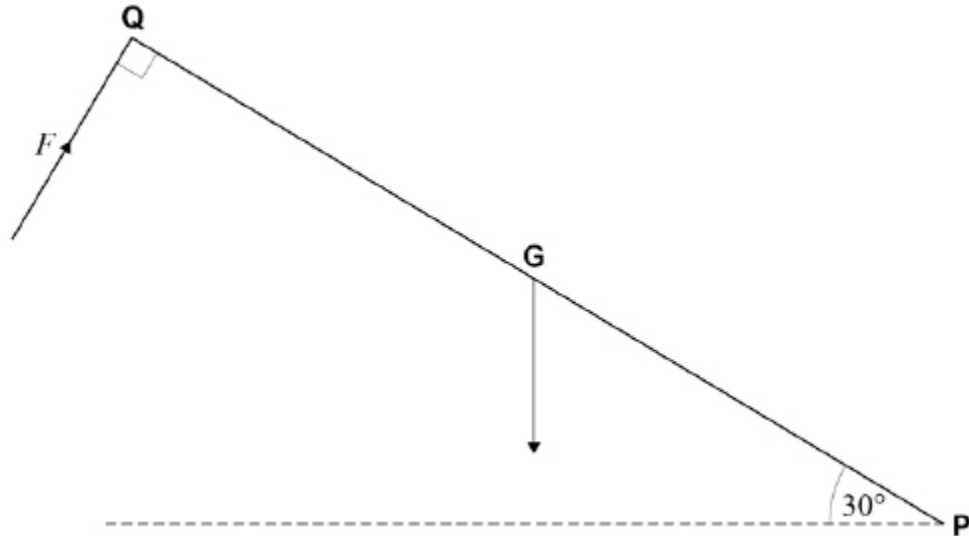


1

A car bonnet, represented by **QP**, of mass 12 kg is pivoted at **P**. Its weight acts at **G** where **QG = GP = 1.0 m**.



What force, F , acting perpendicular to **QP** as shown, is required to hold the bonnet at 30° to the horizontal?

- | | | |
|----------|-------|-----------------------|
| A | 29 N | ☐ |
| B | 51 N | ☐ |
| C | 59 N | ☐ |
| D | 136 N | ☐ |

(Total 1 mark)

2

Which of the following statements is correct?

The force acting on an object is equivalent to

- | | | |
|----------|-------------------------------------|-----------------------|
| A | its change of momentum. | ☐ |
| B | the impulse it receives per second. | ☐ |
| C | the energy it gains per second. | ☐ |
| D | its acceleration per metre. | ☐ |

(Total 1 mark)

3

Two forces of 6 N and 10 N act at a point. Which of the following could **not** be the magnitude of the result?

A 16 N ☐

B 8 N ☐

C 5 N ☐

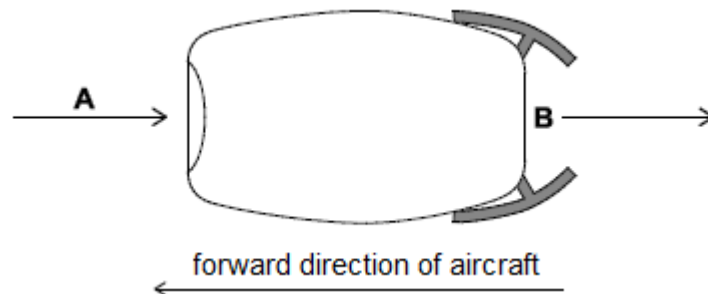
D 3 N ☐

(Total 1 mark)

4

Figure 1 shows a jet engine.

Figure 1



Air enters the engine at **A** and is heated before leaving **B** at a much higher speed.

(a) State what happens to the momentum of the air as it passes through the engine.

(1)

- (b) Explain, using appropriate laws of motion, why the air exerts a force on the engine in the forward direction.

(3)

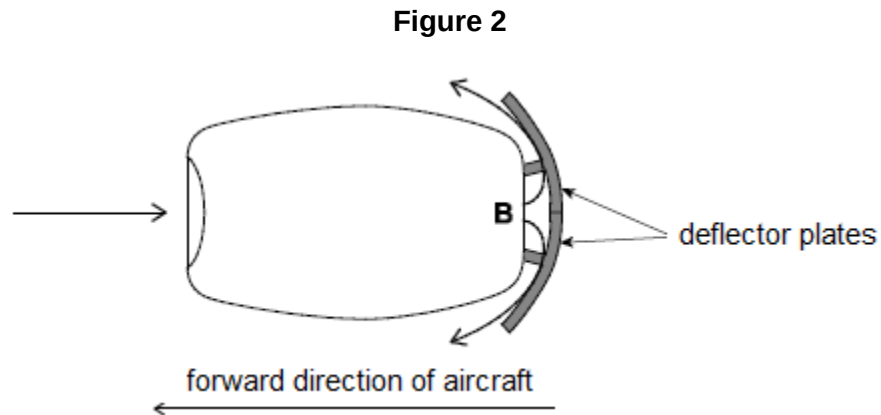
- (c) In one second a mass of 210 kg of air enters at **A**. The speed of this mass of air increases by 570 m s^{-1} as it passes through the engine.

Calculate the force that the air exerts on the engine.

force = _____ N

(1)

- (d) When an aircraft lands, its jet engines exert a decelerating force on the aircraft by making use of deflector plates. These cause the air leaving the engines to be deflected at an angle to the direction the aircraft is travelling as shown in **Figure 2**.



The speed of the air leaving **B** is the same as the speed of the deflected air.

Explain why the momentum of the air changes.

(2)

- (e) The total horizontal decelerating force exerted on the deflector plates of the jet engines is 190 kN.

Calculate the deceleration of the aircraft when it has a mass of 7.0×10^4 kg.

deceleration = _____ m s^{-2}

(1)

- (f) The aircraft lands on the runway travelling at a speed of 68 m s^{-1} with the deflector plates acting.

Calculate the distance the aircraft travels along the runway until it comes to rest. You may assume that the decelerating force acting on the jet engines remains constant.

distance = _____ m

(2)

- (g) Suggest why in practice the decelerating force provided by the deflector plates may not remain constant.

(2)

(Total 12 marks)

5

A deep-space probe travelling forward at constant speed is briefly acted on by a force at right angles to its motion.

What is the effect of this force on the forward speed and sideways speed of this probe?

- | | | |
|----------|---|-----------------------|
| A | its forward speed increases and sideways speed increases | ☐ |
| B | its forward speed decreases and sideways speed increases | ☐ |
| C | its forward speed is unchanged and sideways speed increases | ☐ |
| D | its forward speed decreases and sideways speed is unchanged | ☐ |

(Total 1 mark)

6

In a test a 500 kg car travelling at 10 m s^{-1} hits a wall. The front 0.30 m of the car crumples as the car is brought to rest.

What is the average force on the car during the impact?

A 830 N

☐

B 7500 N

☐

C 8300 N

☐

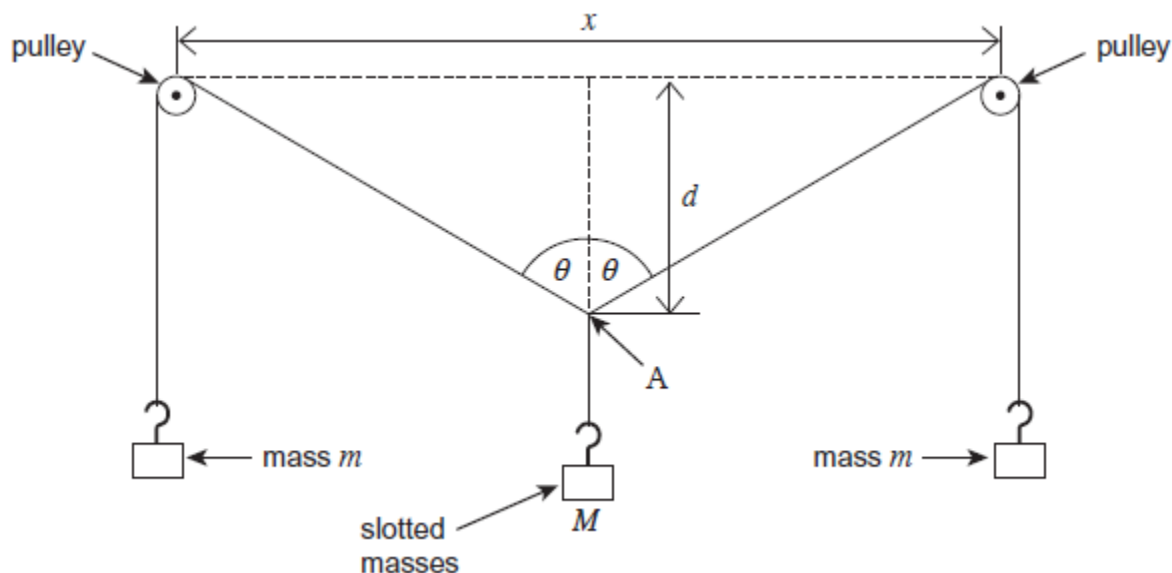
D 83 000 N

☐

(Total 1 mark)

- (a) **Figure 1** shows the arrangement of apparatus in an experiment to investigate the equilibrium of three forces.

Figure 1



The two pulleys are secured in a fixed position at the same height. The centres of the pulleys are separated by a horizontal distance x . Identical masses m are suspended by a continuous string which passes over both pulleys. A third mass M is suspended from the string at point A, equidistant from the pulleys. The strings that pass over the pulleys each make an angle θ to the vertical at point A, as shown in **Figure 1**.

When the forces are in equilibrium the vertical distance d is measured. Mass M is varied and the system is allowed to come into equilibrium. For each M , the corresponding distance d is measured.

The results are shown in the table below.

M / kg	d / m	$\frac{d}{\sqrt{d^2 + \frac{x^2}{4}}}$
0.100	0.035	0.087
0.200	0.066	0.163
0.300	0.105	0.254
0.400	0.139	0.328
0.500	0.183	
0.600	0.228	

(i) Given that $x = 0.800$ m, complete the table above.

(1)

(ii) Complete the graph in **Figure 2** by plotting the two remaining points and drawing a best fit straight line.

(2)

(iii) Determine the gradient of the graph in **Figure 2**.

gradient = _____

(3)

- (iv) (1) Consider the forces that act at point A in **Figure 1**. By resolving these forces vertically, show that $M = 2m \cos \theta$.

Figure 2



(1)

- (2) Express $\cos\theta$ in terms of d and x and hence show that the gradient of the graph is equal to $\frac{1}{2m}$.

(2)

- (3) Determine the value of m using your value for the gradient from (iii).

$$m = \underline{\hspace{2cm}}$$

(2)

- (v) A student obtains different results for d when M is increased compared with those obtained when M is decreased.

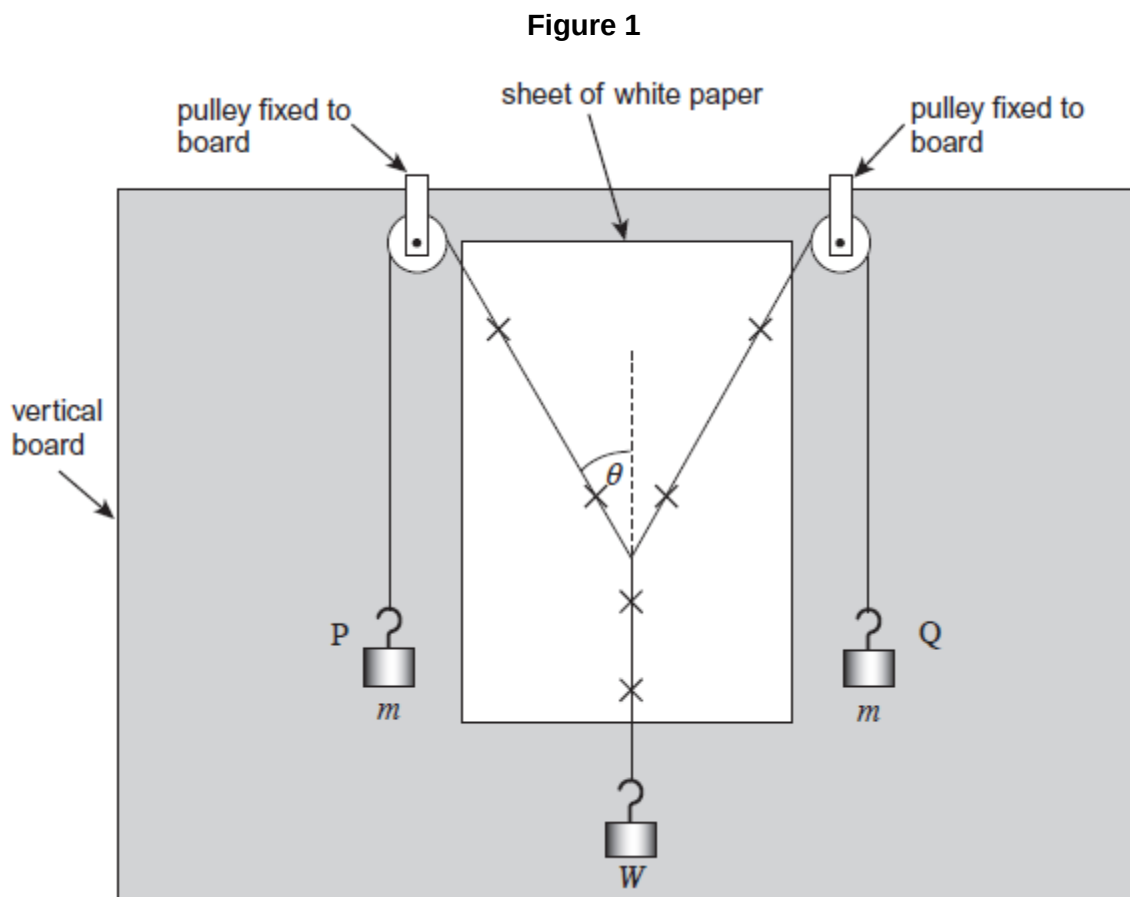
- (1) Suggest why these two sets of results do not agree.

(1)

- (2) State what the student should do with the results to take account of this problem.

(1)

- (b) An arrangement for investigating the equilibrium of forces is shown in **Figure 1**.



In the arrangement shown in **Figure 1**, P and Q are identical masses of mass m . A student uses this arrangement to investigate the relationship between m and θ when the system of forces is in equilibrium. Weight W is constant. The student performs the investigation by marking the position of the strings when the forces are in equilibrium for different values of m . He does this by marking crosses on the sheet of white paper.

- (i) The string is about 10 mm from the paper. Describe and explain a technique to mark accurately the string positions on the paper.

(ii) The crosses on the paper are used to determine the directions of the strings. The results are shown full scale in **Figure 2**.

- (1) Use **Figure 2** and your protractor to measure θ as accurately as possible and calculate the percentage uncertainty in your answer. State the precision of the protractor you used.

precision of protractor = _____

$\theta =$ _____

percentage uncertainty = _____ %

(3)

- (2) Use **Figure 2** and a ruler to determine θ using trigonometry. Show on **Figure 2** the measurements you make.

$\theta =$ _____

(2)

(iii) Theory suggests that $W = 2mg \cos\theta$.

The student produces a set of results for different values of m and the corresponding values of θ .

Suggest and explain a graphical way of testing this relationship between m and θ .

Figure 2

×

×

×

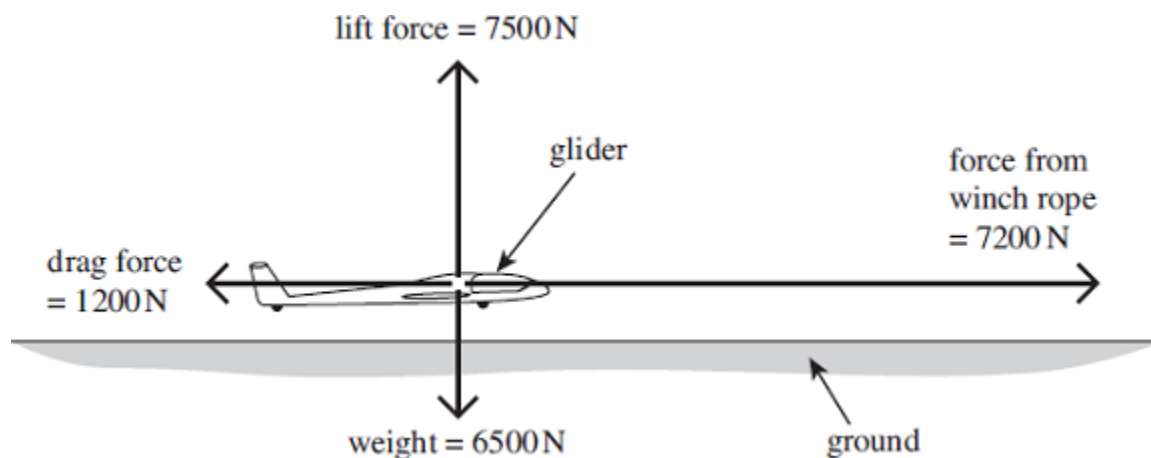
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×

×

8

Gliders can be launched with a winch situated on the ground. The winch pulls a rope that is attached to the glider. The diagram below shows the forces acting on the glider at one instant during the launch.



- (a) The combined weight of the glider and pilot is 6500 N.
- (i) Show that the magnitude of the resultant force acting on the glider is about 6100 N.

(2)

- (ii) Calculate the angle between this resultant force and the horizontal.

angle _____ degrees

(2)

- (iii) Calculate the resultant acceleration of the glider in the diagram above.

resultant acceleration _____ m s^{-2}

(2)

- (b) The glider climbs a vertical distance of 600 m in 55 s. The average power input to the winch motor during the launch is 320 kW.

- (i) Calculate the gain in gravitational potential energy (gpe) of the glider.

gain in gpe _____ J

(2)

- (ii) Calculate the percentage efficiency of the winch system used to launch the glider. Assume the kinetic energy of the glider after the launch is negligible.

efficiency _____ %

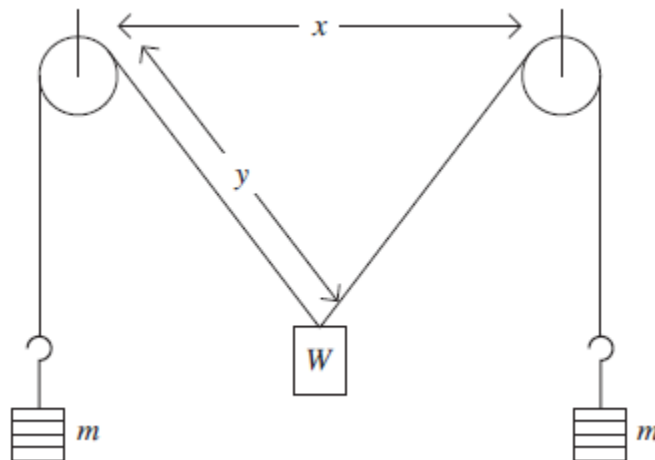
(3)

(Total 11 marks)

9

In an experiment an unknown load, of weight, W , was supported by two strings kept in tension by equal masses, m , hung from their free ends, with each string passing over a frictionless pulley. The arrangement was symmetrical and is shown in **Figure 1**.

Figure 1

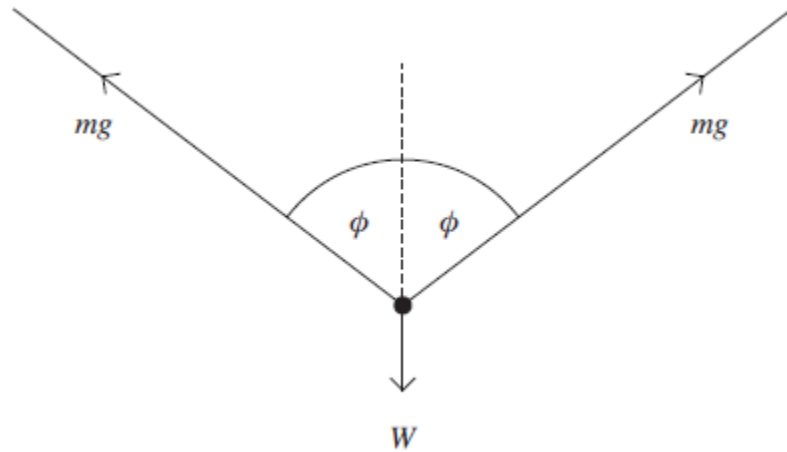


The distance x was kept constant throughout the experiment. The length y was measured for different values of m .

The distance between the strings at the pulleys, $x = 0.500\text{m}$

- (a) **Figure 2** shows the three forces acting through the point at which the strings are attached to the load. The weight of the load is W and the tension in each string is mg , where g is gravitational field strength.

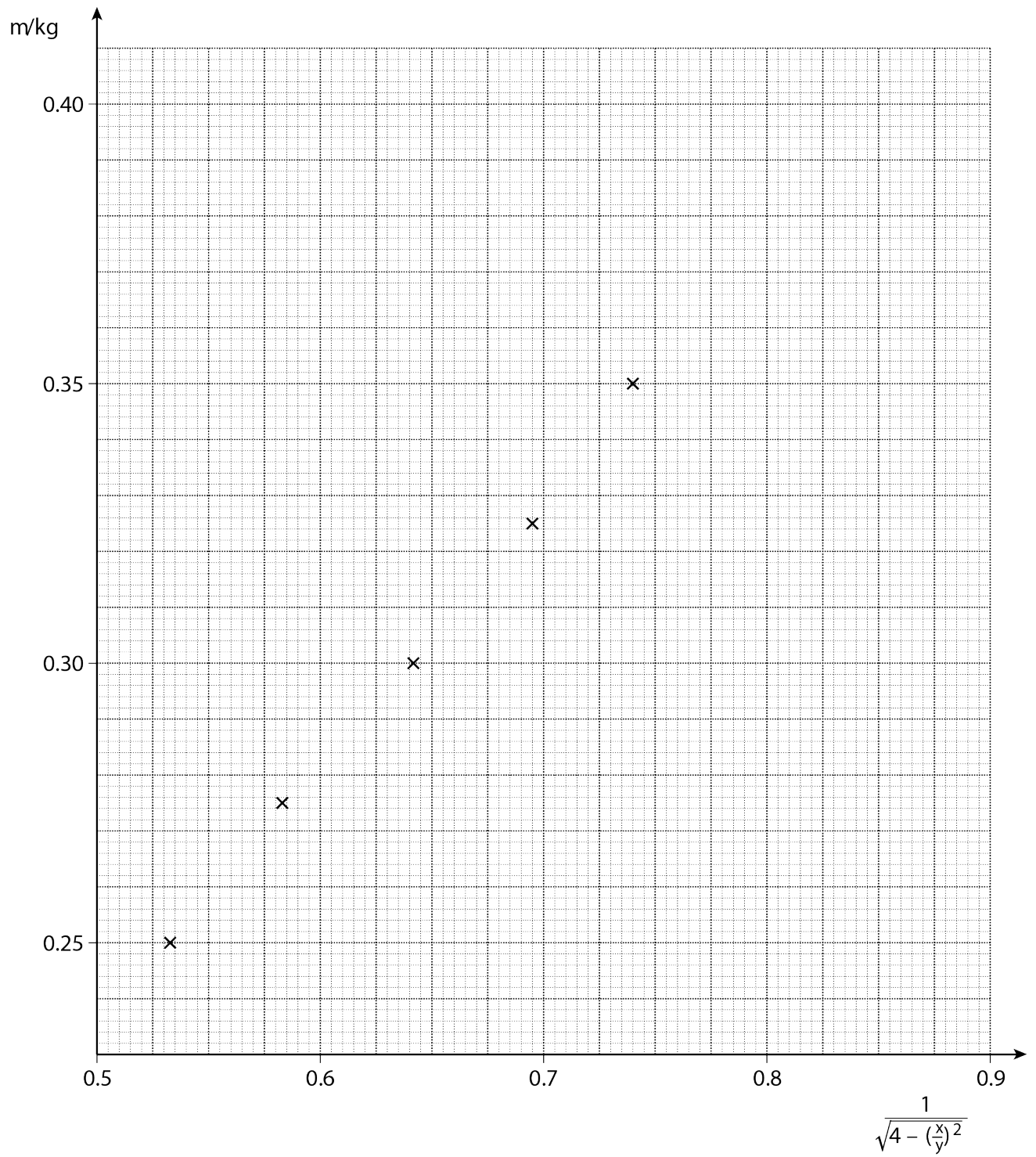
Figure 2



- (i) By resolving the forces vertically show that $m = \frac{W}{2g \cos \phi}$
where ϕ is the angle between each string and the vertical.

(1)

(ii) Draw the line of best fit through the points plotted on the graph.



(1)

- (b) (i) Determine the gradient of your graph.

(3)

- (ii) The equation for the straight line is $m = \frac{W}{g} \times \frac{1}{\sqrt{4 - \left(\frac{x}{y}\right)^2}}$
- Given that $g = 9.81 \text{ N kg}^{-1}$, determine a value for W .

(2)

- (c) When m was 0.300 kg, y was 0.400 m.

Calculate the percentage uncertainty in $\left(\frac{x}{y}\right)^2$ for $m = 0.300 \text{ kg}$.

(3)

- (d) (i) Explain the term *systematic error*.

(1)

- (ii) In practice, there may be a systematic error in this experiment because of friction in the pulleys.

When the measurements were taken, increasing values of m were used. State and explain how friction in the pulleys would have affected the measured values of y .

(2)

(Total 13 marks)

10

- (a) (i) State **two** vector quantities.

vector quantity 1 _____

vector quantity 2 _____

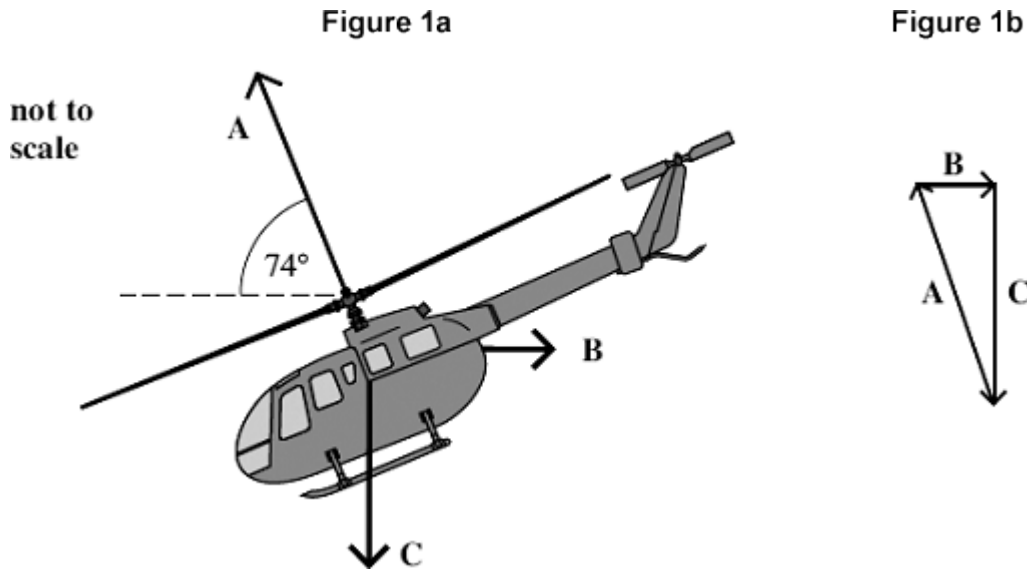
- (ii) State **two** scalar quantities.

scalar quantity 1 _____

scalar quantity 2 _____

(2)

- (b) The helicopter shown in **Figure 1a** is moving horizontally through still air. The lift force from the helicopter's blades is labelled **A**.



- (i) Name the two forces **B** and **C** that also act on the helicopter.

B _____

C _____

(2)

- (ii) The force vectors are also shown arranged as a triangle in **Figure 1b**.

State and explain how **Figure 1b** shows that the helicopter is moving at a constant velocity.

(2)

- (c) The lift force, **A**, is 9.5 kN and acts at an angle of 74° to the horizontal.

Calculate the weight of the helicopter. Give your answer to an appropriate number of significant figures.

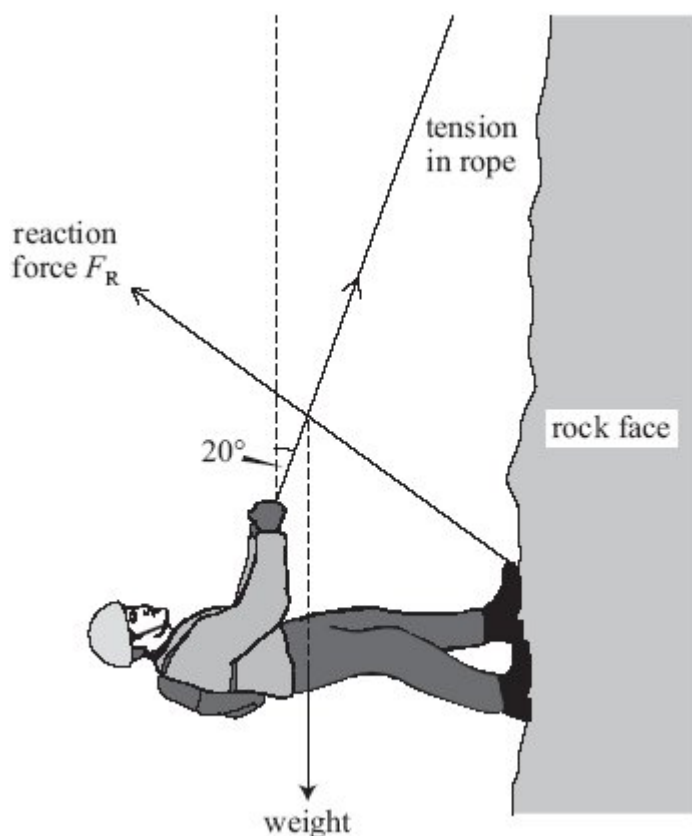
answer = _____ N

(3)

(Total 9 marks)

11

The diagram below shows a rock climber abseiling down a rock face. At the instant shown the climber is stationary and in equilibrium. The forces acting on the climber are shown in the diagram below.



The tension in the rope is 610 N and it acts at 20° to the vertical.
The weight of the climber is 590 N.

Calculate the vertical component of the reaction force, F_R , between the feet of the climber and the rock.

vertical component _____ N

(Total 3 marks)

In the leisure pursuit called parascending a person attached to a parachute is towed by a towrope attached to a motor boat as shown in **Figure 1**.

Figure 1

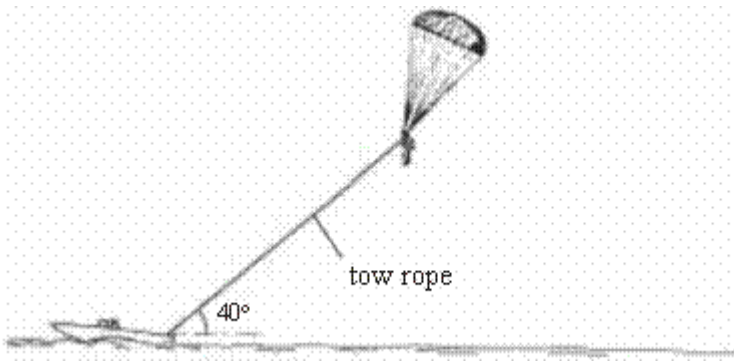


Figure 2

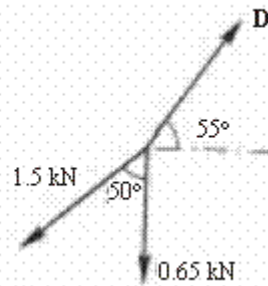


Figure 2 shows the directions of the forces acting on a person of weight 0.65 kN when being towed horizontally at a constant speed of 8.5 m s^{-1} .

The tension in the tow rope is 1.5 kN and D is resultant force exerted by the parachute on the parascender.

- (a) (i) State why the resultant force on the parascender must be zero.

- (ii) Calculate the magnitude of D .

magnitude of _____ kN

(4)

- (b) (i) Calculate the horizontal resistance to motion of the boat produced by the tow rope.

resistance _____ kN

- (ii) The horizontal resistance to the motion of the boat produced by the water is 1200 N . Calculate the total power developed by the boat.

power _____

(5)

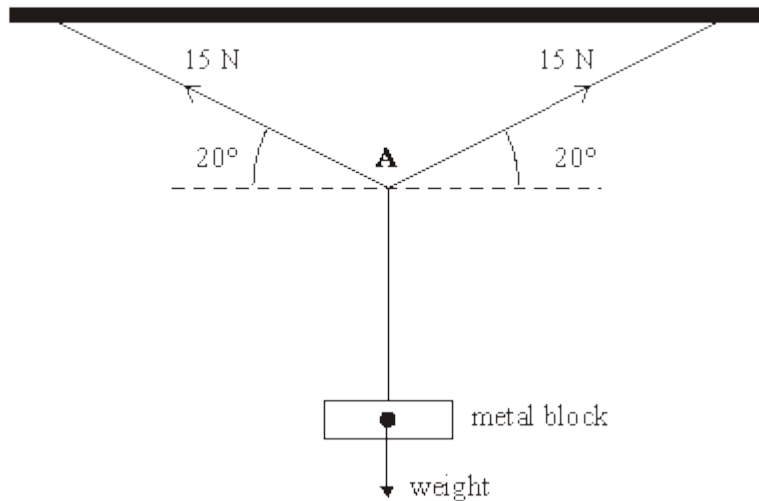
- (c) State and explain the initial effect on the boat if the tow rope were to break.

(2)

(Total 11 marks)

13

The figure below shows a stationary metal block hanging from the middle of a stretched wire which is suspended from a horizontal beam. The tension in each half of the wire is 15 N.



(a) Calculate for the wire at **A**,

(i) the resultant horizontal component of the tension forces,

(ii) the resultant vertical component of the tension forces.

(3)

(b) (i) State the weight of the metal block.

(ii) Explain how you arrived at your answer, with reference to an appropriate law of motion.

(3)

(Total 6 marks)

14

- (a) (i) State what is meant by a scalar quantity.

- (ii) State **two** examples of scalar quantities.

example 1: _____

example 2: _____

(3)

- (b) An object is acted upon by two forces at right angles to each other. One of the forces has a magnitude of 5.0 N and the resultant force produced on the object is 9.5 N.
Determine

- (i) the magnitude of the other force,

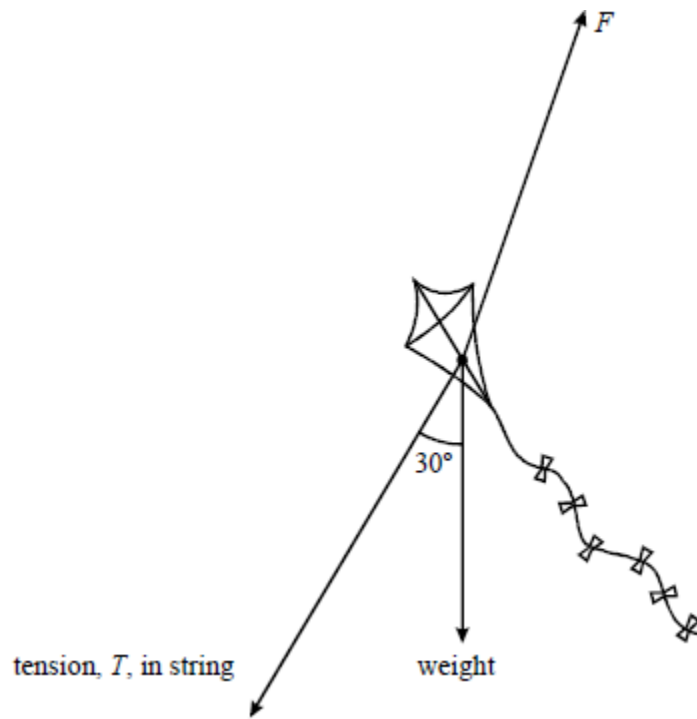
- (ii) the angle between the resultant force and the 5.0 N force.

(4)

(Total 7 marks)

15

The diagram shows the forces acting on a stationary kite. The force F is the force that the air exerts on the kite.



- (a) Show on the diagram how force F can be resolved into horizontal and vertical components. (2)

- (b) The magnitude of the tension, T , is 25 N.

Calculate

- (i) the horizontal component of the tension,

- (ii) the vertical component of the tension.

(2)

- (c) (i) Calculate the magnitude of the vertical component of F when the weight of the kite is 2.5 N.

- (ii) State the magnitude of the horizontal component of F .

- (iii) Hence calculate the magnitude of F .

(4)

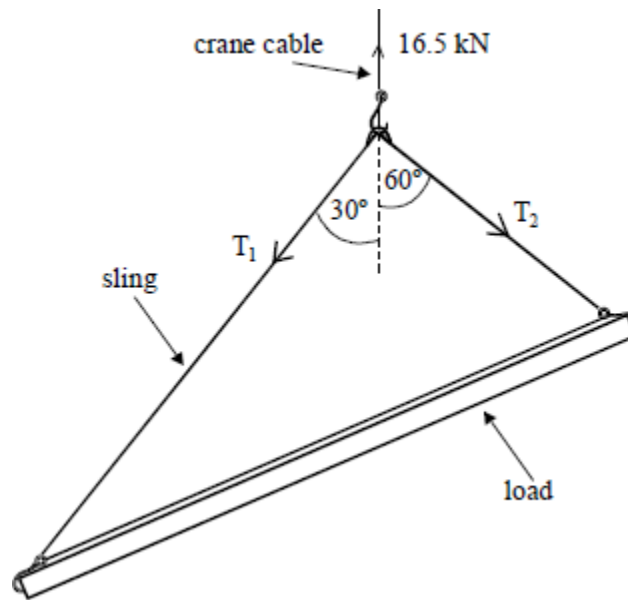
(Total 8 marks)

16

- (a) State the condition necessary for the equilibrium of three coplanar forces acting at a point.

(1)

- (b) The diagram shows a crane hook in equilibrium under the action of a vertical force of 16.5 kN in the crane cable and tension forces T_1 and T_2 in the sling.



Find the tension forces T_1 and T_2 acting in the sling. You may **either** calculate these forces **or** find them by scale drawing. In either case you should show your method clearly.

$$T_1 = \underline{\hspace{2cm}}$$

$$T_2 = \underline{\hspace{2cm}}$$

(4)

(Total 5 marks)

1	B		[1]
2	B		[1]
3	D		[1]
4	(a)	(momentum of air) increases ✓ <i>words implying increase</i>	1
	(b)	(rate of change of momentum so) <u>force</u> acting <u>on</u> the <u>air</u> (Newton 2) ✓ <u>it/air</u> exerts <u>force</u> (on engine) of the <u>same/equal magnitude/size</u> ✓ but <u>opposite</u> in direction (Newton 3) ✓ <i>allow backwards and forwards to indicate opposite</i>	1 1 1 1
	(c)	<i>(use of $F = \Delta mv/t$)</i> $F = 210 \times 570 = 120\,000 \text{ (N)}$ (119 700) ✓	1
	(d)	momentum/velocity is a vector OR momentum/velocity has direction ✓ there is a change (in the air's) <u>direction</u> ✓	1 1
	(e)	<i>(use of $F = ma$)</i> $a = (-) 190\,000 / 7.0 \times 10^4 = 2.7 \text{ (2.71)} \text{ (m s}^{-2}\text{)} \checkmark$	1
	(f)	<i>(use of $v^2 = u^2 + 2as$)</i> <i>CE from 01.5</i> <i>accept range 850 – 860</i> <i>if forget to square u or double a score 1 mark</i>	1
		$0 = 68^2 - 2 \times 2.7 \times s \checkmark$ $s = 68^2 / (2 \times 2.7) = 860 \text{ (m)}$ (856) <i>accept alternatives using $s = ut + 1/2at^2$ OR average speed – first mark for time calculation AND correct substitution</i>	1

- (g) rate of intake of air decreases (as plane slows) OR volume/mass /amount of air (passing through engine) per second decreases ✓
allow argument in terms of (air) resistance
(air) resistance decreases as speed of aircraft decreases for 1 mark

1

- (as) smaller rate of change of momentum OR momentum change ✓
 NOT FRICTION

1

[12]

5

C

[1]

6

D

[1]

7

- (a) (i) 0.416 or 0.417 and 0.495 or 0.496

1

- (ii) Both plotted points to nearest mm✓
 Straight line of best fit ✓
The line should be a straight line with approximately an equal number of points on either side of the line.

2

- (iii) Large triangle drawn (at least 8cmx8cm) ✓

Correct values read from graph✓

Gradient value in range 0.805 to 0.837 to 2 or 3 sf✓

3

- (iv) (1) For showing correct vertical component of at least one of the forces / tensions as $mg\cos\theta$ or both vertical components as $2mg\cos\theta$
 Question specifically referred to resolving forces so component must include g .✓

1

$$(2) \quad \cos\theta = \frac{d}{\text{hypotenuse}} = \frac{d}{\sqrt{d^2 + (x^2/4)}} \quad \checkmark$$

$$\frac{d}{\sqrt{d^2 + (x^2/4)}} = \frac{M}{2m} \quad \text{compared to } y = mx \quad \checkmark$$

(Hence gradient is $\frac{1}{2m}$)

2

- (3) Magnitude of m correct from
E.g middle gradient value gives $m = 0.609 \text{ kg}$

1

$2 \times$ their gradient from (c) ✓ kg and 2 or 3 sf ✓

Allow ecf from gradient value.

Sf and unit mark depends on correct calculation of m from the gradient value.

2

- (v) (1) Friction at the pulleys ✓

1

- (2) Take a mean value of readings from loading and unloading ✓

1

- (b) (i) Description of technique:

Use small plane mirror beneath string / use of set square / bright light source to project shadow of the strings onto the paper, and marking points on shadow to aid drawing lines ✓

Explanation:

Line of sight not perpendicular from string to paper / mark on paper depends on the angle the eye is positioned at / reference to parallax error. ✓

2

Markers should measure the angle to check that no scaling error has been introduced in the photocopying of the paper. If the angle is different, mark accordingly.

Answers should be consistent with protractor precision stated by the candidate.

- (ii) (1) Value of θ quoted as 30° or 31° (for a protractor with precision $\pm 1^\circ$)
 OR
 $\theta = 30.0, 30.5, 31.0$
 (for a protractor with precision $\pm 0.5^\circ$) ✓

Correct computation of % uncertainty, answer quoted to 2 or 1sf ✓

Allow ecf for incorrect angle (penalised in 1st marking point). (e.g. if using a protractor with 1° precision % uncertainty will be $1/31 \times 100\% = 3.2\%$ or 3% OR for candidates who measured the angle 2θ % uncertainty = $1/62 \times 100 = 1.6\%$ or 2% . With a protractor with precision $\pm 0.5^\circ$ the % uncertainties will be half these values)

This is because the question specifically stated "as accurately as possible". It should be clear from the candidate's percentage uncertainty calculation whether 2θ or θ has been measured.

Extra mark for a candidate who measures the angle 2θ (rather than just the single angle θ) ✓

(This 3rd mark can also be awarded for a candidate who has measured θ on both sides of the 'vertical line', and taken the mean value)

3

- (2) Evidence of right angled triangle drawn on to the diagram with dimensions of two sides also shown on the diagram. The minimum dimension shown must be 70mm. ✓

Correct use of cosine rule without right angled triangle is acceptable.

Angle correctly computed using sine cosine or tangent, with value quoted in the range 30.0° to 31.4° ✓

Angle quoted to 3 sf/to 0.1°

2nd mark is still available to a candidate who didn't achieve the 1st mark.

2

- (iii) Plot a graph of $\cos \theta$ against $1/m$
AND

Statement that it should give a straight line through origin. ✓

*Allow graphs of $1/m$ **against** $\cos \theta$, against $1/\cos \theta$ against m , which would all be straight lines through the origin.*

1

[21]

8

- (a) (i) 1000(N) AND 6000(N) seen
Independent marks

OR

$$F = \sqrt{(1000)^2 + (6000)^2} \quad \checkmark \text{ allow incorrect values seen}$$

$$= 6083 \text{ (N) } (= 6100) \quad \checkmark \text{ More than 2 sf seen}$$

Allow full credit for appropriate scale drawing

Ignore rounding errors in 3rd sig fig.

2

- (ii) $\tan \theta = 1000 / 6000$ or correct use of sin or cos ✓

$$\theta = 9.5 \text{ (} 9.46^\circ \text{)} \quad \checkmark$$

Allow range 9.4 – 10.4

Use of cos yields 10.4

Allow use of 6100

Some working required for 2 marks.

Max 1 mark for correct calculation of vertical angle (range 79.6° – 80.6°) some working must be seen

2

- (iii) ($m = W/g =$) $6500 / 9.81$ (= 662.6 kg) ✓

$$(a = F / m = 6083 / 662.6)$$

$$= 9.2 \text{ (ms}^{-2}\text{)} \quad \checkmark \text{ (} 9.180 \text{)}$$

Use of weight rather than mass gets zero

Correct answer on its own gets 2 marks

Penalise use of $g=10$ in this question part only (max 1)

2

- (b) (i) $= 6500 \times 600 \checkmark (662.6 \times 9.81 \times 600)$
 $= 3\,900\,000 \checkmark (J)$
Look out for $W \times g \times h$ which gives 39000000 (gets zero)
Correct answer on its own gets 2 marks
Do not allow use of $1/2 mv^2 (= 39\,000)$

2

- (ii) $(E = Pt =) 320\,000 \times 55 (= 17\,600\,000 \text{ J})$
OR $P = 1(b)(i) / 55 (7.09 \times 10^4) \checkmark$
 $3.9 / 17.6 \text{ OR } 70.9 / 320 \text{ OR } = 0.22(16) \checkmark$ ecf from first line
Some valid working required for 3 marks

conversion to a percentage $(= 22\%) \checkmark$

Look out for physics error: Power / time $(320/55)$ then use of inverted efficiency equation yielding correct answer
Do not allow percentages $\geq 100\%$ for third mark

3

[11]

9

- (a) (i) $W = 2mg \cos\phi \quad \therefore m = W/(2g \cos\phi) \checkmark$
The question says show that, so the candidates must write down both steps.

1

- (ii) Well drawn straight line of best fit. $\checkmark$
The line should follow the trend of the points with an even scatter of points on either side of the line.

1

- (b) (i) Triangle drawn with smallest side at least 8 cm in length. $\checkmark$
 Correct readings taken from the line for the triangle $\checkmark$
 Gradient in the range 0.45 to 0.49 (0.445 to 0.494) quoted to 2 or 3 significant figures $\checkmark$

The size of the triangle can be identified from readings taken from the line.

The third mark is independent of the other two: error carried forward for incorrect readings (or for a poor line of best fit) which give a gradient out of range is not allowed.

3

- (ii) Candidate's answer for gradient in (b)(i) correctly multiplied by g (expected answer 4.6) $\checkmark$
 N $\checkmark$

No s.f. penalty.

The second mark is for the unit and can be awarded if the numerical answer is incorrect.

2

(c) $\delta x\% = 0.2$ and $\delta y\% = 0.5$ ✓

$\delta(x/y)\% = \delta x\% + \delta y\% = 0.2 + 0.5 = 0.7$ ✓

Use of $\delta(x/y)^2\% = 2 \times \delta(x/y)(\%)$ ✓

Final answer is $(\pm) 1.4$ (%) which automatically gains all three marks

Otherwise

Accept only 1 s.f. for 1st and/or 2nd marks.

The third mark is for the method, not the final answer

3

- (d) (i) Systematic errors in measurements are errors which show a pattern or a bias or a trend ✓

Some acceptable alternatives

- **A systematic error** is one which deviates by a fixed amount from the true value of a measurement
- An error which has the same value in all readings
- A difference between the true value of a quantity and the indicated value caused by a fault in the measuring device
- Accept a good example of systematic error.

1

- (ii) y would be larger ✓

because angle θ would be smaller

or

because friction would be opposing the increasing weight of m ✓

2

[13]

10

- (a) (i) two from: velocity, acceleration, force etc ✓

1

- (ii) two from: speed, distance, mass etc ✓

1

- (b) (i) B: drag / air resistance ✓

C: weight ✓

2

- (ii) closed triangle (of vectors) ✓

so forces are in **equilibrium** / **resultant force is zero** / **forces balance**
(so moving at constant velocity) ✓

2

(c) $W = 9500 \sin 74$ ✓

$= 9100$ ✓ (9132)

2 sf ✓

3

[9]

11

vertical component of rope = $610 \times \cos(20)$ or 573(N)

C1

610 cos 20 seen in an equation

(vertical component of resultant) = $590 - 573$ or their F_v

C1

16.8 or 17(N) cao

A1

[3]**12**

(a) (i) velocity is constant **(1)**

no acceleration **(1)**

(ii) $1.5 \sin 50 = D \cos 55$ **(1)**

2.0 kN **(1)**

4

(b) (i) 1.15 kN **(1)**

(ii) total resistance to motion = $1200 + 1150$ N **(1)**

use of power = Fv **(1)**

20 **(1)**

kW **(1)**

5

(c) boat now has resultant force of 1200 N acting on it **(1)**

boat will accelerate (until resistance of water = 2350 N) **(1)**

2

[11]**13**

(a) (i) (horizontal) force = zero **(1)**

(ii) (vertical) force = $2 \times 15 \sin 20$ **(1)**

= 10(.3) N **(1)**

3

(b) (i) weight (of block) = 10(.3) N **(1)**

(allow C.E. for value from (a) (ii))

(ii) resultant force must be zero **(1)**

with reference to an appropriate law of motion **(1)**

3

[6]

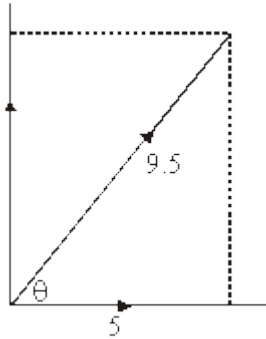
14

(a) (i) a quantity that has magnitude only
[or has no direction] **(1)**

(ii) any two: e.g. energy **(1)**
temperature **(1)**

3

(b) (i)



scale **(1)**

5 N and 9.5 N **(1)**

correct answer (8.1 N $\pm$ 0.2 N) **(1)**

[or $9.5^2 = 5.0^2 + F^2$ **(1)**

$F^2 = 90.3 - 25$ **(1)**

$F = 8.1$ N **(1)** (8.07 N)]

(ii) $\cos \theta = \frac{5.0}{9.5}$

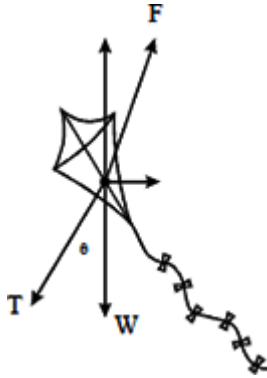
gives $\theta = 58^\circ$ **(1)** ($\pm 2^\circ$ if taken from scale diagram)

4

[7]

15

(a)



components at right angles **(1)**
vertical component in line with the weight **(1)**
vertical components to start from the •

2

(b) (i) (horizontal component) = $25 \sin \theta = 12$ (or 13) N (12.5) **(1)**
(± 0.5 N if scale drawing)

(ii) (vertical component) = $25 \cos \theta = 22$ N (21.7) **(1)**
(± 0.5 N if scale drawing)

2

(c) (i) vertical component of $F = 21.7 + 2.5 = 24$ N (24.2)
[or 25 (24.5)] **(1)** (allow C.E. from (b))

(ii) horizontal component of $F = 12$ (or 13) N **(1)** (12.5) (allow C.E. from (b))

(iii) $F = \sqrt{12.5^2 + 24.2^2}$ **(1)** (allow C.E. from parts (i) and (ii))
 $= 27$ N (27.2) [or 28 (28.2)] **(1)** (26 N to 29 N if scale drawing)

[if θ measured on diagram and $F \cos \theta$ used, (1) (1) (same tolerance)]

4

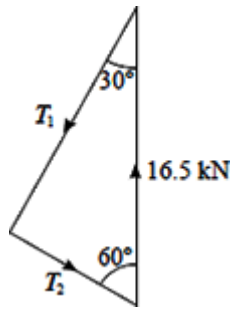
[8]

16

(a) resultant force = zero
(or the forces can be represented in magnitude and direction by the three sides of a triangle taken in order) **(1)**

(1)

(b)



scale drawing:

sensible scale used and stated **(1)**

arrows shown correctly **(1)**

one length measurement correctly stated **(1)**

both scale conversions correct to give $T_1 = 14$ kN, $T_2 = 8$ kN **(1)**

[or by calculation: $T_1 = 16.5 \sin 60$ **(1)** 14.3 kN **(1)**

$$T_2 = 16.5 \cos 60 \text{ **(1)** } \quad 8.3 \text{ kN **(1)** }$$

[or by resolving forces vertically and horizontally:

$$T_1 \sin 30 = T_2 \sin 60 \text{ **(1)** }$$

$$T_1 \cos 30 + T_2 \cos 60 = 16.5 \text{ (kN) **(1)** }$$

gives $T_1 = 14.3$ kN **(1)** and $T_2 = 8.3$ kN **(1)**

(4)

[5]