A level Physics

Holiday homework

Name: ……

Print this booklet (or write answers on file paper) and enjoy working through the 5 tasks. One of the first topics that we will be studying in Year 12 is motion. Some of these tasks are designed to get you tuned into the motion topic. They should build on your GCSE physics courses. DON'T WORRY IF YOU FIND SOME ASPECTS DIFFICULT, WE WILL SORT OUT ANY PROBLEMS NEXT TERM.

This booklet will be collected from you for assessment in the first physics lesson of your A Level course in September. We look forward to welcoming you to the Physics department.

Checklist:

Put a tick ✓on the table as you complete each task

Task 1: Units (*10 minutes*)

Write down the **symbols**, **units** and **equations** for each of the following physical quantities. Some have been completed for you:

Physical Quantity	Symbol	Units	Equation
Distance	d	metres, m	N/A
Displacement	s	metres, m	N/A
Time	t		N/A
Velocity			
Acceleration			
Force			
Mass			N/A
Kinetic Energy			$E_k = ½ mv^2$
Gravitation Potential Energy			G.P.E = mgh
Work Done			
Momentum			

Task 2: Unit Prefixes (*10 minutes*)

Units often require a prefix to make them more *appropriate* for the size of the measurement. (The 'case' of the prefix letters is important, lower case m means 'milli', capital M means 'Mega')

Prefix	Symbol	Example in metres	Value	Standard form
pico	p	pm		$x\ 10^{-12}$
nano				
milli		mm		
centi	c		0.01	
-		m	1	$x\ 10^{0}$
kilo				
mega	M	Mm		
	G		100000000	
tera				

Task 3: S.I. Base Units (*10 minutes*)

Research task: S.I. Base Units are the international system of units of measurement based on seven basic quantities.

1. …… which measures ……
2. …… which measures ……
3. …… which measures ……
4. …… which measures ……
5. …… which measures ……
6. …… which measures …..amount of substance……
(7. …… which measures ……luminous intensity…..)

All other quantities in the world can be expressed in terms of these units.

e.g. the unit of velocity is '*m/s*' and the unit of force is the *newton*, which can also be written as *kg m/s*^{2}. (You will use all of these units apart from the last one in A Level Physics).

Task 4: Mechanics (forces and motion questions) (2 hours)

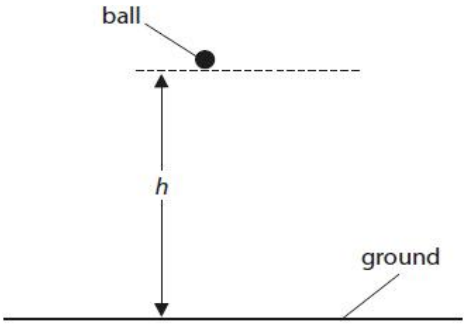
You should be able to complete the 10 questions in Section A with your GCSE Physics knowledge. Section B is made up of A Level questions that build on your GCSE knowledge. Show full working out.

Please mark your work using mark scheme at the end and do your corrections in a different colour pen. The mark schemes for both are at the end of section B.

Note: The mark schemes use the GCSE value of 10 m/s^2 for section A and the A-Level value of g= 9.81 m/s^2 for section B

Section A – GCSE Physics Questions (1 hour)

Q1. Figure 1 shows a small steel ball held at a height, *h*, above the ground.



The ball is released and allowed to fall to the ground.

The height *h* is 1.4 m.

Calculate the time, *t*, for the ball to reach the ground.

Use the equation

$$t^2 = \frac{2h}{g}$$

Assume g = 10 m/s^2

(2)

t = ... s

(Total for question = 2 marks)

Q2. A rock falls off the top of a cliff of height *h*.

Figure 2 shows the rock falling.

The Earth exerts a force of 150 N on the rock.

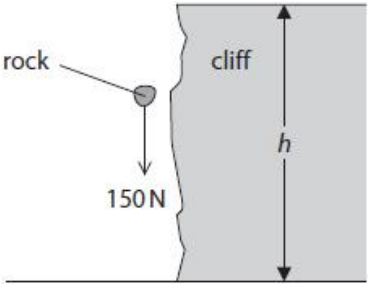


Figure 2

The work done by this force when the rock falls from the top to the bottom of the cliff is 2700 J.

(i) Calculate the height, *h*, of the cliff.

(2)

h = ... m

(ii) State the value of the kinetic energy of the rock just before it hits the ground.

(1)

kinetic energy = ... J

(iii) The mass of the rock in Figure 3 is 15 kg.

Calculate the velocity of the rock just before it reaches the bottom of the cliff.

(2)

velocity = ... m/s

(Total for question = 5 marks)

Q3. (i) Figure 3 shows the vertical forces on an aeroplane.

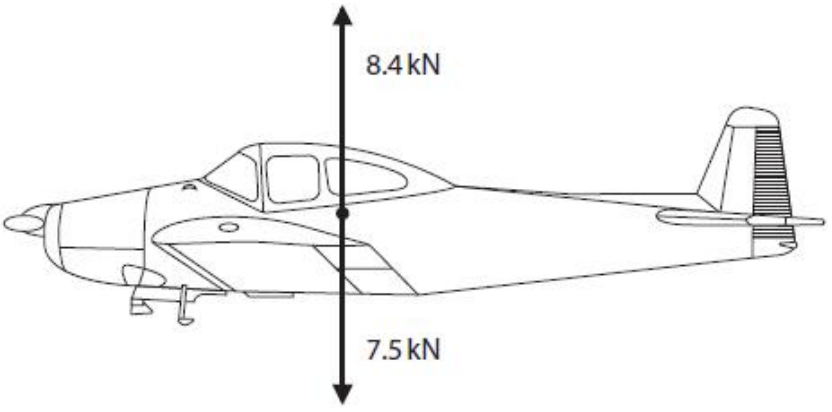


Figure 3

Use information from the diagram to determine the size and direction of the resultant vertical force on the aeroplane.

(2)

size = ... kN, direction is .....

(ii) The aeroplane is descending.

Figure 4 shows a diagram of the resultant vertical and horizontal forces on the aeroplane as it is descending.

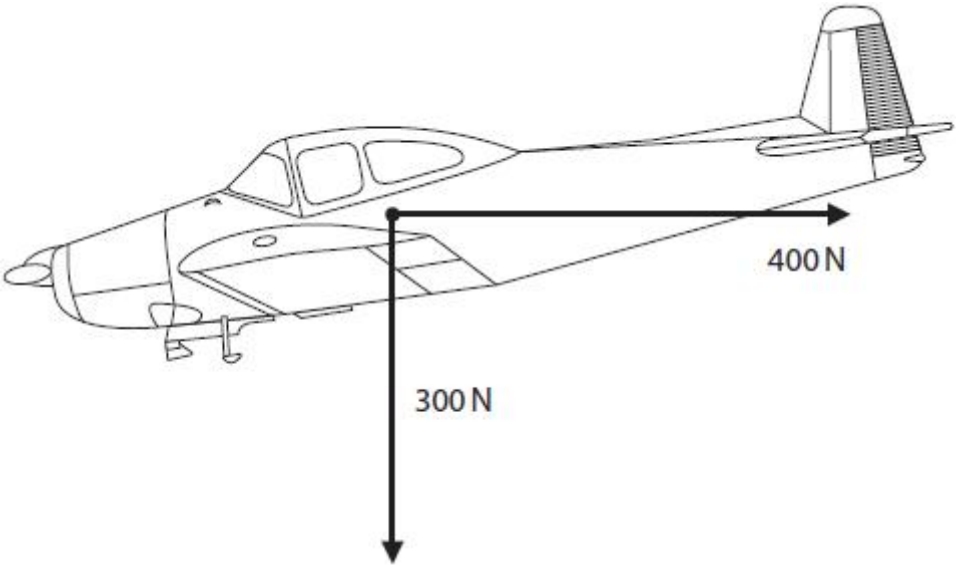


Figure 4

Complete the diagram to show the resultant of these two forces.

(1)

(iii) The mass of the aeroplane is 750 kg.

Calculate the change in gravitational potential energy of the aeroplane as it descends from 1300 m to the ground.
Gravitational field strength (g) = 10 N/kg

(2)

energy = ... J

(Total for question = 5 marks)

Q4. (i) An aircraft starts from rest and accelerates along the runway for 36 s to reach take-off velocity.

Take-off velocity for this aircraft is 82 m/s.

Show that the acceleration of the aircraft along the runway is about 2 m/s^2 .

Assume the acceleration is constant.

(2)

(ii) Calculate the distance the aircraft travels along the runway before take-off.

Use the equation

$$v^2 - u^2 = 2ax$$

(3)

distance = ... m

(iii) Suggest **one** reason why the length of the runway used is always much longer than the calculated distance that the aircraft travels along the runway before take-off.

(1)

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(Total for question = 6 marks)

Q5. Figure 5 is a velocity/time graph for a lift moving upwards in a tall building.

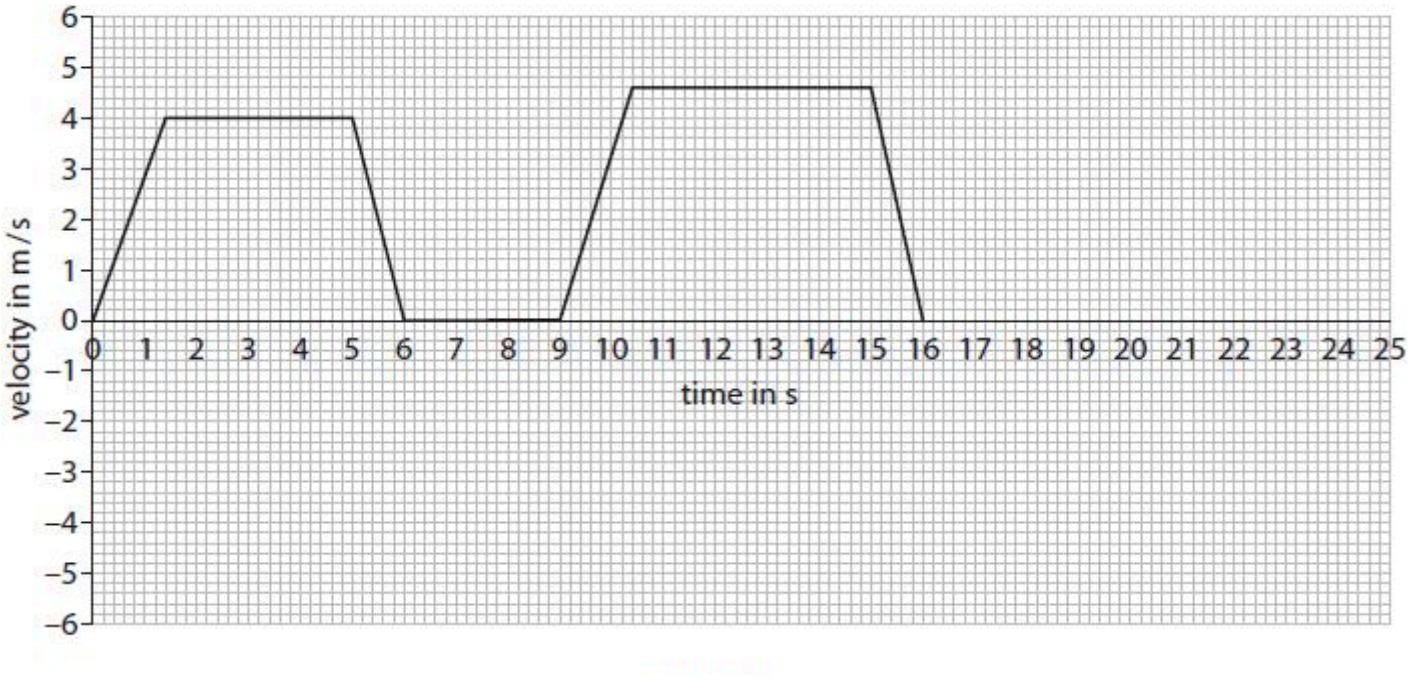


Figure 5

Use the graph in Figure 5 to determine the distance that the lift travelled during the first 6.0 s.

(3)

distance = ... m

(Total for question = 3 marks)

Q6. For what length of time is the lift at rest during the first 16 s?

(1)

- ☒ **A** 1.4 s
- ☒ **B** 3.0 s
- ☒ **C** 3.6 s
- ☒ **D** 4.0 s

(Total for question = 1 mark)

Q7. Use the graph in Figure 5 to determine the maximum velocity of the lift during the first 16 s.

(1)

maximum velocity = ... m/s

(Total for question = 1 mark)

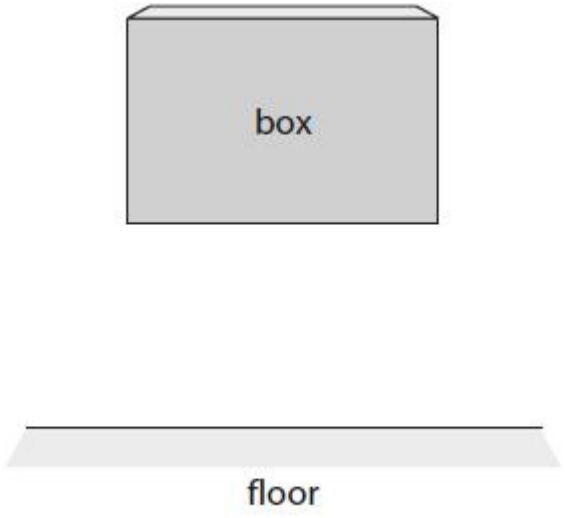
Q8. Use the graph in Figure 5 to determine the acceleration of the lift during the first 1.4 s.

(3)

acceleration = ... m/s^2

(Total for question = 3 marks)

Q9. Figure 6a shows a box falling towards a hard floor.



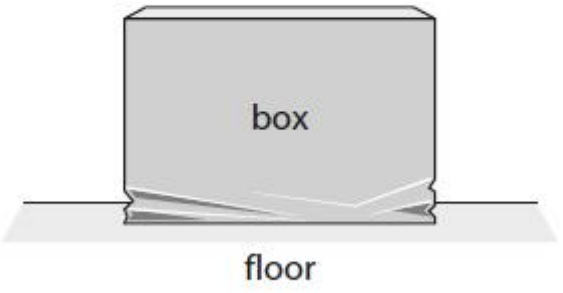


Figure 6a **Figure 6b**

The box hits the floor and crumples a little before it comes to rest as shown in Figure 6b.

The momentum of the box just before it hits the floor is 8.7 kg m/s.

The box comes to rest 0.35 s after it first hits the floor.

(i) Calculate the magnitude of the force exerted by the floor on the box.

(2)

force exerted by the floor on the box = ... N

(ii) State the magnitude and direction of the force exerted by the box on the floor.

(2)

magnitude .....

direction .....

(Total for question = 4 marks)

Q10. * Figure 7 shows two objects, Q and R, before and after they collide.

Figure 7

The arrows show the direction of movement of the objects.
The arrows are not to scale.

Explain how momentum is conserved in the collision.

Use Newton's third law and Newton's second law in your answer.

Newton's second law can be written as

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

(6)

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(Total for question = 6 marks)

Q11. Figure 8 shows a rocket soon after it takes off from the ground.

(Source: © Alones/Shutterstock)

Figure 8

The force that the rocket engines produce remains constant during the first few seconds after take-off.

Explain what happens to the acceleration during the first few seconds.

(3)

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(Total for question = 3 marks)

Q12. Another rocket has a total mass of 90 g when it takes off. The acceleration of the rocket when it takes off is 3.3 m/s^2.

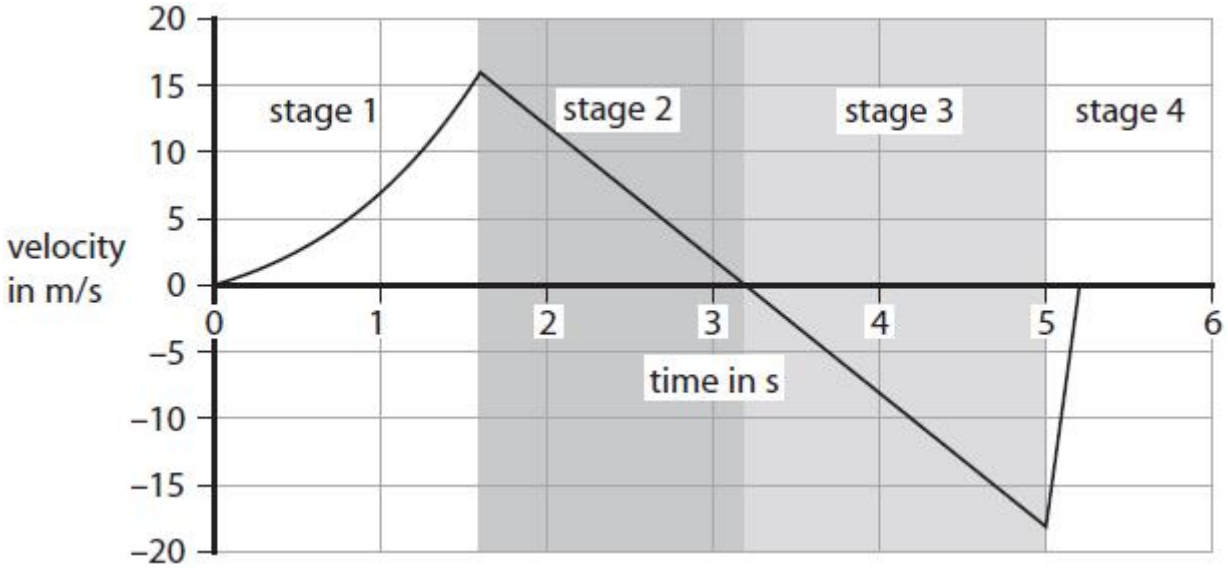
(i) Calculate the resultant force on the rocket when it takes off.

(2)

resultant force = ... N

*(ii) The rocket contains 50 g of fuel when it takes off.
The fuel burns and the rocket rises vertically.
After a while, there is no fuel left.
Eventually the empty rocket falls back to the ground.

The graph is a velocity–time graph for the rocket.
Four stages are labelled on the graph.



Explain why the velocity of the rocket changes as shown in the graph.

(6)

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(Total for question = 8 marks)

Q13. Figure 9 shows a bicycle.

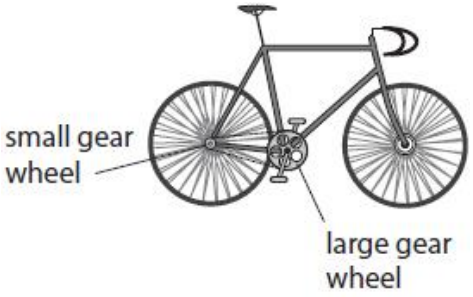

Figure 9

(i) The rider uses the pedals to make the large gear wheel turn.

The large gear wheel moves the chain.
The chain turns the small gear wheel.
The large gear wheel has 48 teeth.
The small gear wheel has 12 teeth.
The large gear wheel turns 2 times each second.
Calculate the number of times that the small gear wheel turns each second.

(2)

..... turns each second

(ii) Oil is applied to the wheel of a bicycle at the point shown in Figure 9.

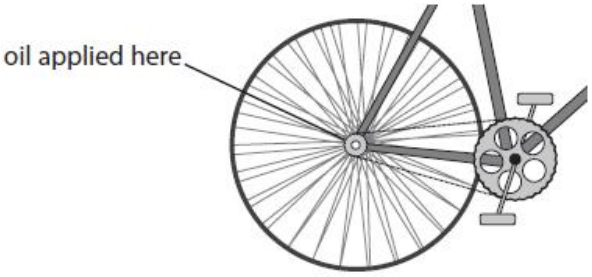

Figure 10

Explain how the oil improves the efficiency of the bicycle.

(3)

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(Total for question = 5 marks)

Q14. The kinetic energy of another cyclist is 2800 J.

The mass of the cyclist is 85 kg.

Calculate the velocity of this cyclist.

(3)

velocity = ... m / s

(Total for question = 3 marks)

Q15. Figure 11 shows a pulley system that enables a person to lift a heavy barrel.

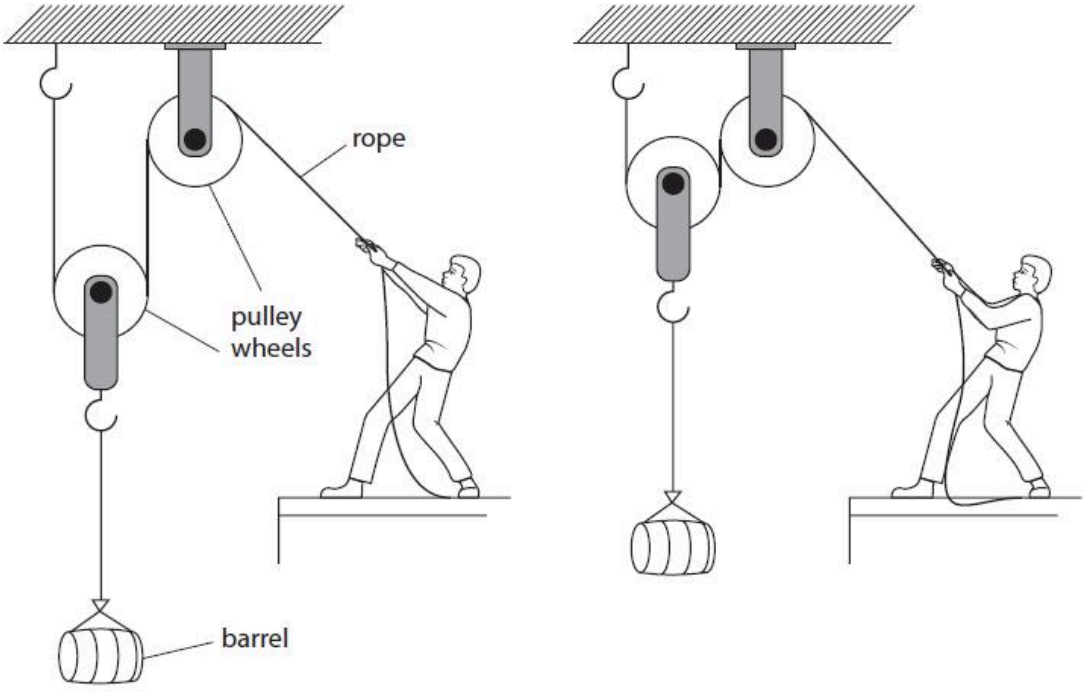

Figure 11

The person pulls down on the rope to make the barrel rise through 1.2 m.

The work done against gravity on the barrel is 1800 J.

(i) Calculate the weight of the barrel.

(2)

weight of the barrel = ... N

(ii) The efficiency of the system is 64%.

Calculate the total work done by the person.
Use the equation

$$\text{efficiency} = \frac{\text{(work done against gravity on the barrel)}}{\text{(total work done by the person)}} \times 100\%$$

(2)

work done = ... J

(iii) Some energy is wasted due to friction.

Suggest **another** reason why some energy is wasted in using this pulley system.

(1)

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(Total for question = 5 marks)

End of GCSE questions

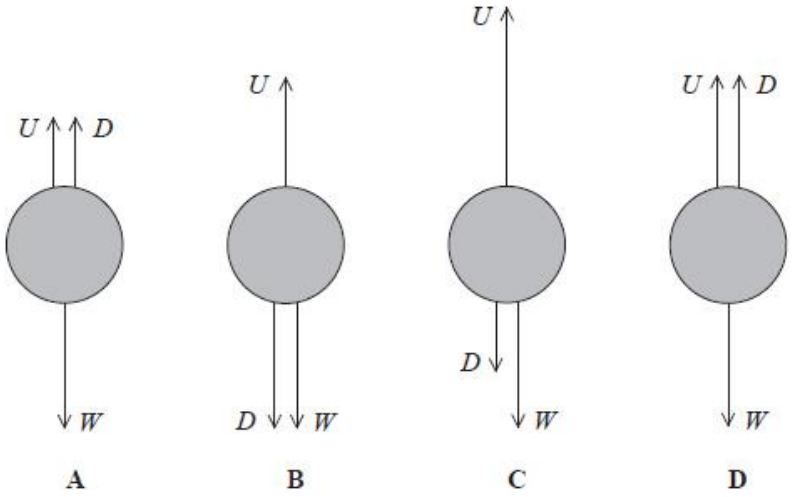
Section B - A Level Questions (1 hour) (45 marks)

For questions 1-15 answer the question with a cross in the box you think is correct ☒.

Q1. A small plastic bead is released below the surface of water and rises towards the surface.

The diagrams show the forces acting on the bead as it rises with constant velocity.

U = upthrust, *D* = drag, *W* = weight



Which diagram correctly represents the directions and relative magnitudes of the forces?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for question = 1 mark)

Q2. The diagram shows the forces acting on a hot air balloon when at a constant height.

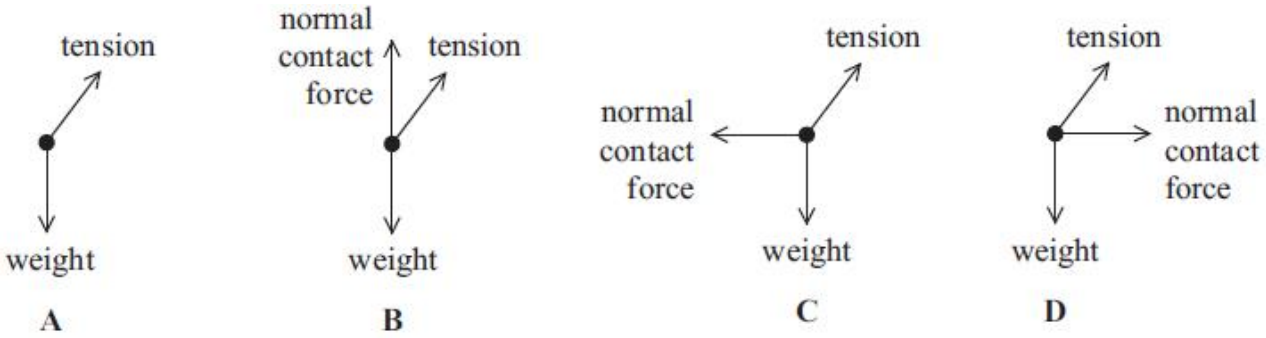
Select the row in the table that correctly describes the situation when the air in the balloon is heated.

	Observation	Reason
☐ A	Balloon rises	Weight > Upthrust
☐ B	Balloon falls	Weight > Upthrust
☐ C	Balloon rises	Weight < Upthrust
☐ D	Balloon falls	Weight < Upthrust

(Total for Question = 1 mark)

Q3. A climber slides down a rope attached to a rock face, as shown in the photograph.

Select a possible free-body force diagram for the climber.



☐ **A**

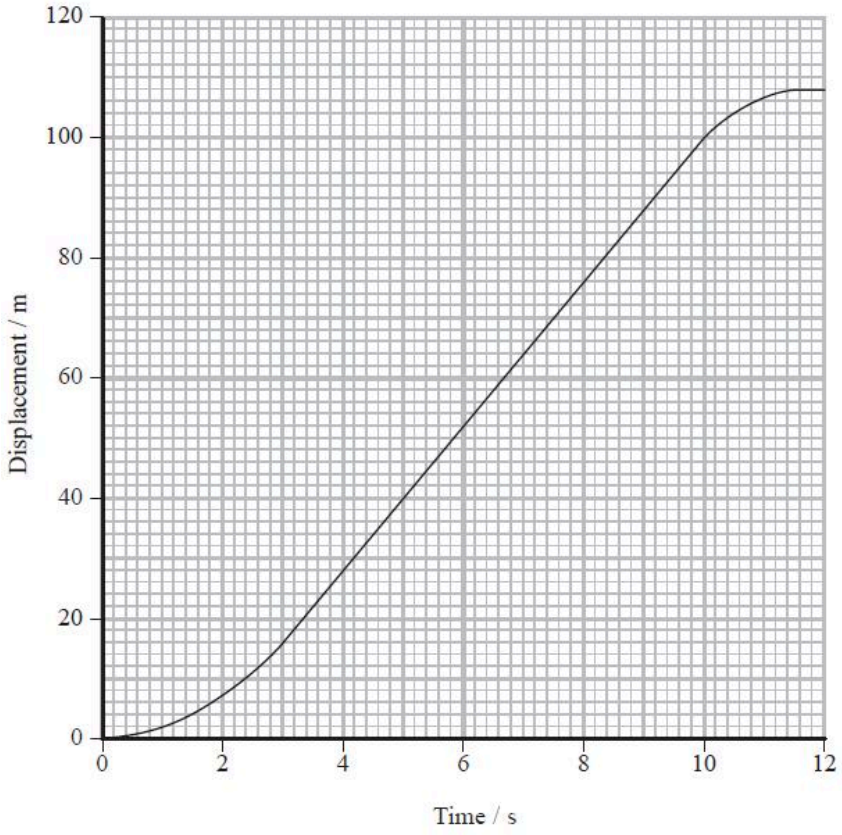
☐ **B**

☐ **C**

☐ **D**

(Total for question = 1 mark)

Q4. The graph is a displacement-time graph for a runner.



The velocity of the runner at 5 s is approximately

- ☒ **A** 8 m s^{-1}
- ☒ **B** 9 m s^{-1}
- ☒ **C** 12 m s^{-1}
- ☒ **D** 40 m s^{-1}

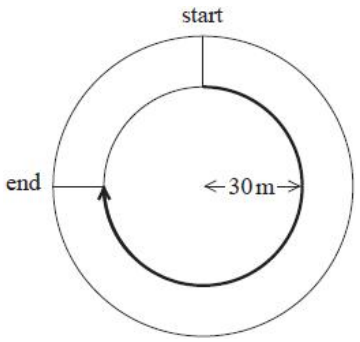
(Total for question = 1 mark)

Q5. Which of the following is a scalar quantity?

- ☒ **A** displacement
- ☒ **B** force
- ☒ **C** weight
- ☒ **D** work

(Total for question = 1 mark)

Q6. An athlete runs a race around three quarters of a circular track of radius 30 m using the inside lane.



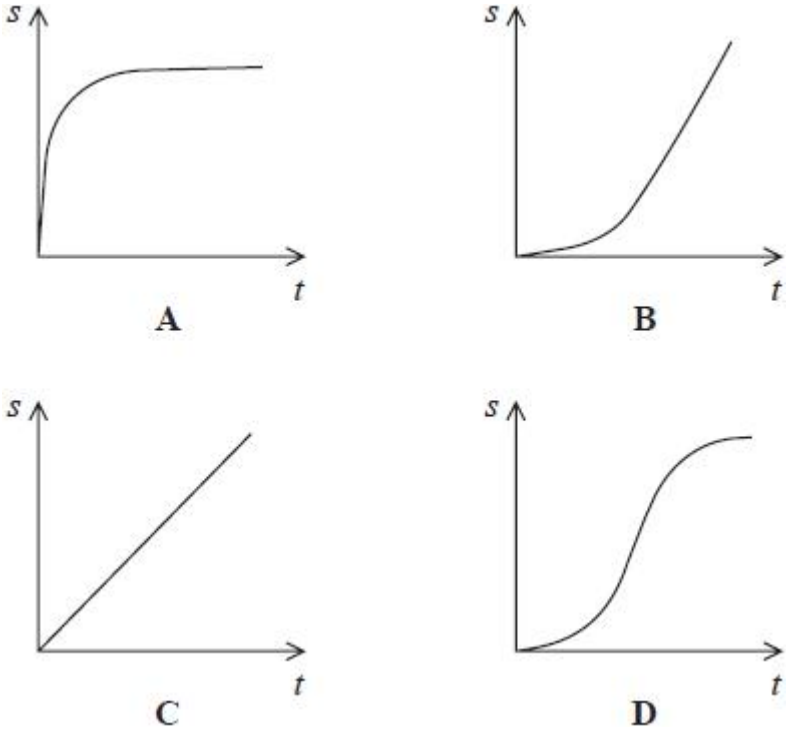
What is the magnitude of the displacement of the athlete at the end of the race?

- ☒ **A** 141 m
- ☒ **B** 47 m
- ☒ **C** 42 m
- ☒ **D** 30 m

(Total for question = 1 mark)

Q7. A ball falls from rest through glycerine and reaches terminal velocity.

Which of the following graphs shows how displacement *s* varies with time *t* for the ball?



- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for question = 1 mark)

Q8. An object of weight 7 N is raised from a height of 2 m to a height of 8 m.
The change in gravitational potential energy is

- ☒ **A** 42 J
- ☒ **B** 56 J
- ☒ **C** 412 J
- ☒ **D** 549 J

(Total for question = 1 marks)

Q9. Physical quantities can be vectors or scalars.

Describe what is wrong with each of the following statements.

A car has a mass of 10 000 N acting vertically downwards.

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The velocity of light from the Sun is 3×10^8 m s^{-1}.

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The car slowed down with an acceleration of 2.5 m s^{-2}.

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(Total for question = 3 marks)

Q10. A car is travelling at a constant speed in a straight line along a horizontal road.

Which row of the table gives a Newton's third law pair of forces?

		Force 1	Force 2
☐	A	normal force of car on road	friction between wheels and road
☐	B	normal force of car on road	normal force of road on car
☐	C	weight of car	normal force of car on road
☐	D	weight of car	normal force of road on car

(Total for question = 1 mark)

Q11. The winner of a 400m race must have the greatest

(1)

- ☒ **A** acceleration.
- ☒ **B** average speed.
- ☒ **C** instantaneous speed.
- ☒ **D** maximum speed.

(Total for question = 1 mark)

Q12. Select the answer in which both quantities are vectors.

- ☒ **A** acceleration, speed
- ☒ **B** displacement, velocity
- ☒ **C** mass, time
- ☒ **D** power, weight

(Total for question = 1 mark)

Q13. A car of mass 1.5×10^3 kg is travelling at a speed of 25 m s^{-1}. The driver applies the brakes and the car comes to rest.

Which of the following gives the decrease in kinetic energy, in joules, as the car is brought to rest?

- ☐ **A** $750 \times (25)^2$
- ☐ **B** $750 \times \left(\frac{25}{2}\right)^2$
- ☐ **C** $1500 \times (25)^2$
- ☐ **D** $1500 \times \left(\frac{25}{2}\right)^2$

(Total for question = 1 mark)

Q14. Which of these statements about work is **not** correct?

- ☒ **A** For work to be done a force must always be applied.
- ☒ **B** When work is done energy is transferred.
- ☒ **C** Work done is the product of force and distance moved perpendicular to the force.
- ☒ **D** Work done is a scalar quantity.

(Total for Question = 1 mark)

Q15. A car of mass 1.2×10^3 kg is travelling at a speed of 18 m s^{-1}. The driver applies the brakes and the car comes to rest.

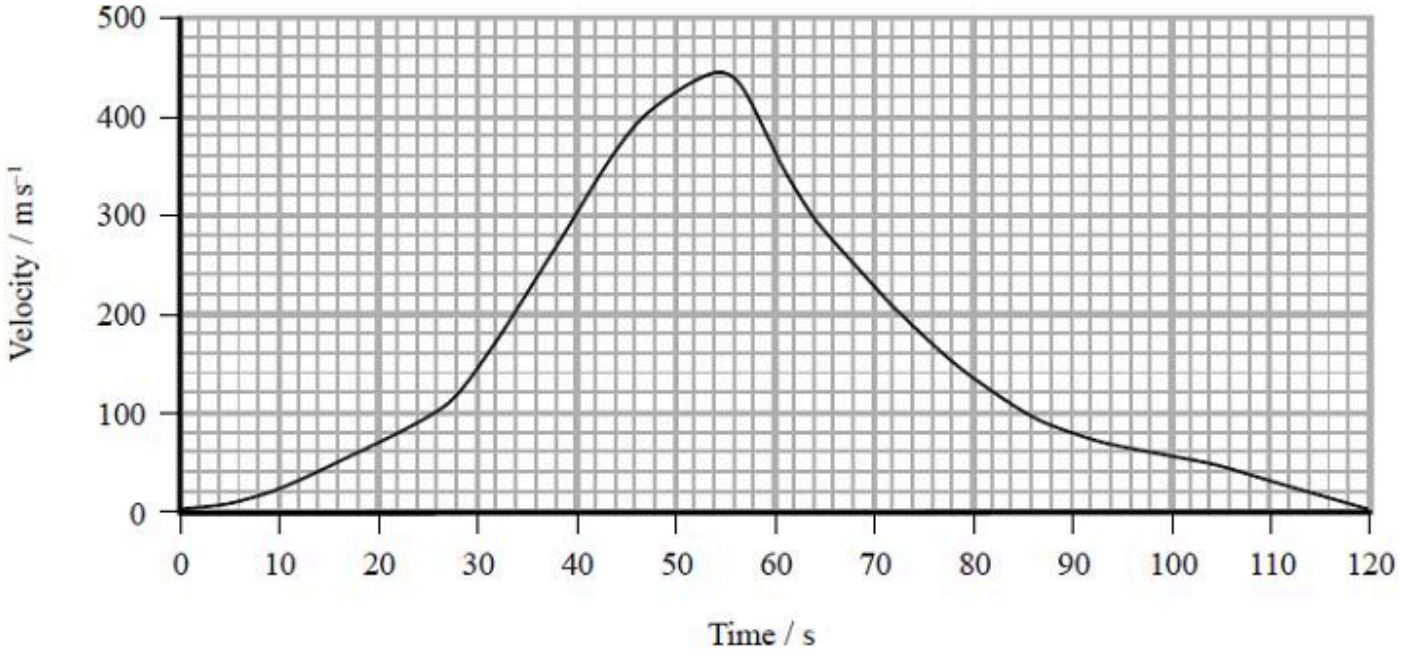
What is the work done by the brakes in stopping the car?

- ☒ **A** 11 kJ
- ☒ **B** 22 kJ
- ☒ **C** 190 kJ
- ☒ **D** 390 kJ

(Total for question = 1 mark)

Q16. The world land speed record of 341 m s^{-1} was set in October 1997. In an attempt to break this record, a new supersonic car has been developed called the Bloodhound.

The developers of the Bloodhound have used computer modelling to produce a velocity-time graph for the predicted motion of the car, on a straight track, during the record attempt.



A track of length 23 km is available for the record attempt.

Determine whether this track is long enough.

(3)

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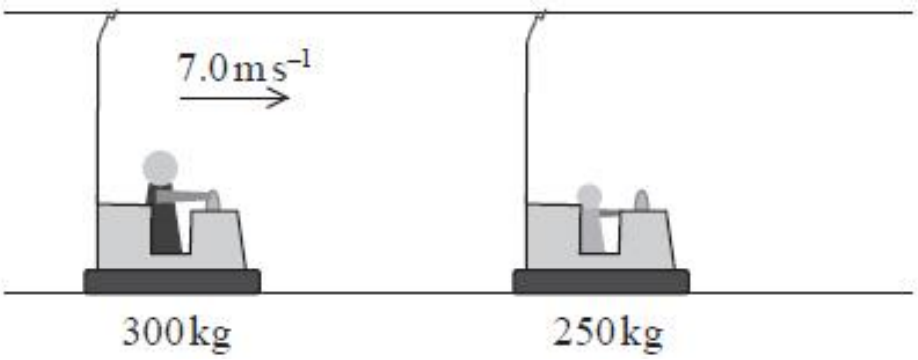
(Total for question = 3 marks)

Q17. A child in a bumper car travelling at velocity of 7.0ms^{-1} collides with a stationary bumper car directly ahead of him. The diagram shows the bumper cars before the collision.



(a) (i) Assume that the bumper cars move off together after the collision.
Calculate the velocity of the bumper cars after the collision.

(3)

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Velocity = ...

(ii) After travelling 1.3m the cars come to rest.
Calculate the magnitude of the frictional force between the cars and the floor.

(3)

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Frictional force = ...

(b) State **one** assumption made in order to carry out the calculation in (a)(i).

(1)

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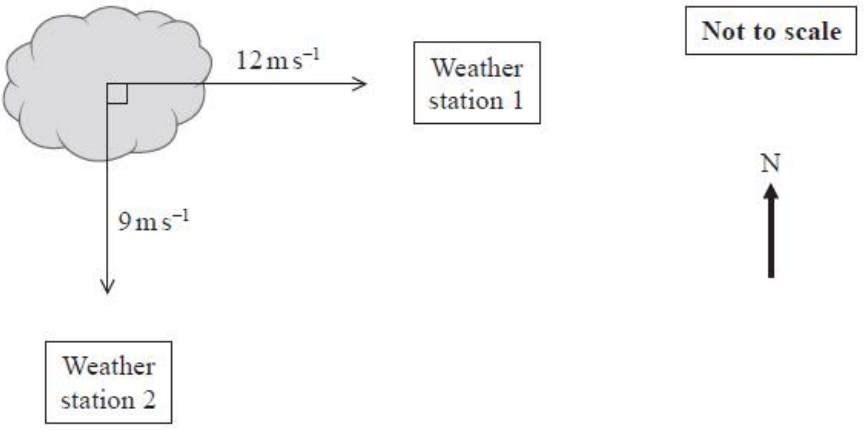
(Total for question = 7 marks)

Q18. Weather stations monitor the position of storm clouds.

The movement of a storm cloud is monitored by two weather stations. The components of the velocity of the storm cloud towards each weather station are shown in the diagram.



Determine the velocity of the storm cloud.

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Magnitude of velocity = ...

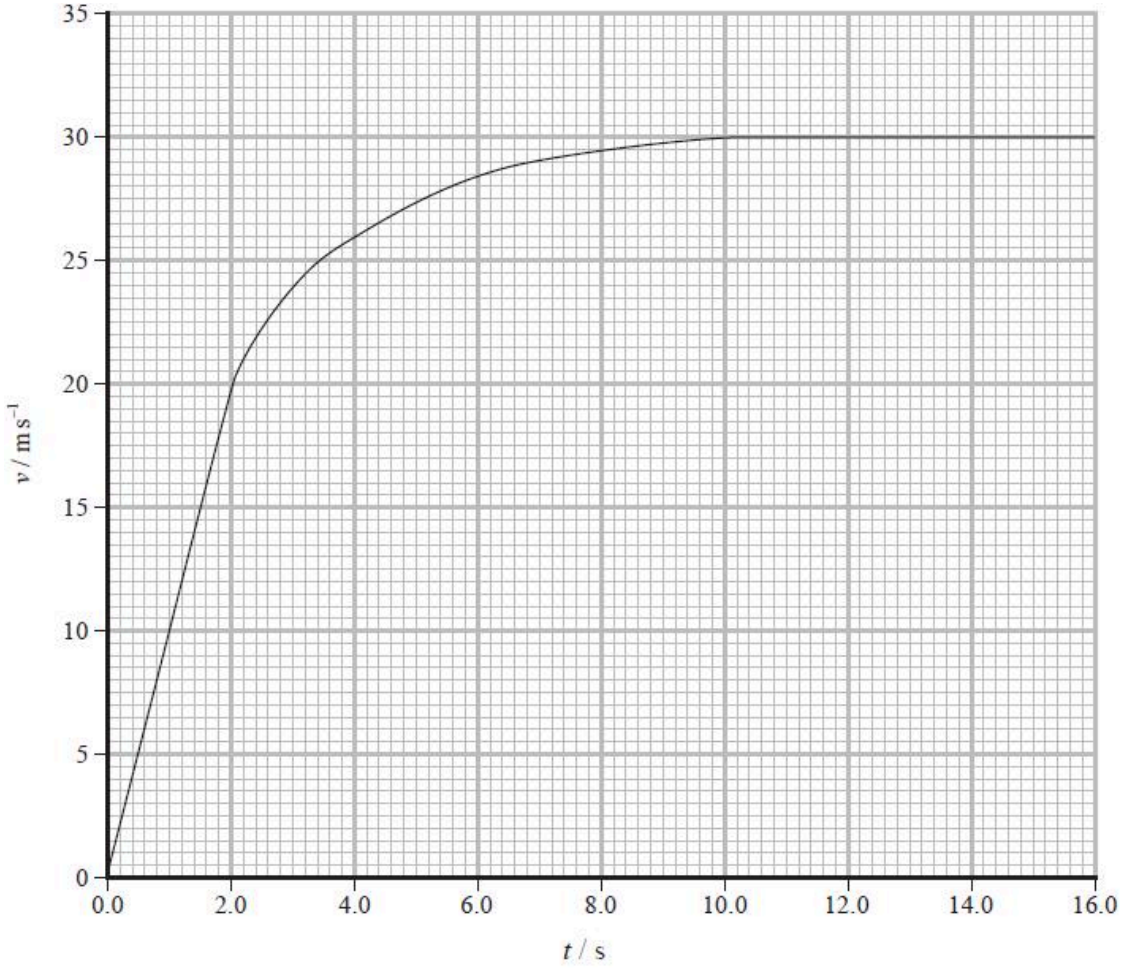
Direction of velocity = ...

(Total for question = 4 marks)

Q19. A skydiver made a skydive from a plane.

(Source: © Sky Antonio/Shutterstock)

The graph shows how the velocity *v* of the skydiver varied with time *t*, from the instant she left the plane to the instant just before the parachute opened.



Determine the acceleration of the skydiver when t = 4.0 s.

(3)

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Acceleration of skydiver = ...

(Total for question = 3 marks)

Q20. Two ice skaters are gliding across the horizontal ice surface at an ice rink.

(Source: © ITAR-TASS News Agency/Alamy Stock Photo)

Initially the skaters move together with a speed of 5.6 m s^{-1}.

The male skater pushes the female skater forwards. After being pushed, she has a forward speed of 7.5 m s^{-1}.

Calculate the speed of the male skater immediately after pushing the female skater forwards.

mass of male skater = 66 kg
mass of female skater = 52 kg

(3)

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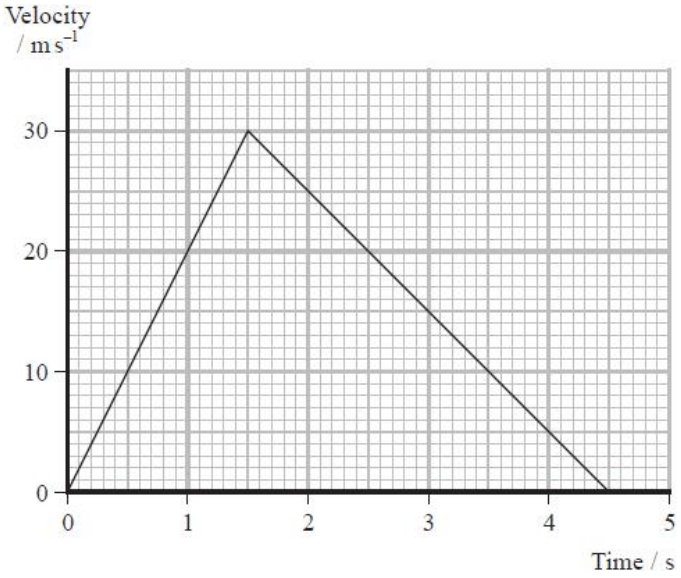
Speed of male skater = ...

(Total for question = 3 marks)

Q21. A model rocket accelerates vertically upwards then decelerates due to gravity until it reaches a maximum height.

A velocity-time graph for the rocket until it reaches maximum height is shown.



Show that the rocket reaches a maximum height of about 68 m.

(2)

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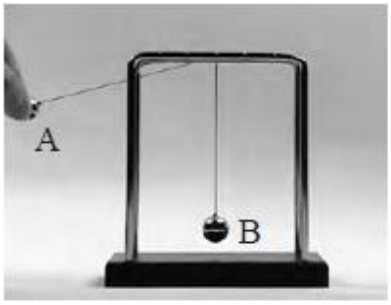
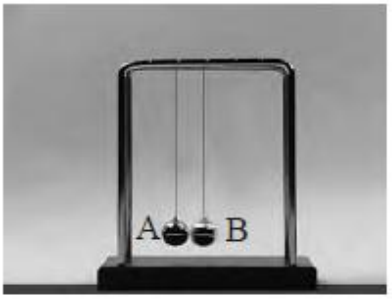
(Total for question = 2 marks)

Q22. Two small identical solid metal spheres, A and B, are suspended by light inextensible threads from a frame.

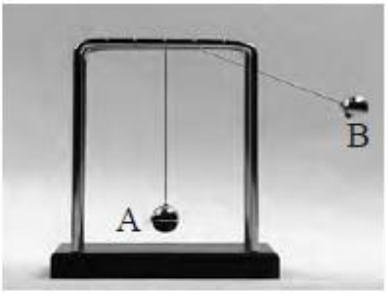
* Sphere A is pulled to one side as shown and released. Sphere A collides with sphere B and stops and sphere B swings upwards. The time intervals between the photographs below are the same.



Photograph 1



Photograph 2



Photograph 3

Using Newton's laws of motion, explain the motion of the spheres during the collision in terms of the forces acting on them.

(6)

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(Total for question = 6 marks)

End of A Level questions

Task 5 : Reading list

Website:

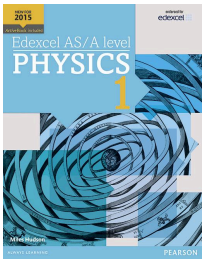
Course information (Edexcel A Level Physics from 2015) :
http://qualifications.pearson.com/en/qualifications/edexcel-a-levels/physics-2015.html

Textbooks:

Textbook you will need to buy and bring to every lesson:

For Year 12:

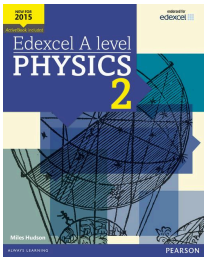
Edexcel AS/A level Physics Student Book 1 + ActiveBook
(Turquoise cover) published by Pearson
ISBN:**9781447991182**



Current price on Amazon: £33.82 (If purchasing a second-hand version of book, be aware that the single use code for the online ActiveBook will be unlikely to work)

For Year 13 (does not need to be purchased until next summer):

Edexcel A level Physics Student Book 2 + ActiveBook
(Blue cover) published by Pearson
ISBN:**9781447991199**

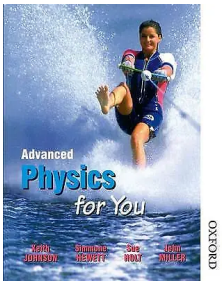


Optional: other useful textbooks

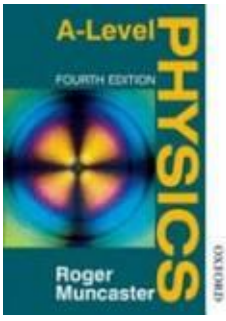
Advanced Physics for You – Keith Johnson
(Not Edexcel specific but good, straightforward explanations. Either first or second edition are suitable)

(First edition: Blue cover with water skier)
Often available second-hand for less than £10
ISBN: 978-0-7487-5296-6

OR (Second edition: Blue cover with snowboarder)
More expensive second-hand at about £30
ISBN: 978-1408527375



A Level Physics – Roger Muncaster
Very old traditional textbook – excellent for students aiming for A*
(Between £5-£20 second-hand)



Mark Scheme for GCSE Questions

Q1.

Question number	Answer	Additional guidance	Mark
CS5	substitution (1) $(t^2=)\ \frac{2 \times 1.4}{10}$ evaluation (1) $(t =)$ 0.53 (s)	0.28 allow numbers that round to 0.53 e.g. 0.52915 award full marks for correct answer without working.	(2) AO2

Q2.

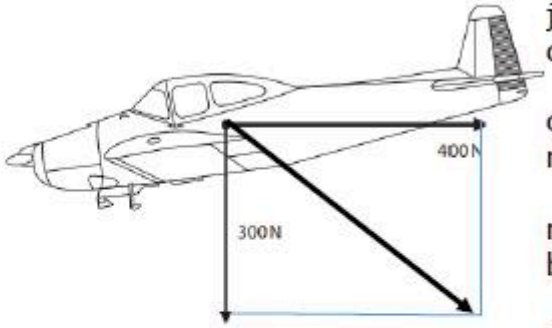
Question number	Answer	Additional guidance	Mark
(i)	rearrangement of work = force × distance to give distance = work ÷ force (1) substitution and evaluation (1) 18 (m)	seeing 2700 ÷ 150 Award full marks for correct answer without working	(2)

Question number	Answer	Mark
(ii)	2700 (J)	(1)

Question number	Answer	Additional guidance	Mark
(iii)	rearrangement of $KE = ½ mv^2$ $v = \sqrt{(2 \times KE \div m)}$ (1) substitution and evaluation (1) 19 (m/s)	 $v = \sqrt{(2 \times 2700 \div 15)}$ $v^2 = (2 \times 2700 \div 15)$ allow answers that round to 19 award full marks for correct answer without working allow alternative route using $v^2 - u^2 = 2ax$ for full marks	(2)

Q3.

Question Number:	Answer	Additional guidance	Mark
(i)	0.9 (k N) (1) up / upwards / ascending (1)	accept .9 or 0.90 north N ↑	(2) AO 3 2a AO 3 2b

Question Number:	Answer	Additional guidance	Mark
(ii)		judge length and direction by eye construction lines need not be shown magnitude need not be stated allow missing arrowhead if direction and length are correct reject answers which have any additional vectors drawn	(1) AO 3 2b

Question Number:	Answer	Additional Guidance	Mark
(iii)	recall and substitution (1) GPE = 750 x 10 x 1300 evaluation (1) (energy =) 9 800 000 (J)	 no POT error (could have missed out g) allow answers in standard form 9.8×10^6 allow answers that round to 9 800 000 e.g. 9 750 000 J allow 9800 kJ or 9.8MJ allow 9 555 000 J allow negative values award full marks for correct answer without working	**(2)** AO 2 1

Q4.

	Answer	Additional guidance	Mark
(i)	selection and substitution (1) (a =) $\frac{82 (- 0)}{36}$ evaluation (1) 2.3 (m/s^2)	**note: this is a "show that" question** accept any value that rounds to 2.3 (m/s^2) accept 2.2 (m/s^2) for 1 mark maximum answer of 2 (m/s^2) without a substitution scores 0 marks	**(2)** **AO2**

	Answer	Additional guidance	Mark
(ii)	substitution (1) $82^2 (- 0^2) = 2 \times 2.3 \times x$ rearrangement (1) $(x) = \frac{82^2 (- 0^2)}{2 \times 2.3}$ evaluation (1) 1500 (m)	allow substitution and rearrangement in either order accept 2, 2.2, 2.27, 2.3 for "a" throughout $(x) = \frac{v^2 (- u^2)}{2 \times a}$ ignore sign accept 1460 (m) allow answers in the ranges: 1460 (m) to 1482 (m) 1520 (m) to 1530 (m) 1680 (m) to 1700 (m) award full marks for correct answer without working	(3) AO2

	Answer	Additional guidance	Mark
(iii)	one statement from take off aborted (1) mechanical/engine failure (1) acceleration reduced (1) weather related reasons (1) larger mass / heavier plane / extra passengers (1) (longer runway required) for landing (1)	any other sensible suggestion	(1) AO3

Q5.

	Answer	Additional guidance	Mark
	(distance =) area (under graph) (1) substitution (1) ½(1.4 x 4) + (3.6 x 4) + ½(1x 4) evaluation (1) 19 (m)	may be seen on graph 2.8 + 14.4+ 2.0 ½ x [3.6+6] x 4 allow values that round to 19 (m) (e.g. 19.2..) award full marks for the correct answer without working if no other marks scored allow (4 x 6 =)24 (m) for 1 mark	(3) AO3

Q6.

	Answer Additional guidance	Mark
	B 3.0 s **A, C** and **D** are incorrect as they are the wrong time.	**(1)** **AO3**

Q7.

	Answer	Additional guidance	Mark
	4.6 (m/s)	allow any value between 4.5 and 4.7 (m/s) inclusive	**(1)** **AO3**

Q8.

	Answer	Additional guidance	Mark
		allow MP1 and MP2 in either order	**(3)** **AO3**
	correct data point(s) seen (1)	any data point(s) on the line e.g. (1.4,4)	
	(accel =) $\frac{\Delta v}{t}$ (1)	allow 'gradient' allow e.g. $\frac{4}{1.4}$ for 2 marks	
	evaluation (1) 2.9 (m/s^2)	allow values that round to 2.9 (m/s^2) (e.g. 2.857...)	
		award full marks for the correct answer without working	

Q9.

Question number	Answer	Additional guidance	Mark
(i)	substitution (1) (force =) $\frac{8.7}{0.35}$ evaluation (1) 25 (N)	use of force = $\frac{\text{change in momentum}}{\text{time}}$ allow numbers that round to 25 e.g 24 .8571 award full marks for correct answer without working.	(2) AO2

Question number	Answer	Additional guidance	Mark
(ii)	(magnitude) 25 (N) (1) (direction) down(wards)/ towards floor (1)	ecf from 7bi allow arrow drawn pointing down "south"	(2) AO3

Q10.

Question Number	Answer	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (6 marks)** • momentum = mass × velocity • action and reaction are equal and opposite (N 3) • force of R on Q = -force of Q on R • $\frac{\text{change in momentum of Q}}{\text{time}} = \frac{\text{- change in momentum of R}}{\text{time}}$ • time of collision same for both • change in momentum of Q = - change in momentum of R • no overall change in momentum • R accelerates because of force from Q • transfer of momentum between Q and R	**(6)** AO 1 1

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• An explanation that demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• An explanation that demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• An explanation that demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Q11.

Question number	Answer	Additional guidance	Mark
CS4	An explanation linking three of: acceleration increases (1) as F = ma (1) (and) mass decreases (1) due to burning/using fuel (1)	independent mark	(3) AO1

Q12.

Question Number	Answer	Acceptable answers	Mark
(i)	Substitution $\frac{90}{1000} \times 3.3$ (1) evaluation 0.30 (N) (1)	A value which rounds to 0.30 eg 0.297 Give full marks for correct answer with no working Ignore power of ten error until evaluation Allow 1 mark for 297 even with no working shown	**(2)**

Question Number		Indicative Content	Mark
QWC	*(ii)	An explanation demonstrating some of the following: Descriptions of the graph • Accelerates upwards during stage1 • Maximum velocity is reached at the end of stage 1 • Accelerates downwards / decelerates during stage 2 • Accelerates during stage 3 • Comes to rest during stage 4. Interpretations of the shape of the graph • Fuel is burnt creating thrust in stage • Thrust is upwards in stage 1/ • Gravity/weight (is always) a downward force • Fuel runs out at end of stage 1/ has ran out by stage 2 • Still going up during/ max height at end of stage 2 • Starts to fall at start of stage 3 • Negative velocity during stage 3 because it is falling. • Rapid deceleration / collision with the ground during stage 4/end of stage 3 Explanations for changes in velocity • Resultant force upwards/ thrust greater than gravity force during stage 1 • Acceleration non-linear because mass is decreasing / resultant force is increasing • Linear deceleration in stage 2/3 because force of gravity is constant • Resultant downward force/only gravity/ weight is acting during stage 2 and 3 • Large resultant force of impact during stage 4	(6)

Level	0	No rewardable content
1	1 - 2	• A limited explanation involving descriptions of the graph. • E.g. The rocket gets faster as it goes up during stage 1. The rocket slows down during stage 2 • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• A simple explanation involving interpretations of the shape of the graph e.g. The rocket's velocity increases during stage 1 because the burning fuel provides a force. The rocket accelerates downwards during stage 3 • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	• A detailed explanation which includes descriptions and interpretations for the shape of the graph including an explanation. E.g. The rocket's acceleration during stage 1 is increasing because it is losing mass as the fuel is burnt. It then slows down until it reaches maximum height at the end of stage 2 • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q13.

Question Number	Answer	Additional guidance	Mark
(i)	(In every second), distance moved by chain around large gear = distance moved by chain around small gear (1) 2 x 48 = turns x 12 rearrangement and evaluation (1) 8 (turns each second)	accept use of gear ratio seen or implied e.g. 4:1 or 4/1 or 48:12 or 48/12 or converse e.g. 1:4 award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking reduces friction/amount of thermal energy transferred (1) extra useful energy is available/less input energy is required (1) efficiency = useful energy transferred (by the bicycle) ÷ total energy supplied (to the bicycle) (1)	 (oil provides) lubrication less energy wasted allow for the last **two** mark points; **either** less input energy is required to produce the same output for **2** marks **or** more output energy is available for the same input energy for **2** marks	**(3)**

Q14.

Question number	Answer	Additional guidance	Mark
	substitution (1) $2{,}800 = ½ \times 85 \times v^2$ rearrangement (1) $(v^2 =) \quad \frac{2800 \times 2}{85}$ evaluation (1) v = 8.1 (m/s)	allow substitution and rearrangement in either order 66 or 65.88 seen allow values that round to 8.1 e.g 8.1168 award full marks for the correct answer without working	**(3)** **AO2**

Q15.

Question number	Answer	Additional guidance	Mark
(i)	substitution into work done = force x distance (1) 1800 = force x 1.2 rearrangement and evaluation (1) (force =) 1500 (N)	alternative method rearrangement (1) $(\text{force} =) \frac{\text{work (done)}}{\text{d(istance moved)}}$ **or** $(\text{force} =) \frac{1800}{1.2}$ (substitution and) evaluation (1) (force =) 1500 (N) if no other marks scored allow one mark for answer of 500 (N) or 4500 (N) award full marks for correct answer without working.	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
(ii)	substitution (1) $64 = \frac{1800 \times 100}{\text{total work done}}$ **or** $0.64 = \frac{1800}{\text{total work done}}$ rearrangement and evaluation (1) (work done =) 2800 (J)	alternative method re-arrangement (1) (total work done =) $\frac{\text{work done on barrel} \times 100}{\text{efficiency}}$ **or** (work done=) $\frac{1800 \times 100}{64}$ **or** (work done=) $\frac{1800}{0.64}$ (substitution and) evaluation (1) (work done =) 2800 (J) allow values that round to 2800; e.g. 2812.5 award full marks for correct answer without working.	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
(iii)	any **one** of additional mass in the system (1) rope stretches (1)	 (bottom) pulley / rope has {mass / weight} ignore references to the mass / weight of barrel tension in rope ignore references to consequences of friction such as air resistance, heat or sound. ignore pulling at an angle ignore references to person	**(1)** **AO1**

Mark Scheme for A Level questions

Q1.

Question Number	Answer	Mark
	C 	1
	Incorrect Answers: A – this is the diagram for a bead moving downwards with a constant velocity B – this is the diagram for a bead moving upwards with a decreasing velocity D – this is the diagram for a bead moving downwards with a decreasing velocity	

Q2.

Question Number	Acceptable Answers	Reject	Mark
	C		1

Q3.

Question Number	Answer	Mark
	C	1

Q4.

Question Number	Answer	Mark
	C	1

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	D		1

Q6.

Question Number	Answer	Mark
	C 42 m	1
	Incorrect Answers: A – 141 m is ¾ of the internal circumference of the track (¾ × 2 × π × 30 = 141 m) B – 141 m is ¼ of the internal circumference of the track (¼ × 2 × π × 30 = 47 m) D – 30 m (the radius) is the displacement travelled in one direction (downwards from the start position)	

Q7.

Question Number	Answer	Mark
	B Incorrect Answers: A – this answer is incorrect C – this answer is incorrect D – this answer is incorrect	1

Q8.

Question Number	Answer	Mark
	A	1

Q9.

Question Number	Answer	Mark
	This is describing weight/force and not the mass **Or** the newton is not the unit of mass **Or** mass does not have a direction **Or** kg is the unit of mass and not force/weight (1) The velocity should be speed **Or** velocity would need a direction (1) The car would be decelerating **Or** the car should be speeding up (for an acceleration) **Or** a direction is needed **Or** the value should be negative/-2.5 m s^{-2} (1)	3

Q10.

Question Number	Answer	Mark
	B Incorrect Answers: A – normal force and friction are different types of forces and not in opposite directions C – weight and normal force on the road, are in the same direction and are different types of force. D – weight and normal force on the car are different types of force and are both on the same object.	1

Q11.

Question Number	Acceptable Answer	Additional Guidance	Mark
	B Average speed		1

Q12.

Question Number	Answer	Mark
	B	1

Q13.

Question Number	Answer	Additional Guidance	Mark
	A is the only correct answer	B is incorrect because speed has been divided by 2 C is incorrect because $E_K = 0.5\ mv^2$ D is incorrect because $E_K = 0.5\ mv^2$	**1**

Q14.

Question Number	Acceptable Answers	Reject	Mark
	C		1

Q15.

Question Number	Answer	Mark
	C 190 kJ	1
	Incorrect Answers: A – The velocity was not squared when using the formula $E_k = ½\ mv^2$ e.g. $½\ (1.2 \times 10^3)(18) = 11$ kJ B – The velocity was not squared and the ½ was omitted when using the formula $E_k = ½\ mv^2$ e.g. $(1.2 \times 10^3)(18) = 22$ kJ D – The ½ was omitted when using the formula $E_k = ½\ mv^2$ e.g. $(1.2 \times 10^3)(18)^2 = 390$ kJ	

Q16.

Question Number	Acceptable answers	Additional guidance	Mark
	• Attempt to find area under the graph (1) • Length from 18 000 m to 20 000 m (1) • Comparison of calculated value to 23 km (1) e.g. The length is long enough	MP1: use of triangles or counting squares MP3: conclusion to be consistent with calculated value Example of calculation Area under the graph (counting large squares) = 18.7 × 100 m s^{-1} × 10 s = 18 700 m	3

Q17.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(i)	• use of $p = mv$ (1) • use of conservation of momentum (1) • v = 3.8 m s^{-1} (1)	Example of calculation p = 300 kg × 7 m s^{-1} p = 2100 kg m s^{-1} 2100 kg m s^{-1} = (300 kg + 250 kg) v v = 3.8 m s^{-1}	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(ii)	• use of $E_k = ½ mv^2$ (1) • use of $W = Fd$ (1) • F = 3100 N (1)	Example of calculation E_k = ½ × 550 kg × (3.8 m s^{-1})^2 E_k = 3970 J 3970 J = F × 1.3 m F = 3050 N Allow error carried forward for velocity from (a)(i)	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	no external forces acted on the cars/system		**(1)**

Q18.

Question Number	Acceptable Answers	Additional guidance	Mark
	• Uses Pythagoras (1) • Speed = 15 m s^{-1} (1) • Uses trigonometry (1) • Angle to N-S line = 53° **Or** Angle to E-W line = 37° (1)	Example of Calculation $v = \sqrt{12^2 + 9^2} = 15$ m s^{-1} $\tan\theta = \frac{12}{9} = 53°$ to N-S line	4

Q19.

Question Number	Answer	Additional Guidance	Mark
	• Tangent drawn at t = 4.0 s (1) • Gradient of tangent determined (1) • a in the range 1.4 – 1.6 m s^{-2} (1)	Example of calculation $a = \frac{(35.0-25.0)\text{ m s}^{-1}}{(10.0-0.0)\text{ s}} = 1.50\text{ m s}^{-2}$	3

Q20.

Question Number	Answer	Additional Guidance	Mark
	• Use of $p = mv$ **(1)** • Use of momentum conservation **(1)** • $v = 4.1\ \text{m s}^{-1}$ **(1)**	Example of calculation $p_i = (66 + 52)\ \text{kg} \times 5.6\ \text{m s}^{-1}$ $p_f = (66\ \text{kg})v + (52\ \text{kg} \times 7.5\ \text{m s}^{-1})$ $\therefore v = \frac{(661 - 390)\ \text{kg m s}^{-1}}{66\ \text{kg}} = 4.11\ \text{m s}^{-1}$	**3**

Q21.

Question Number	Acceptable answers	Additional guidance	Mark
	• Height = area under the triangle **(1)** • Height = 67.5 m **(1)**	Example of calculation height = (4.5 s × 30 m s^{-1}) / 2 height = 67.5 m	**2**

Q22.

<table>
<tr><th>Question Number</th><th>Additional guidance</th><th colspan="2">Mark</th></tr>
<tr><td>*</td><td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5 - 4</td><td>3</td></tr>
<tr><td>3 - 2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
Indicative content
• Sphere A applies a force to sphere B (on impact)
• According to Newtons third law Sphere B will apply an (equal and) opposite force to Sphere A
• This force opposes the motion of Sphere A
• Sphere A decelerates, according to N2
• The (resultant) force on sphere B accelerates B
• The forces/impulse acting (on the spheres) are equal so the change in speeds/momentum are the same for each sphere.</td><td>The following table shows how the marks should be awarded for structure and lines of reasoning
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table></td><td>6</td></tr>
</table>