

Answer **all** the questions.

1 (a) (i) State the difference between a scalar and a vector quantity.

.....
[1]

(ii) Underline the vector quantities in the list below.

acceleration density force kinetic energy power volume weight

[2]

(b) Fig. 1.1 shows the path of a ball that is thrown from point **A** to point **B**. The ball reaches its maximum height at point **H**.

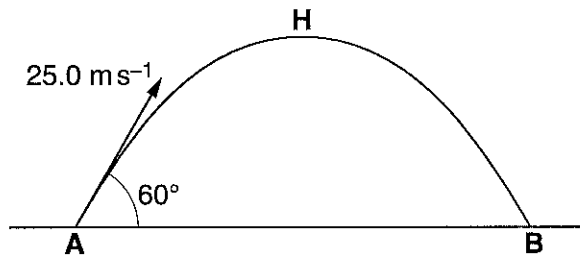


Fig. 1.1

The ball is thrown with an initial velocity of 25.0 ms⁻¹ at 60° to the horizontal. Assume that there is no air resistance.

(i) 1 Show that the vertical component of the initial velocity is 21.7 ms⁻¹.

[1]

2 Calculate the time taken for the ball to reach point H.

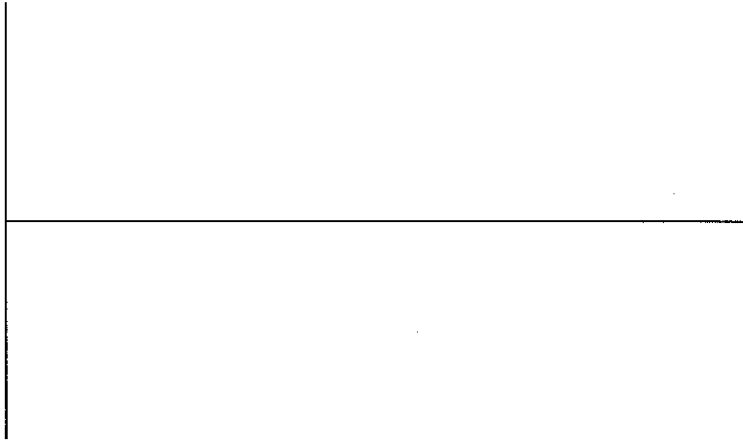
time = s [2]

3 Calculate the displacement from **A** to **B**.

displacement = m [3]

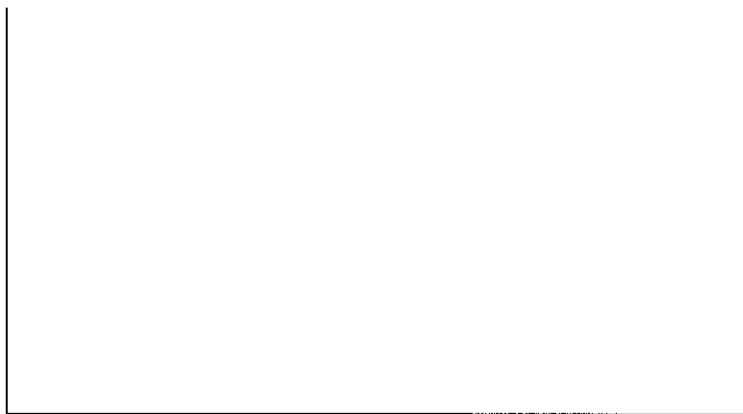
(ii) For the path of the ball shown in Fig. 1.1, draw sketch graphs, with labelled axes but without numerical values, to show the variation of

1 the vertical component of the ball's velocity against time



[3]

2 the distance travelled along its path against time.



[2]

(b) Fig. 2.1 shows a system for supporting a load.

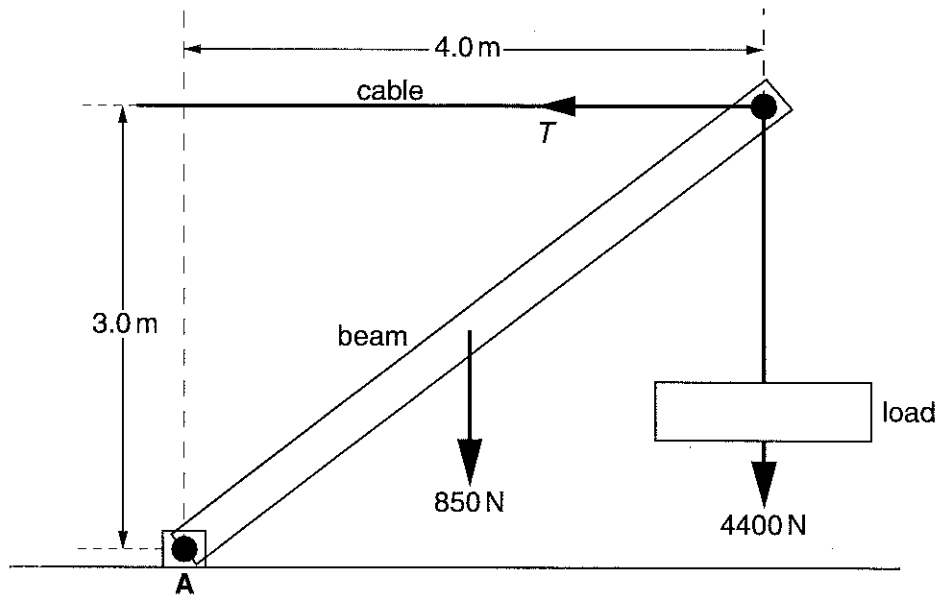


Fig. 2.1

The load of weight 4400 N is hanging from a uniform beam that is supported by a horizontal cable. The beam has a weight of 850 N and is hinged at A.

(i) Take moments about A and show that the tension T in the cable is 6400 N (to 2 significant figures).

[3]

(ii) State and explain what force, in addition to those shown, must act on the beam to keep it in equilibrium. You are not expected to calculate this force. Draw this force on Fig. 2.1 and label it F.

.....

.....

.....

.....[2]

[Total: 8]

2821 Forces and Motion

Question	Expected Answers	Marks	Additional Guidance
1 a i	A vector has a direction	B1	This is the minimum required. The reverse argument that a scalar does not have a direction can be implied. Allow extra comments such as magnitude, size, number and quantity but identified quantities such as a scalar has a distance and a vector has a distance and direction should not be allowed.
ii	[acceleration, force and weight] 3 correct scores 2 2 correct scores 1. (-1 for incorrect scalar answers)	B2	e.g. acceleration, force and power would score 0 (+1 and -1) acceleration, force, power and weight would score 1 (+2 and -1)
b i 1	($v_v =$) 25 sin60 or 25cos30 = 21.7 (21.65) ($m s^{-1}$)	M1 A0	Or $t = (v-u) / a$ or $a = (v-u) / t$
2	$v = u + at$ $0 = 21.7 - (9.81 \times t)$ $t = 2.2(1)$ (s)	C1 A1	Do not accept $t = 2$ (SF error). If $g=10$ used then penalise -1 but only once on the paper
3	distance = speed x time using speed = 25 cos60 or 25sin30 using time = 2t = 55(.2) (m)	M0 C1 C1 A1	Any equation with acceleration cannot score these marks unless a=0 stated Correct horizontal component (12.5) Note ECF from (b)(i) 2

Question	Expected Answers	Marks	Additional Guidance
ii 1	straight line negative / positive gradient line continues into negative / positive v values with the same gradient	B1 B1	The velocity must start from a non zero point and be a straight line as far as the time axis If time not labelled at half way mark, then use the ruler available to check times and allow 3 mm difference. Judge velocities by eye
2	same time in both + and – regions and to same v (only if correct line drawn) decreasing gradient increasing gradient (roughly same gradient at beginning and end)	B1 B1 B1	But not reaching a vertical line at end
b iii	ANY FOUR: PE zero or minimum at A / rises from A to H / maximum at H / falls from H to B. KE max at A / falls from A to H / rises from H to B. KE is a <u>minimum</u> at H (<i>not zero</i>) KE is <u>converted</u> to PE / PE is <u>converted</u> to KE / <u>loss</u> in PE = <u>gain</u> in KE KE / PE at B is the <u>same</u> as at A	MAX B4 B1	Only one of these is required for the mark but any further contradictions about the PE would cancel this mark. Similarly for the KE statements The candidate's first four statements should be marked with a cross or a tick on script and the remainder checked for contradictions only. Do not allow or penalise: PE = KE half way up (AVV)
QWC	Spelling and punctuation		Penalise if more than two errors in spelling or punctuation. No tick or cross needed. Allow GPE and KE
	Total	19	

Question	Expected Answers	Marks	Additional Guidance
2	a		
	i	B1	Do not allow: upward forces equal downward forces / forces are balanced / all forces are equal (and opposite) Allow: <u>sum of clockwise moments equals sum of anticlockwise moments</u>
	ii	B1	
	Force x <u>perpendicular</u> distance from the pivot / point / axis	B1	
b	i	B1	Any correct moment scores the first mark
	ii	B1	The two correct clockwise moments added
	(Sum of clockwise =) $850 \times 2 + 4400 \times 4$ equating this sum with the anticlockwise moment $T \times 3$ and solving to give $T = 6400$ (6433) (N)	B1	The clockwise and anticlockwise moments are then equated and solved and not just the clockwise divided by 3
	ii	B1	Mark diagram with a tick or cross to show F has been looked for
	Force at A drawn up and to the right of vertical allow up to parallel with beam	B1	Do not accept the system is not in equilibrium (that is in the question)
	Another force is required to give zero resultant force or <u>up and down</u> / <u>left and right</u> forces do not balance	B1	
	Total	8	

Answer **all** the questions.

- 1 (a) State the difference between a vector and a scalar quantity.

.....
..... [1]

- (b) In the following list underline **all** the scalar quantities.

displacement kinetic energy mass power velocity weight [1]

- (c) Fig. 1.1 shows a climber on a vertical rock face supported by a rope. The climber is in equilibrium.

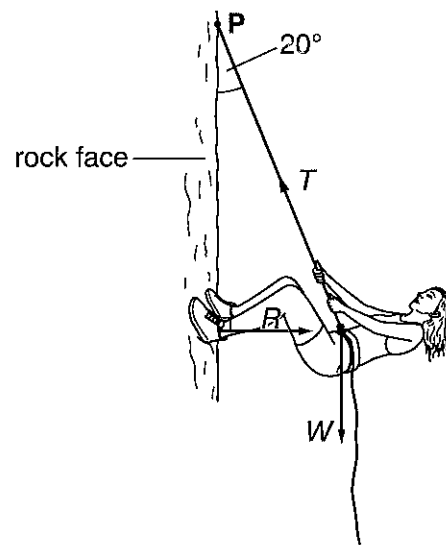


Fig. 1.1

The weight of the climber and her equipment is 650 N. The rope is attached to the climber and fixed to a point **P** where it makes an angle of 20° to the vertical. The contact force R acts on the climber at right angles to the rock face.

(i) Use a vector triangle or resolve forces to calculate

1 the tension T in the rope

$T = \dots\dots\dots$ N

2 the contact force R .

$R = \dots\dots\dots$ N
[3]

(ii) The climber moves down the rock face and the angle the rope makes with the vertical decreases. Explain why the magnitude of the tension decreases.

.....
.....
..... [1]

[Total: 6]

2821 Forces and Motion

Question 1	Expected Answers	Marks	Additional Guidance
(a)	A vector <u>has a direction</u>	B1	Ignore additional comments unless there is a contradiction
(b)	Kinetic energy, mass and power all correct (no others underlined)	B1	
(c) (i)	$T \cos 20 = W$ ($W = 650$) $T = 692$ (N) allow 2 sf	C1 A1	Solution involving triangles: correct triangle and three arrows C1 Scale diagram requires scale and correct triangle (no arrows) C1 allow +/- of 20 (N) for scale diagram do not allow 691 (N) but penalise only once on the paper
2	$T \sin 20 = R$ $R = 692 \sin 20 = 237$ $236(.6)$ (N) Allow 240 (N)	A1	Allow ecf for T from (c)(i) 1 Allow +/- 220 to 250 (N) for scale diagram Correct answer for 1 and 2 in reverse can score 1 mark
(ii)	With the angle made with rock face less the tension is closer to equaling the weight value or example quoted $\cos 10$ is greater than $\cos 20$ i.e. closer to one	A1	Expect clear answer here. Do not allow answers such as R decreases therefore T increases. Allow answers that refer to cos angle is greater (for smaller angles) hence T will be less
	Total	6	

Answer **all** the questions.

1 (a) State a similarity and a difference between *distance* and *displacement*.

(i) similarity:
 [1]

(ii) difference:
 [1]

(b) Fig. 1.1 shows two airports **A** and **C**.

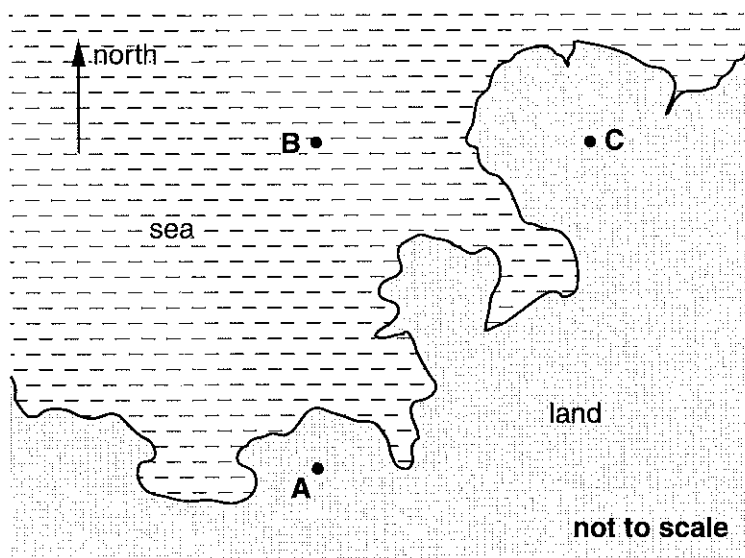


Fig. 1.1

An aircraft flies due north from **A** for a distance of 360 km (3.6×10^5 m) to point **B**. Its average speed between **A** and **B** is 170 m s^{-1} . At **B** the aircraft is forced to change course and flies due east for a distance of 100 km to arrive at **C**.

(i) Calculate the time of the journey from **A** to **B**.

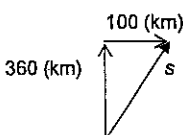
time = s [1]

3

- (ii) Draw a labelled displacement vector triangle below. Use it to determine the magnitude of the displacement in km of the aircraft at **C** from **A**.

displacement = km [3]

[Total: 6]

Question	Expected Answers	Marks	Additional Guidance
1 (a) (i)	Both measured in metre/m	B1	Allow: Both have the same unit/Both have 'magnitude' Not: Both are distance/length
(ii)	Distance is a scalar/does not have direction or Displacement is a vector/has direction	B1	Not: One is a vector and the other a scalar
(b) (i)	$\text{time} = \frac{3.6 \times 10^5}{170}$ $\text{time} = 2.1(18) \times 10^3 \text{ (s)} \text{ or } 2.1 \times 10^3 \text{ (s)}$	B1	Note: Answer to 2sf or more is required
(ii)	Correct vector triangle Eg:  $s^2 = 360^2 + 100^2 \quad / \quad s = \sqrt{360^2 + 100^2}$ $s = 373.6 \text{ (km)} \quad / \quad 370 \text{ (km)}$	B1 C1 A1	The vector triangle must have at least two labels (360, 100 and s – allow x or d for s). The 'orientation' of the triangle must be as shown. Ignore the direction of the arrows. Allow: Full credit can be given for a scale drawing 2 marks if answer in the range (370 – 380) 1 mark if answer in the range (360 – 370) or (380 - 390) Note: Bald answer to 2sf or more and no diagram scores 2/3 marks.
Total		6	

- 4 (a) An electron in a particle accelerator experiences a constant force. According to one student, the acceleration of the electron should remain constant because the ratio of force to mass does not change. In reality, experiments show that the acceleration of the electron decreases as its velocity increases. Describe what can be deduced from such experiments about the nature of accelerated electrons.

.....

.....

.....

..... [2]

- (b) Fig. 4.1 shows the velocity vector for a particle moving at an angle of 31° to the horizontal.

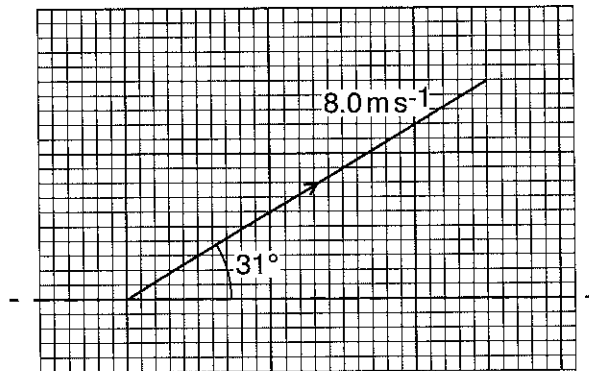


Fig. 4.1

- (i) On Fig. 4.1, show the horizontal (x -direction) and vertical (y -direction) components of the velocity. [2]
- (ii) Calculate the horizontal (x -direction) component of the velocity.

velocity = ms^{-1} [1]

(c) Fig. 4.2 shows a ship **S** being pulled by two tug-boats.

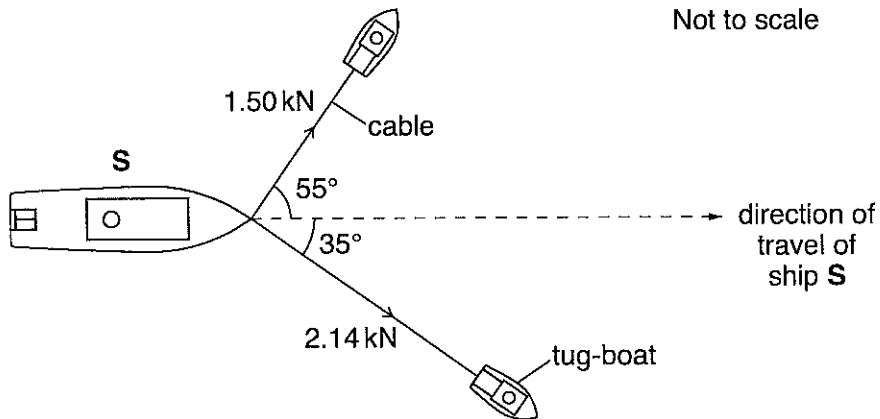


Fig. 4.2

The ship is travelling at a constant velocity. The tensions in the cables and the angles made by these cables to the direction in which the ship travels are shown in Fig. 4.2.

(i) Draw a vector triangle and determine the resultant force provided by the two cables.

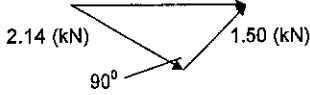
resultant force = kN [3]

(ii) State the value of the drag force acting on the ship **S**. Explain your answer.

.....

 [2]

[Total: 10]

Question	Expected Answers	Marks	Additional Guidance
4 (a)	The mass (of the electron) increases as its speed approaches c / speed of light / $3 \times 10^8 \text{ m s}^{-1}$	M1 A1	Not: mass 'changes' / 'electron becomes heavier'
(b) (i)	A line with correct arrow in the y direction has length of 14 to 16 'small squares' A line with correct arrow in the x direction has length of 24 to 26 'small squares'	B1 B1	Note: If correct arrows are not shown, then maximum mark is 1
(ii)	component = $(8.0 \cos 31) = 6.86 \text{ (m s}^{-1}\text{)}$ or $6.9 \text{ (m s}^{-1}\text{)}$	B1	Allow: 6.85 as BOD
(c) (i)	Correct vector triangle drawn  $(\text{resultant force})^2 = 2.14^2 + 1.50^2$ resultant force = 2.61 (kN)	B1 C1 A1	Note: Expect at least one 'label' on the sketch, eg: 2.14, 1.5, 90° The 'orientation' of the triangle is not important The directions of all three arrows are required Allow: 2 sf answer of 2.6 (kN) Allow a scale drawing; 2 marks if answer is within ± 0.1 kN and 1 mark if ± 0.2 kN Alternative for the C1 A1 marks: $1.50 \cos(55)$ or $2.14 \cos(35)$ C1 resultant force = $1.50 \cos(55) + 2.14 \cos(35)$ resultant force = 2.61 (kN) A1
(ii)	2.6(1) (kN) (Constant velocity implies) zero <u>net</u> force / zero acceleration	B1 B1	Possible ecf Not: 'resultant force = drag' since the first B1 assumes this
	Total	10	

- 5 Use your knowledge of physics to state if each statement is correct or incorrect. You then need to explain the reason for your answer. An example has been done for you:

In a vacuum, a 2.0 kg object will fall faster towards the ground than an object of mass 1.0 kg.

This statement is **incorrect**.

Explanation: **All objects falling towards the Earth in a vacuum have the same acceleration.**

- (a) The mass of a particle (e.g. electron) remains constant as its speed approaches the speed of light.

This statement is

Explanation:

.....

..... [2]

- (b) A ball is thrown vertically upwards. Air resistance has negligible effect on its motion. During the flight, the total energy of the ball remains constant.

This statement is

Explanation:

.....

..... [2]

- (c) An object falling through air has a terminal velocity of 30 m s^{-1} . At terminal velocity, the weight of the object is equal to the acceleration of free fall.

This statement is

Explanation:

.....

..... [2]

- (d) The technique of 'triangle of vectors' is used by a global positioning system (GPS) to locate the position of cars.



In your answer, you should use appropriate technical terms, spelled correctly.

This statement is

Explanation:

.....

..... [2]

[Total: 8]

Q5	Expected Answers	Marks	Additional Guidance
a	... incorrect	M1	In question 5, use tick or cross on Scoris to show if the mark is awarded Not: mass <i>changes</i>
	Mass (of the particle) increases (as it approaches speed of light)	A1	
b	... correct	M1	Note: This mark is for stating the transfer of energy between kinetic and (gravitational) potential
	KE is changed into (G)PE or (G)PE is changed into KE or change in KE = change in (G)PE (AW)	A1	
c	... incorrect	M1	Allow alternative response: incorrect M1 Acceleration and weight are not the same quantities (AW) A1
	Weight is equal to drag / air resistance / friction (and not acceleration of free fall)	A1	
d	... incorrect	M1	Note 1 mark if 'trilateration' is misspelled but candidate has mentioned that the statement is incorrect
	The technique is trilateration ✍ The term <i>trilateration</i> to be included and spelled correctly to gain the A1 mark	A1	
Total		8	

- 3 (a) Define a *vector* quantity and give one example.

.....
 [2]

- (b) Fig. 3.1 shows a force F at an angle of 30° to the horizontal direction.



Fig. 3.1

- (i) The **horizontal component** of the force F is 7.0 N. Calculate the magnitude of the force F .

$$F = \dots\dots\dots \text{ N [2]}$$

- (ii) The force F moves an object in the horizontal direction. In a time of 4.2 s, the object moves a horizontal distance of 5.0 m. Calculate

1 the work done by the force

$$\text{work done} = \dots\dots\dots \text{ J [2]}$$

2 the rate of work done by the force.

$$\text{rate of work done} = \dots\dots\dots \text{ W [1]}$$

- (c) Fig. 3.2 shows the forces acting on a stage light of weight 120 N held stationary by two separate cables.

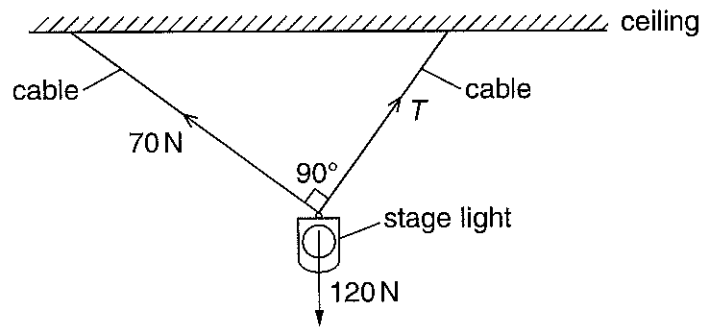



Fig. 3.2

The angle between the two cables is 90° . One cable has tension 70 N and the other has tension T .

- (i) State the magnitude and the direction of the **resultant** of the tensions in the two cables.
- magnitude
- direction [2]
- (ii) Sketch a labelled vector triangle for the forces acting on the stage light. Hence, determine the magnitude of the tension T .

$T = \dots\dots\dots$ N [4]

[Total: 13]

Question	Expected Answers	Marks	Additional Guidance
3	a	A quantity with magnitude / size and direction	B1
		Suitable example: displacement / velocity / acceleration / force / weight etc	B1
	b i	$F_x = F \cos \theta$ $7.0 = F \times \cos 30$ $F = 8.1 \text{ (N) or } 8.08 \text{ (N)}$	C1 A1 Allow: 1 mark for 'radian' error; answer is 45.3 (N) Note: No marks for ' $7.0 \times \cos 30 = 6.06 \text{ N}$ '
	ii	1 $W = 7.0 \times 5.0$ or $W = 8.08 \times 5.0 \times \cos 30$ work done = 35 (J) 2 'power' = $35/4.2$ = 8.3 (W)	C1 A1 Possible ecf Note: If answer for (b)(i) is 6.06 (N), then ' $6.06 \times 5.0 \times \cos 30 = 26.2 \text{ (J)}$ ' scores 2/2 because of ecf B1 Possible ecf
	c i	Magnitude is 120 (N) / equal to weight Direction is (vertically) up / opposite to weight	B1 B1
	ii	Correct diagram Correct detail on diagram  $120^2 = 70^2 + T^2$ $T = 97 \text{ (N) or } 97.5 \text{ (N)}$	M1 Note: For the M1 mark, the basic diagram must have all sides labelled (70, 120 and T) and the angle between 70 (N) and T is judged by eye to be 90° A1 Note: For the A1 mark, all the arrows are marked and cyclic C1 A1 Note: For the C1 A1 marks, $T = \sqrt{120^2 + 70^2} = 140$ scores zero Allow: 2 marks for T in the range of 94 (N) to 100 (N) if scale drawing is done
	Total		13

Answer **all** the questions.

- 1 (a) State **one** difference between a scalar quantity and a vector quantity.

.....
 [1]

- (b) Fig. 1.1 shows two sets of quantities listed as 'scalars' and 'vectors' by a student.

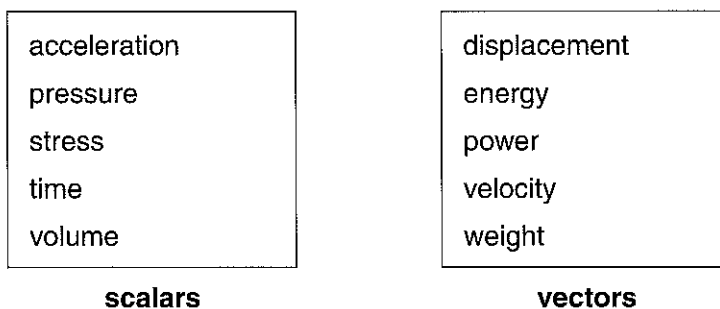


Fig. 1.1

- (i) State the one quantity that has been incorrectly listed as a scalar.

..... [1]

- (ii) State two quantities that have been incorrectly listed as vectors.

1.

2.

[1]

- (iii) State two quantities listed as scalars that have the same unit. Name this unit.

1.

2.

unit:

[2]

- (c) Circle the correct value for the prefix tera (T) in the list below.

10^6 10^9 10^{12} 10^{15}

[1]

- (d) Rearrange the following prefixes in the order of smallest to largest.

μ c p k

..... [1]

[Total: 7]

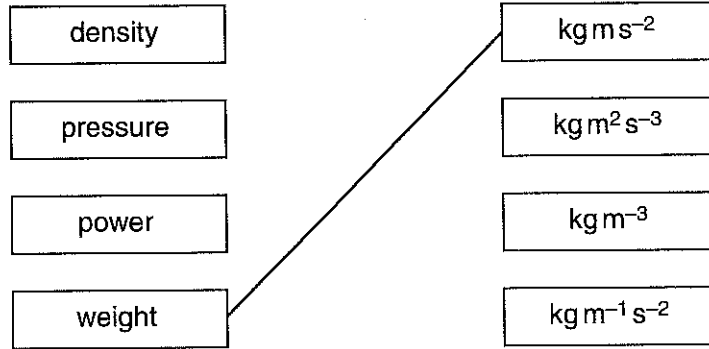
Note about significant figures:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf.
 If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
 Any exception to this rule will be mentioned in the Additional Guidance.

Question		Answer	Marks	Guidance
1	(a)	A vector quantity has <u>direction</u> / scalar quantity does not have <u>direction</u>	B1	Not: 'Scalar only has magnitude' because there is no mention of <u>direction</u>
	(b)	(i) acceleration	B1	
		(ii) power <u>and</u> energy	B1	
		(iii) stress <u>and</u> pressure unit: pascal / Pa / N m ⁻² / kg m ⁻¹ s ⁻²	M1 A1	Note: The A1 mark can only be scored if M1 is awarded
	(c)	10 ¹²	B1	
	(d)	<i>p μ c k</i>	B1	
Total			7	

Answer **all** the questions.

- 1 Draw a line from each quantity on the left-hand side to the correct unit on the right-hand side. One quantity (weight) has already been matched to its unit.



[2]

[Total: 2]

- 2 (a) Speed is a scalar quantity and velocity is a vector quantity. State one difference and one similarity between speed and velocity.

difference:

.....

similarity:

..... [2]

- (b) Fig. 2.1 shows a toy locomotive on a circular track.

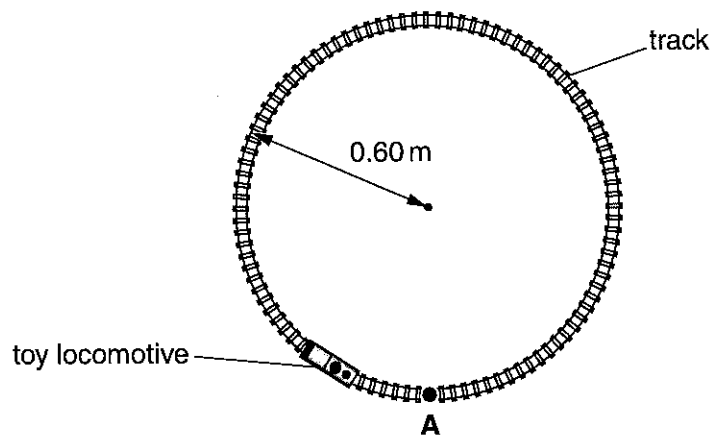


Fig. 2.1

3

The locomotive travels at constant speed round the track in a clockwise direction. It takes 12 s to travel completely round the track. At time $t = 0$, the locomotive is at point **A**.

- (i) Calculate the speed of the locomotive.

speed = ms^{-1} [2]

- (ii) Calculate the magnitude of the displacement s of the locomotive from point **A** after it has travelled one quarter of the way round the track.

$s =$ m [2]

- (iii) Explain why the average velocity of the locomotive is zero after a time of 12 s.

.....
..... [1]

- (iv) Explain why the velocity of the locomotive changes even though its speed is constant.

.....
..... [1]

[Total: 8]

G481

Mark Scheme

January 2013

Note about significant figures and rounding errors:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf. If an answer is given to fewer than 2 sf, then penalise once only in the entire paper. Any exception to this rule will be mentioned in the Guidance.
Penalise a rounding error once only in the entire paper.

Question	Answer	Marks	Guidance
1	Lines joining density to ' kg m^{-3} ' pressure to ' $\text{kg m}^{-1} \text{s}^{-2}$ ' power to ' $\text{kg m}^2 \text{s}^{-3}$ '	B1×2	Note: All correct – 2 marks, deduct 1 mark for each error or omission. (Minimum score = 0)
Total		2	

Question		Answer	Marks	Guidance
2	(a)	Difference: Velocity / vector has direction (and speed does not) or speed / scalar does not have direction (velocity has) Similarity: Both have the same unit / both have m s^{-1} (as the unit) / both have magnitudes	B1 B1	Not 'velocity is a vector / speed is a scalar' since it is stated in the question
	(b) (i)	distance = $2 \times \pi \times 0.60$ (= 3.77 m) / speed = $\frac{3.77}{12}$ speed = 0.31 (m s^{-1})	C1 A1	Note: Answer to 3 sf is 0.314 (m s^{-1})
	(ii)	$s^2 = 0.60^2 + 0.60^2$ $s = 0.85$ (m)	C1 A1	Note: Answer to 3 sf is 0.849 (m) Note: 0.72 scores 1 mark (square root omitted)
	(iii)	The (change in) displacement is zero	B1	
	(iv)	The direction changes (even though the magnitude is the same)	B1	
Total			8	

2 (a) Explain why force is a *vector* quantity.



In your answer, you should use appropriate technical terms, spelled correctly.

.....
 [1]

(b) Fig. 2.1 shows the forces acting on a water drop on the windscreen of a stationary car.

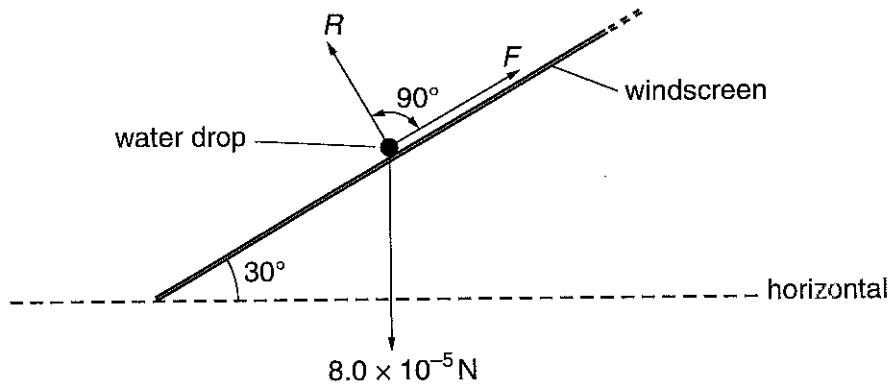


Fig. 2.1

The windscreen makes an angle of 30° to the horizontal. The weight of the water drop is $8.0 \times 10^{-5} \text{ N}$. The normal contact force on the water drop is R . There is also a force F acting on the water drop as shown. The water drop is **stationary**.

(i) Use Fig. 2.1 to determine the component of the weight of the water drop

1 perpendicular to the windscreen

component = N

2 parallel to the windscreen.

component = N
 [2]

5

(ii) Determine the magnitude of F . Explain your answer.

.....

.....

.....

..... [2]

[Total: 5]

Question 3 begins on page 6

Question		Answer	Marks	Guidance
1	(a)	N m^{-2} or N/m^2 or Pa m s^{-2} or m/s^2 or $(\text{kg}) \text{m s}^{-2}$ 1000	B2	Allow any prefix given Allow: 2 marks if all three correct; 1 mark if one is correct or two are correct
	(b)	(volume =) $82 - 75 \text{ (cm}^3\text{)} or 7 \text{ (cm}^3\text{)}$ density = $\frac{1.6 \times 10^{-2}}{7 \times 10^{-6}}$ density = $2.3 \times 10^3 \text{ (kg m}^{-3}\text{)}$	C1 A1	Allow: 1 mark for $2.3 \times 10^n, n \neq 3$
Total			4	

Question		Answer	Marks	Guidance
2	(a)	It has direction (and magnitude/size)	B1	Note: <i>direction</i> must be spelled correctly for the mark
	(b) (i)	perpendicular component = $8.0 \times 10^{-5} \cos 30$ perpendicular component = $6.9 \times 10^{-5} \text{ (N)}$ parallel component = $8.0 \times 10^{-5} \sin 30$ parallel component = $4.0 \times 10^{-5} \text{ (N)}$ or $4 \times 10^{-5} \text{ (N)}$	B1 B1	Allow: 1 mark if the correct numerical values of the components have been swapped Note: Penalise POT error once only; eg 6.9 and 4 respectively scores 1 mark Note: Calculator in radian mode gives 1.23×10^{-5} and $(-)$ $7.90 \times 10^{-5} \text{ (N)}$; this scores 1 mark
	(ii)	$(F =) 4.0 \times 10^{-5} \text{ (N)}$ The net force parallel to windscreen = 0 or F is equal to the parallel component (of the weight down the windscreen) or parallel forces must be equal and opposite or $F = 8.0 \times 10^{-5} \sin 30$	B1 B1	Possible ecf from (b)(i) Allow: Total force down/up the windscreen/slope is zero Not: 'net force = 0' – this is an incomplete answer
Total			5	

- 4 (a) Fig. 4.1 shows the path of a tennis ball after bouncing on the ground at **A** and hitting a vertical wall at **B**.

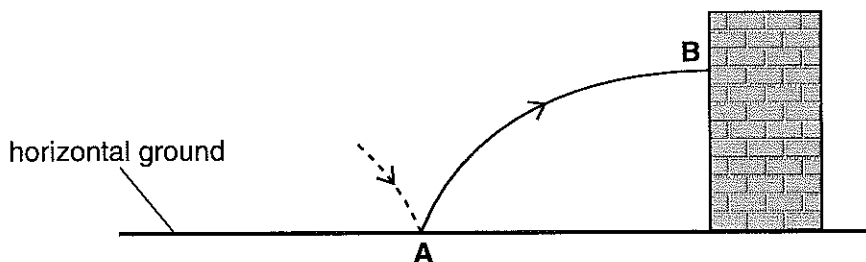


Fig. 4.1

The ball is travelling horizontally as it hits the wall at **B**. Air resistance has negligible effect on the motion of the ball.

- (i) Explain why the horizontal component of the velocity of the ball remains constant as it moves from **A** to **B**.

.....
 [1]

- (ii) The ball loses some of its kinetic energy when it hits the wall at **B**. It leaves the wall horizontally.

- 1 On Fig. 4.1, sketch the path of the ball between bouncing at the wall and hitting the ground.
- 2 Explain how the time taken for the ball to travel from **A** to **B** compares with the time it takes to travel from **B** to the ground.

.....

 [3]

- (b) A student is given a metre rule, a stopwatch and a tennis ball.
 Explain how this equipment can be used to determine an **approximate** value for the acceleration g of free fall.

.....

 [3]

(c) Fig. 4.2 shows a tennis ball moving up a smooth ramp at time $t = 0$.

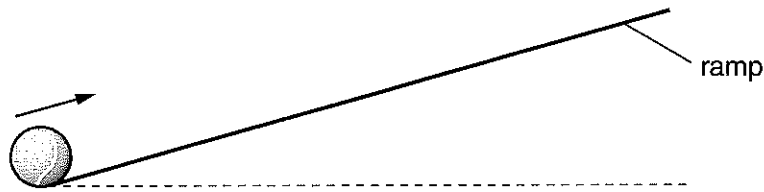


Fig. 4.2

Fig. 4.3 shows a graph of velocity v against time t for this ball.

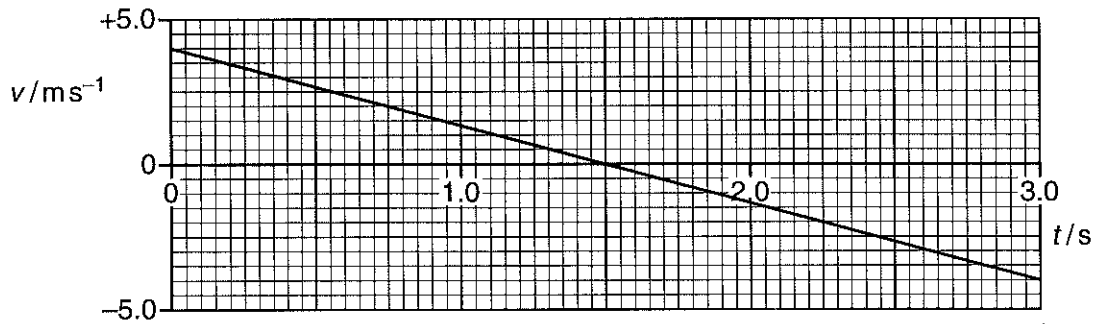


Fig. 4.3

(i) Describe, without calculation, the motion of the ball between $t = 0$ and $t = 3.0$ s.

.....

.....

.....

.....

.....

..... [3]

(ii) Calculate the maximum distance D travelled by the ball up the ramp.

$D =$ m [2]

[Total: 12]

Turn over

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Mark Scheme

June 2014

Question			Answers	Marks	Guidance
4	(a)	(i)	There is only a vertical force / weight is vertical / no horizontal force(s) / acceleration is vertical	B1	Not 'horizontal acceleration is zero' -- since horizontal velocity is constant is given in the question
		(ii)	1 Correct sketch of the rebound path. 2 The time is the same. For both, the height / vertical distance and (vertical) acceleration are the same.	B1 M1 A1	Note: The ball must hit the ground closer to wall. The rebound path should be curved and below the original path. Allow $s = \frac{1}{2}at^2$ with s and a are the same (for both)
	(b)	Drop the ball from a given height and measure time of fall. $s = ut + \frac{1}{2}at^2$ and $u = 0$ or $s = \frac{1}{2}at^2$ (The acceleration of free fall is determined using) $a = 2s/t^2$	B1 B1 B1	Allow $a \equiv g$ and $h \equiv s$ Note: a must be the subject to gain this B1 mark Note: $a = 2s/t^2$ will score the last two B1 marks Allow full credit for graphical approach: Drop ball from different heights & measure the times of fall (B1) ; plot a graph of s against t^2 (B1) ; $g = 2 \times \text{gradient}$ (B1)	
		(c)	(i) <u>Constant</u> deceleration or <u>uniform</u> deceleration or <u>constant negative</u> acceleration or <u>constant</u> rate (of change) of velocity (Momentarily) stops at 1.5 (s) or reaches maximum height at 1.5 (s) Clear idea of returning back. (AW)	B1 B1 B1	Allow <u>constant</u> / <u>uniform</u> acceleration / acceleration is 2.66.. (m s^{-2}) Allow 'constant rate of deceleration or acceleration' Not 'slowing down' Allow: (The ball) goes up and (then) down (the ramp) Not: velocity changes sign or direction changes
	(ii)	distance = $\frac{1}{2} \times 4.0 \times 1.5$ distance = 3.0 (m)	C1 A1	Note: Speed in range 3.0 to 5.0 (m s^{-1}) and $v \neq 4.0$ (m s^{-1}), then possible ecf Allow 1 sf answer Allow full credit for correct use of equation(s) of motion Special case: total distance travelled is calculated; allow 1 mark for an answer of 6.0 (m)	
Total				12	

3 (a) Fig. 3.1 shows the path taken by an aircraft as it flies from **A** to **B**.

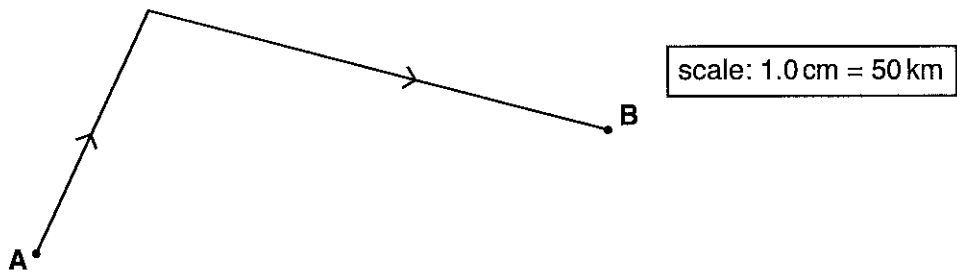


Fig. 3.1

On Fig. 3.1, a distance of 1.0 cm represents a distance of 50 km travelled by the aircraft. The aircraft takes 25 minutes to travel from **A** to **B**.

(i) Use Fig. 3.1 to determine the magnitude of the average velocity of the aircraft as it travels from **A** to **B**.

average velocity = ms^{-1} [3]

(ii) Without doing any calculations, explain why the average speed of the aircraft is not the same as the magnitude of its average velocity.

.....

 [1]

- (b) Io is one of the many moons of Jupiter. It travels at constant speed around Jupiter in a circular orbit of radius 4.2×10^8 m. Io takes 1.5×10^5 s to orbit once around Jupiter.
- (i) Calculate the speed of Io in its orbit.

speed = ms^{-1} [2]

- (ii) Io has several active volcanoes on its surface. One of these volcanoes produces jets of sulphur with a velocity of 1.3 km s^{-1} that rise to 470 km above the volcano.

Calculate the constant acceleration of free fall on the surface of Io.

acceleration = ms^{-2} [3]

Question			Answer	Marks	Guidance
3	a	i	Length from A to B = 8.0 (cm) displacement = 400 (km) or time = 1500 (s) average velocity = $400 \times 10^3 / 1500$ average velocity = $270 \text{ (m s}^{-1}\text{)}$	C1 C1 A1	Allow $\pm 0.1 \text{ cm}$ Possible ecf within the calculation for an incorrect value for length AB. Note no credit if distance is used.
		ii	(The average speed is different because) the <u>distance</u> (travelled) is different / not the same / greater than the <u>displacement</u>	B1	
		b	i	distance = $2 \times \pi \times 4.2 \times 10^8$ speed = $\frac{2 \times \pi \times 4.2 \times 10^8}{1.5 \times 10^5}$ speed = $1.8 \times 10^4 \text{ (m s}^{-1}\text{)}$	C1 A1
		ii	$(0 = u^2 - 2as)$ $(1.3 \times 10^3)^2 = 2 \times a \times 470 \times 10^3$ (Any subject) $a = \frac{(1.3 \times 10^3)^2}{2 \times 470 \times 10^3}$ (a must be the subject) acceleration = $1.8 \text{ (m s}^{-2}\text{)}$	C1 C1 A1	Allow full credit for ' $mgh = \frac{1}{2} mu^2$ ' approach Ignore signs Allow: 2 marks for 1.8×10^0 ; $n \neq 0$
Total				9	

2 (a) *Energy* and *work done* are scalar quantities and have the same unit as each other.

State **two** other scalar quantities in physics that have the same unit as each other.

.....
 [1]

(b) Two forces **A** and **B** act through the same point in an object. These two forces are shown in Fig. 2.1. No other forces act on the object.

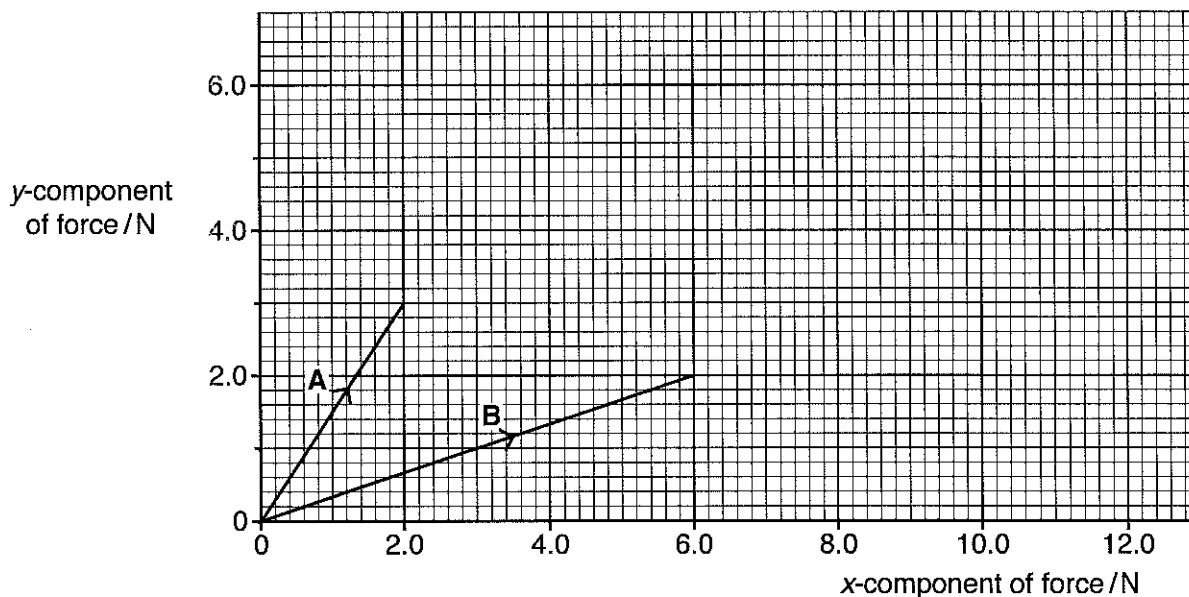


Fig. 2.1

(i) Use Fig. 2.1 to determine the *x*- and *y*- components of the force **B**.

x-component = N

y-component = N

[1]

(ii) Use Fig. 2.1 to determine the magnitude of the resultant of the two forces **A** and **B**.

resultant force = N [3]

(c) Fig. 2.2 shows a jet of water from the end of a hosepipe.

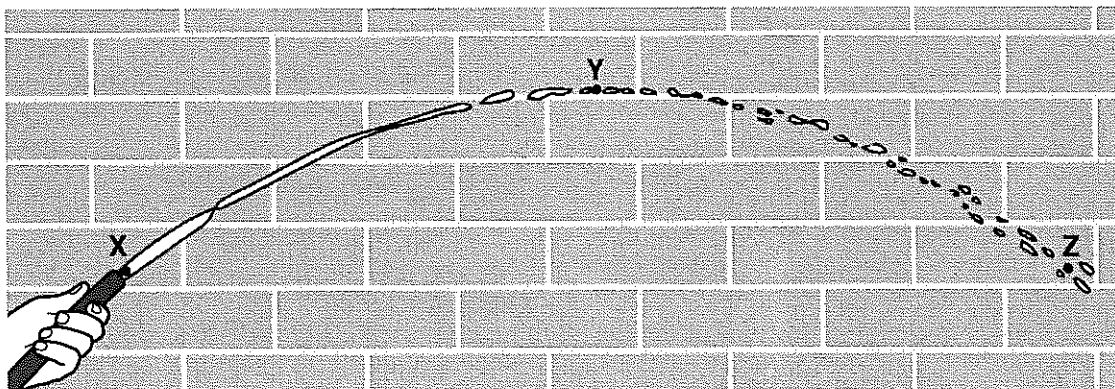


Fig. 2.2

Air resistance has negligible effect on the motion of the water jet. The water jet reaches maximum height at point Y.

(i) State the direction of the force acting on the water at Y.

..... [1]

(ii) Describe and explain how the horizontal component of the velocity of the water varies from point X to point Y.

.....

 [2]

(iii) Describe how the vertical component of the velocity of the water varies from point X to point Z.

.....

 [2]

Question		Answer	Marks	Guidance	
2	a	pressure and stress or pressure and Young modulus or stress and Young modulus or moment (of a force) and torque (of a couple)	B1	<p>Allow other correct combinations</p> <p>Allow the following:</p> <ul style="list-style-type: none"> e.m.f. and p.d. Any two from frequency, activity, decay constant and Hubble constant because of the s^{-1} <p>Ignore any units given (even if incorrect)</p> <p>Special case: Allow quantities with no units, e.g. strain and efficiency.</p> <p>Not any combination of length, distance and extension</p>	
	b	i	x-component = 6.0 (N) and y-component = 2.0 (N)	B1	<p>Allow 1 sf answers</p> <p>Allow tolerance ± 0.1 N</p> <p>Not x-component = 2.0 (N) and y-component = 6.0 (N)</p>
		ii	<p>resultant components are 8.0 (N) and 5.0 (N)</p> <p>$F^2 = 8.0^2 + 5.0^2$ force = 9.4 (N)</p>	<p>C1</p> <p>C1</p> <p>A1</p>	<p>Allow: 1 sf values for this C1 mark</p> <p>Possible ecf from (b)(i) with x-components = 2 + b(i) and y-component = 3 + b(i).</p> <p>Note: Answer is 9.43 to 3sf</p> <p>Not an answer left in square root form, e.g. $\sqrt{89}$</p> <p>Allow full credit for a scale drawing; marks awarded as below:</p> <ul style="list-style-type: none"> A dot / cross / mark at 8.0,5.0 (± 0.1) C1 Line drawn from 0,0 to 8.0,5.0 C1 force = 9.4 ± 0.1 (N) A1
	c	i	Down	B1	Allow a downward arrow on Fig. 2.2

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Mark Scheme

June 2015

Question			Answer	Marks	Guidance
		ii	Horizontal component of the velocity is constant There is no <u>horizontal force</u>	B1 B1	Allow: There is no horizontal <u>acceleration</u> Allow: Weight / g has no horizontal component or Weight / g is 90° to the horizontal or Weight / g is vertical or 'there is <u>only</u> a vertical force' (Not 'gravity' for 'weight'; allow 'force of gravity')
		iii	Any <u>two</u> from: <ul style="list-style-type: none"> • It decreases from X to Y • It is zero at Y / It has the same magnitude at X and Z • It increases from Y to Z • It is positive from X to Y and negative from Y to Z (or vice versa) 	B1 \times 2	Ignore description in terms of acceleration or deceleration Allow it changes sign / direction from X to Z
Total				10	