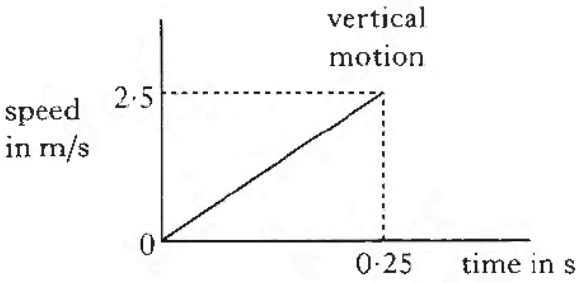
22. Table tennis players can practise using a device which fires balls horizontally.



The following graphs describe the horizontal and vertical motions of a ball from the instant it leaves the device until it bounces on the table 0·25 s later.

The effects of air resistance are assumed to be negligible.





(*a*) Explain why the shape of the path taken by the ball is curved. 2

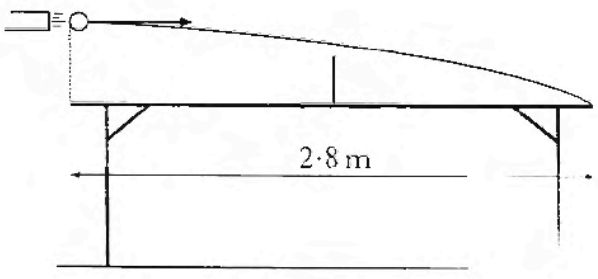
(*b*) (i) What is the instantaneous speed of the ball as it leaves the device? 1

(ii) Describe a method of measuring the instantaneous speed of the ball as it leaves the device. 3

(iii) Calculate the height above the table at which the ball is released. 2

(*c*) The device is adjusted to fire a second ball which lands at the end of the table.

The height and position of the device are not changed.



The length of the table is 2·8 m.

Assuming that the effects of air resistance are negligible, calculate the instantaneous speed of the second ball as it leaves the device. 2

(10)

Space Exploration

2000 Int 2

9. The specific latent heat of vaporisation of water is $2{\cdot}26 \times 10^6$ J/kg.

The energy required to change 50 g of water at 100 °C to steam is

A $1{\cdot}13 \times 10^5$ J

B $1{\cdot}13 \times 10^6$ J

C $1{\cdot}13 \times 10^7$ J

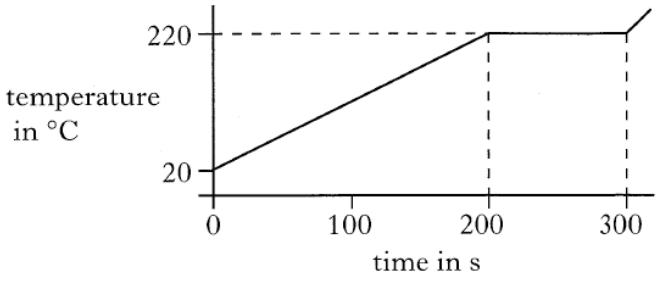
D $1{\cdot}13 \times 10^8$ J

E $1{\cdot}13 \times 10^{11}$ J.

2001 Int 2

6. A heater rated at 500 W is used to heat 1 kg of a substance. Initially the substance is in the solid state.

The following graph of temperature of substance against time is obtained.



Which of the following values can be obtained from the information given?

I The melting point of the substance.

II The specific heat capacity of the solid substance.

III The specific latent heat of fusion of the substance.

A I only

B I and II only

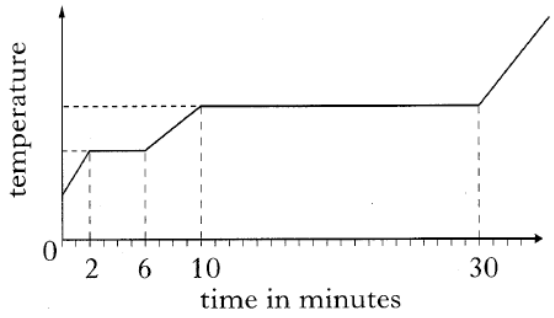
C I and III only

D II and III only

E I, II and III

2002 Int 2

7. A solid is placed in an insulated flask and heated continuously with an immersion heater. The sketch graph below shows how the temperature of the contents of the flask changes with time.



After 5 minutes the contents of the flask are

A in the solid state

B in the liquid state

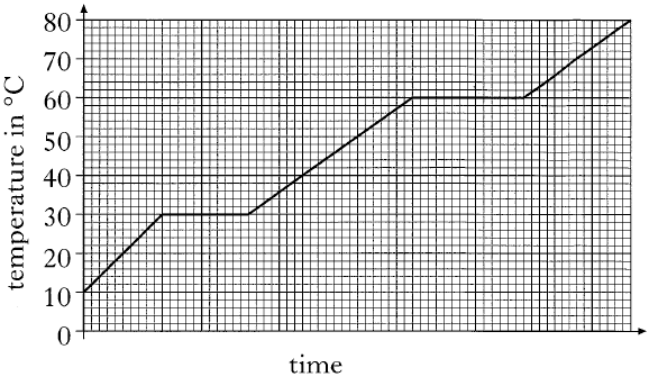
C a mixture of solid and liquid

D in the gaseous state

E a mixture of liquid and gas.

2003 Int 2

6. A block of wax, initially in the solid state, is heated. The graph below shows how the temperature of the wax changes with time.



At what temperature does the wax melt?

A 0 °C

B 10 °C

C 30 °C

D 60 °C

E 80 °C

2004 Int 2

7. Information about water is shown below.

Specific latent heat of fusion

$$= 3{\cdot}34 \times 10^5 \text{J/kg}$$

Specific heat capacity

$$= 4{\cdot}18 \times 10^3 \text{J/kg°C}$$

Specific latent heat of vaporisation

$$= 2{\cdot}26 \times 10^6 \text{J/kg}$$

The heat energy required to turn 0·25 kg of water at 100 °C into steam at 100 °C is

A $0{\cdot}25 \times 3{\cdot}34 \times 10^5$ J

B $0{\cdot}25 \times 4{\cdot}18 \times 10^3$ J

C $4{\cdot}18 \times 10^3 \times 0{\cdot}25 \times 100$ J

D $2{\cdot}26 \times 10^6 \times 0{\cdot}25 \times 100$ J

E $0{\cdot}25 \times 2{\cdot}26 \times 10^6$ J.

2006 Int 2

2. Which of these physical quantities are equivalent?

A Mass *and* weight

B Mass *and* acceleration due to gravity

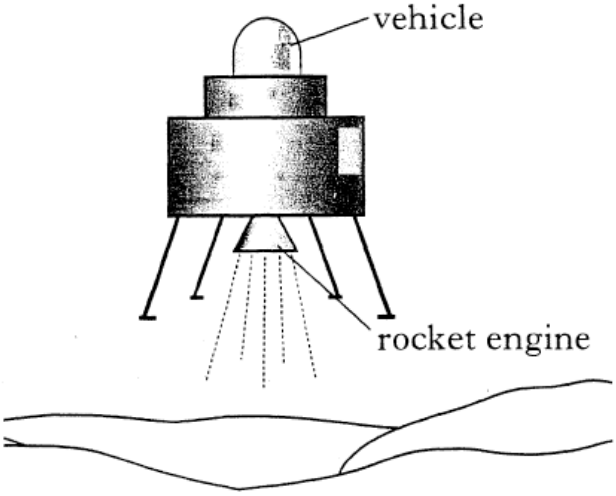
C Weight *and* acceleration due to gravity

D Weight *and* gravitational field strength

E Acceleration due to gravity *and* gravitational field strength

3. A space vehicle of mass 120 kg is falling vertically towards a planet. The gravitational field strength at this point is 3·5 N/kg.

The vehicle fires a rocket engine which applies a steady upward force of 660 N to the vehicle.



Initially the vehicle will

A move towards the surface, accelerating

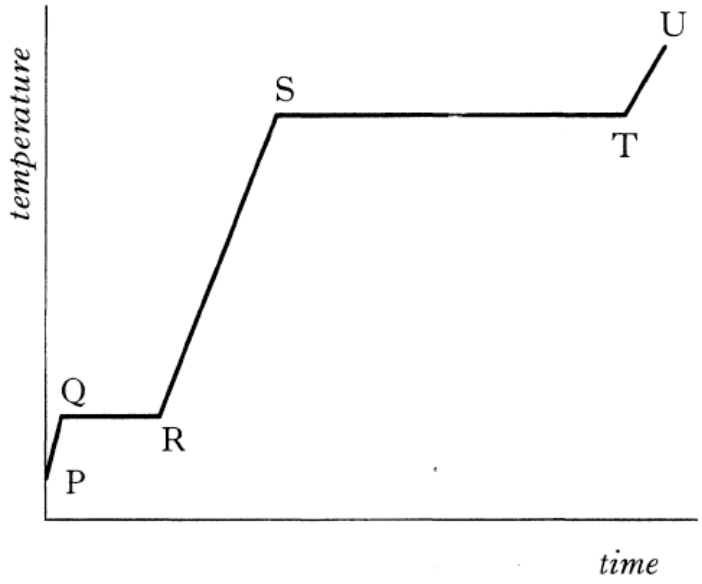
B move towards the surface at steady speed

C move towards the surface, decelerating

D move away from the surface, accelerating

E move away from the surface at steady speed.

6. A solid substance is placed in an insulated container and heated. The graph shows how the temperature of the substance varies with time.



To calculate the specific latent heat of fusion of the substance, a student would use the time from section

A PQ

B QR

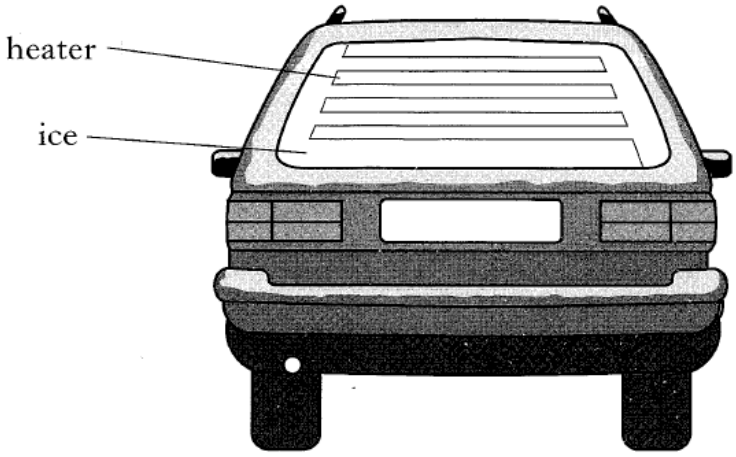
C RS

D ST

E TU.

2003 Int 2
26.

(*a*) A heater is used to melt ice on the rear window of a car.



(i) Calculate the heat energy required to melt 0·05 kg of ice.
(Latent heat of fusion of ice = $3{\cdot}34 \times 10^5$ J/kg) **2**

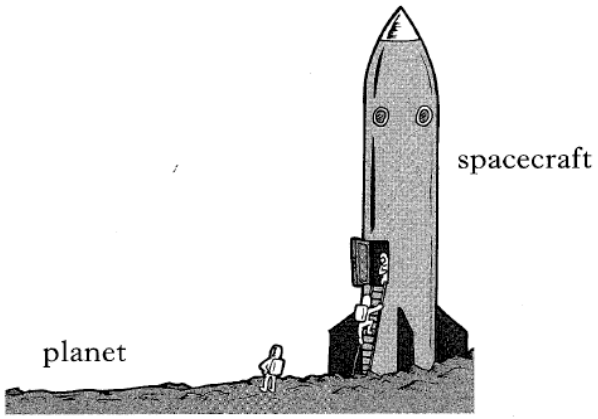
(ii) The heater takes 5 minutes to melt 0·05 kg of ice. Assuming all the energy is used to melt the ice, calculate the output power of the heater. **2**

22. A spacecraft travels through space between planet X and planet Y. Information on these planets is shown in the table below.

	planet X	*planet Y*
Gravitational field strength on surface	8·4 N/kg	13 N/kg
Surface temperature	17·0 °C	9·0 °C
Atmosphere	No	Yes
Period of rotation	48 hours	17 hours

The spacecraft has a total mass of $2{\cdot}5 \times 10^6$ kg.

The spacecraft engines produce a total force of $3{\cdot}8 \times 10^7$ N.



(*a*) The spacecraft is initially on planet X.

(i) Calculate the weight of the spacecraft when it is on the surface of planet X. **2**

(ii) Sketch a diagram showing the forces acting on the spacecraft just as it lifts off from planet X. You must name these forces and show their directions. **2**

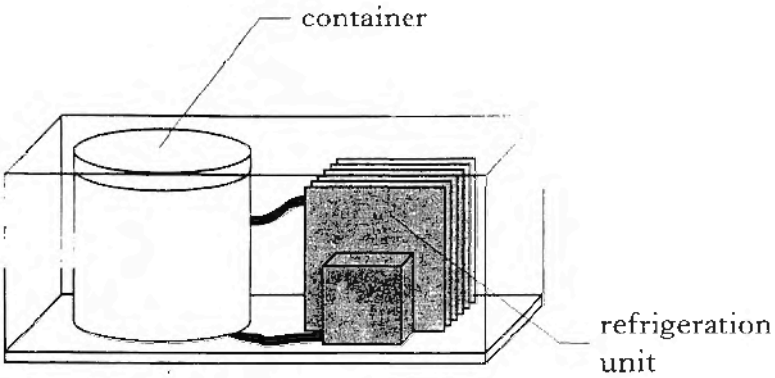
(iii) Calculate the acceleration of the spacecraft as it lifts off from planet X. **3**

(*b*) On another occasion, the spacecraft lifts off from planet Y. The mass and engine force of the spacecraft are the same as before. Is the acceleration as it lifts off from planet Y less than, more than or equal to the acceleration as it lifts off from planet X?

You **must** give a reason for your answer using information contained in the table above. **2**

(9)

24. An ice cream maker has a refrigeration unit which can remove heat at 120 J/s. Liquid ice cream, of mass 0·6 kg at a temperature of 20 °C, is added to the container.



(*a*) Calculate how much energy must be removed from the mixture to cool it to its freezing point of –16 °C.
(Specific heat capacity of ice cream = 2100 J/kg °C) 2

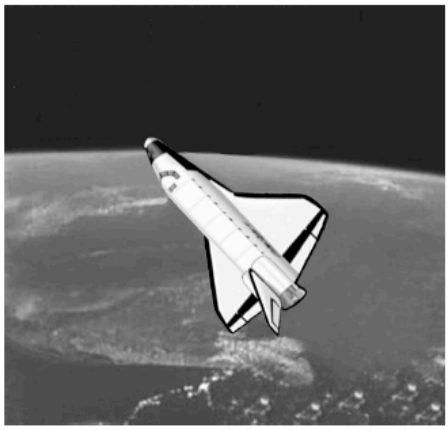
(*b*) Calculate how much heat energy must be removed to freeze the ice cream at this temperature.
(Specific latent heat of fusion of ice cream = $2{\cdot}34 \times 10^5$ J/kg) 2

(*c*) (i) Calculate the time taken to cool and freeze the ice cream. 3

(ii) What assumption have you made in carrying out this calculation? 1

(8)

15. (*a*) A spacecraft is used to transport astronauts and equipment to a space station. On its return from space the spacecraft must re-enter the Earth's atmosphere. The spacecraft has a heat shield made from special silica tiles to prevent the inside from becoming too hot.



(i) Why does the spacecraft increase in temperature when it re-enters the atmosphere?

.....

1

(ii) The mass of the heat shield is $3{\cdot}5 \times 10^3$ kg and the gain in heat energy of the silica tiles is 4·7 GJ.

Calculate the increase in temperature of the silica tiles.

Space for working and answer

3

(iii) Explain why the actual temperature rise of the silica tiles is less than the value calculated in (*a*)(ii).

.....

.....

1

Cosmology

2001 Credit

13. Read the following passage about the launching of a space observatory using the Space Shuttle Columbia.

In July 1999, NASA used the Space Shuttle Columbia to launch a space-based observatory, called the Chandra X-ray Observatory.

This observatory is designed to detect X-rays emitted by objects in our solar system and beyond. X-rays are absorbed by the Earth's atmosphere, so a space-based observatory is necessary to detect them. Signals are sent from the observatory to Earth using radio waves.

There are now three observatories orbiting the Earth. The other two are the Hubble Space Telescope that detects visible light and the Compton Gamma Ray Observatory.

(*a*) Why is it necessary to site an observatory in space to detect X-rays?

.....

..... **1**

(*b*) Four members of the electromagnetic spectrum are mentioned in the passage. Complete the diagram by placing these members in the correct order of wavelength.

		Ultraviolet		Infrared	Microwaves	

The electromagnetic spectrum **4**

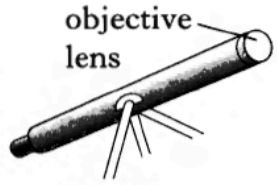
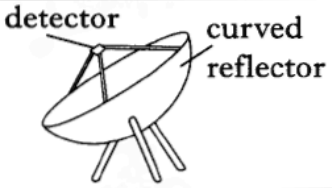
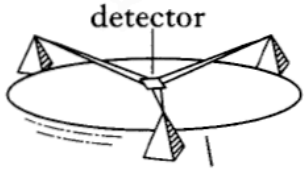
(*c*) Explain why different kinds of observatory are used to detect signals from space.

.....

.....

..... **2**

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

	Refracting telescope in Edinburgh, with 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 shown above is best for detecting very weak radio signals from deep space.

.....

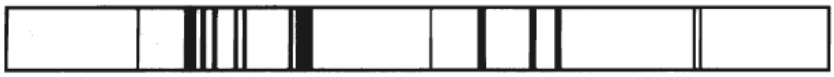
.....

.....

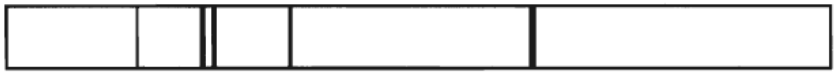
..... **2**

13. (*b*) (continued)

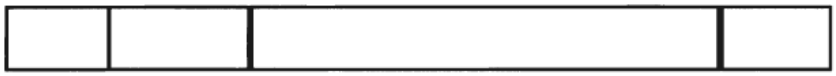
(iii) The probe carried equipment to analyse the spectral lines of radiation from gases in the atmosphere of Titan. These lines are shown. The spectral lines of a number of elements are also shown.



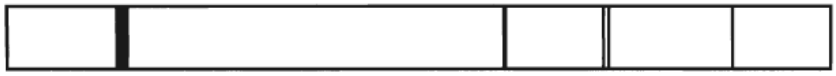
Spectral lines from gases in Titan's atmosphere



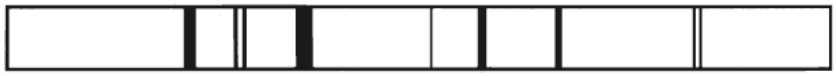
Helium



Hydrogen



Mercury



Nitrogen

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

.....

.....

..... **2**

14. The diagram represents the electromagnetic spectrum in order of increasing wavelength. Some of the radiations have not been named.

Electromagnetic Spectrum

Gamma rays	**P**	Ultraviolet	**Q**	Infrared	**R**	TV and Radio

increasing wavelength

(*a*) (i) Name radiation: **P** .....

Q .....

R **2**

(ii) Which radiation in the electromagnetic spectrum has the highest frequency?

..... **1**

(*b*) Stars emit **ultraviolet** and **infrared** radiation.

Name a detector for **each** of these two radiations.

Infrared.....

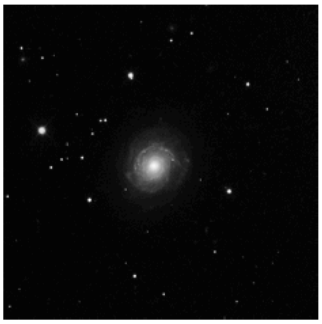
Ultraviolet..... **2**

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

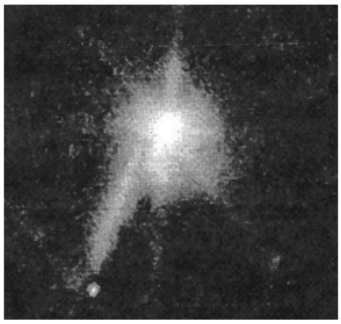
(*a*) State what is meant by the term "light-year".

..... **1**

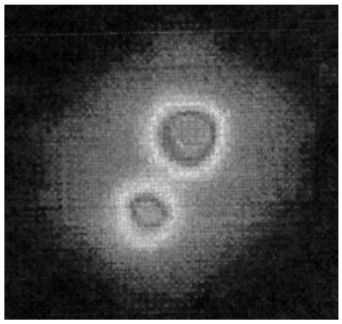
(*b*) Images of the star are taken with three different types of telescope as shown.



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**