



Mark Scheme (Results)

January 2013

GCE Physics (6PH01) Paper 01

Physics On The Go

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

## Physics Specific Marking Guidance

### Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

Horizontal force of hinge on table top 66.3 (N) or 66 (N) **and** correct indication of direction [no ue]

[Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

### Mark scheme format

- Bold lower case will be used for emphasis.
- Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
- Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

### Unit error penalties

- A separate mark is not usually given for a unit but a missing or incorrect unit will normally cause the final calculation mark to be lost.
- Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.
- There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given.
- The same missing or incorrect unit will not be penalised more than once within one question but may be penalised again in another question.
- Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.
- The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

### Significant figures

- Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.
- Use of an inappropriate number of significant figures will normally be penalised in the practical examinations or coursework.
- Using  $g = 10 \text{ m s}^{-2}$  **will** be penalised.

### Calculations

- Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
- Rounding errors will not be penalised.
- If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.
- use of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.
- recall of the correct formula will be awarded when the formula is seen or implied by substitution.
- The mark scheme will show a correctly worked answer for illustration only.

Question Number	Answer	Mark
<b>1</b>	A	<b>1</b>
<b>2</b>	A	<b>1</b>
<b>3</b>	D	<b>1</b>
<b>4</b>	B	<b>1</b>
<b>5</b>	A	<b>1</b>
<b>6</b>	C	<b>1</b>
<b>7</b>	A	<b>1</b>
<b>8</b>	C	<b>1</b>
<b>9</b>	D	<b>1</b>
<b>10</b>	D	<b>1</b>

Question Number	Answer	Mark
<b>11</b>	<p>Statement describing the relationship between viscosity and temperature. e.g. Viscosity increases with decreasing temperature <b>Or</b> viscosity decrease with increasing temperature <b>Or</b> viscosity is inversely proportional to temperature</p> <p>Statement describing either what happens between the oil and the (engine) parts when it gets too hot or too cold e.g. If too cold, the oil could be too viscous/thick to spread sufficiently <b>Or</b> if too hot, the oil would run off <b>Or</b> if too hot oil would not stick to parts</p>	<p>(1)</p> <p>(1)</p> <p><b>2</b></p>
<b>Total for question 11</b>		<b>2</b>

Question Number	Answer		Mark
12*	<p><b>(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)</b></p> <p><b>Max 4</b></p> <p>Most metals are both malleable and ductile</p> <p>Malleable materials <b>Or</b> lead: will undergoes plastic/permanent deformation/behaviour of significant extent <b>Or</b> under small stress <b>Or</b> reference to ‘a lot of’ <b>Or</b> reference to ‘large(amount of)’</p> <p>under compressive force <b>Or</b> under compressive stress <b>Or</b> under compression <b>Or</b> when compressed <b>Or</b> can be hammered into shape <b>Or</b> rolled into sheets</p> <p>Lead can’t be drawn into wires <b>Or</b> Lead will not deform plastically under tension <b>Or</b> lead will not deform plastically under a tensile force/stress (MP5 may be implied with MP4 e.g. under compression but not under tension)</p>	<p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p> <p>(1)</p>	<p>4</p>
	<b>Total for question 12</b>		<b>4</b>

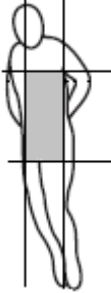
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13 (a) (i)	<p>Each <b>row</b> of the table contains a suitable method. One mark for each column, do not allow a mix and match of methods (rows)</p> <table border="1" data-bbox="260 315 1315 1487"> <thead> <tr> <th data-bbox="260 315 496 454"><b>Distance measured with the metre rule</b></th> <th data-bbox="496 315 788 454"><u>Corresponding time</u></th> <th data-bbox="788 315 1026 454"><b>Correct use of measurements referred to in columns 1 and 2</b></th> <th data-bbox="1026 315 1315 454"><b>To calculate g use:</b> (formula/expression seen)</th> </tr> </thead> <tbody> <tr> <td data-bbox="260 454 496 589">Record the position on the <b>rule</b> for each frame</td> <td data-bbox="496 454 788 589">Time between frames</td> <td data-bbox="788 454 1026 589">Plot distance against <math>t^2</math></td> <td data-bbox="1026 454 1315 589"><math>g = 2 \times \text{gradient}</math></td> </tr> <tr> <td data-bbox="260 589 496 759">Measure distance between (successive) frames against a metre <b>rule</b></td> <td data-bbox="496 589 788 759">Time between frames</td> <td data-bbox="788 589 1026 759">Calculate the speed each frame using distance /time and plot against time</td> <td data-bbox="1026 589 1315 759"><math>g = \text{gradient}</math></td> </tr> <tr> <td data-bbox="260 759 496 1028">Use metre <b>rule</b> to measure: (total) distance ball falls through <b>Or</b> height from which the ball was dropped (e.g. 1 m)</td> <td data-bbox="496 759 788 1028">Number of frames <math>\times</math> time between frame <b>Or</b> total time of journey recorded/found</td> <td data-bbox="788 759 1026 1028">Use of: <math>s = ut + \frac{1}{2} at^2</math> <b>Or</b> <math>s = \frac{1}{2} at^2</math> <b>Or</b> <math>s = \frac{1}{2} gt^2</math></td> <td data-bbox="1026 759 1315 1028"><math>g = 2s/t^2</math> <b>Or</b> Re-arrange <math>s = \frac{1}{2} gt^2</math> substituting in s and t to find g.</td> </tr> <tr> <td data-bbox="260 1028 496 1290">Measure distance between frames (at beginning and) end of drop using the <b>rule</b></td> <td data-bbox="496 1028 788 1290">Time between frames known and count frames <b>Or</b> if stated <math>u = 0</math> then time for ball to fall and the time between frames.</td> <td data-bbox="788 1028 1026 1290">Use speed = <math>\Delta s/\Delta t</math> to find their final velocity using correct time interval [may take u as 0]</td> <td data-bbox="1026 1028 1315 1290"><math>g = (v-u)/t</math> <b>Or</b> <math>a = (v-u)/t</math></td> </tr> <tr> <td data-bbox="260 1290 496 1487">Record the position on the <b>rule</b> each frame</td> <td data-bbox="496 1290 788 1487">Time between frames</td> <td data-bbox="788 1290 1026 1487">Calculate the speed each frame using d/t and plot a graph of <math>v^2</math> against s.</td> <td data-bbox="1026 1290 1315 1487">Gradient/2 = acceleration</td> </tr> </tbody> </table> <p>Accept metre stick or ruler in place of metre rule (The candidate may refer to the acceleration of free fall as 'a' or 'g')</p>	<b>Distance measured with the metre rule</b>	<u>Corresponding time</u>	<b>Correct use of measurements referred to in columns 1 and 2</b>	<b>To calculate g use:</b> (formula/expression seen)	Record the position on the <b>rule</b> for each frame	Time between frames	Plot distance against $t^2$	$g = 2 \times \text{gradient}$	Measure distance between (successive) frames against a metre <b>rule</b>	Time between frames	Calculate the speed each frame using distance /time and plot against time	$g = \text{gradient}$	Use metre <b>rule</b> to measure: (total) distance ball falls through <b>Or</b> height from which the ball was dropped (e.g. 1 m)	Number of frames $\times$ time between frame <b>Or</b> total time of journey recorded/found	Use of: $s = ut + \frac{1}{2} at^2$ <b>Or</b> $s = \frac{1}{2} at^2$ <b>Or</b> $s = \frac{1}{2} gt^2$	$g = 2s/t^2$ <b>Or</b> Re-arrange $s = \frac{1}{2} gt^2$ substituting in s and t to find g.	Measure distance between frames (at beginning and) end of drop using the <b>rule</b>	Time between frames known and count frames <b>Or</b> if stated $u = 0$ then time for ball to fall and the time between frames.	Use speed = $\Delta s/\Delta t$ to find their final velocity using correct time interval [may take u as 0]	$g = (v-u)/t$ <b>Or</b> $a = (v-u)/t$	Record the position on the <b>rule</b> each frame	Time between frames	Calculate the speed each frame using d/t and plot a graph of $v^2$ against s.	Gradient/2 = acceleration	(1) (1) (1) (1)	4
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<p><b>13 (a) (ii)</b></p>	<p>Ball may be released between 1st and 2nd images (so times used all too long because they include a short time before it is dropped)  <b>Or</b> ball released before the 1<sup>st</sup> image so <math>u</math> is not 0  <b>Or</b> the ruler is not vertical/straight  <b>Or</b> the idea that the camera has not been calibrated correctly i.e. runs too fast/slow  <b>Or</b> the idea that there is a parallax error from camera to object</p> <p>(Parallax alone is insufficient)                  (Do not award a mark for air resistance)</p>	<p>(1)</p>	<p><b>1</b></p>								
<p><b>13 (b)</b></p>	<p>Small / dense / streamlined shape / smooth surface / shiny</p> <p>Correct explanation, e.g.:                  Small surface area– minimise drag                  Dense – weight &gt; upthrust <b>Or</b> weight &gt; drag                  Streamlined /aerodynamic– minimise drag <b>Or</b> ensure laminar flow                  Smooth surface – minimise drag <b>Or</b> ensure laminar flow                  Shiny – easy to see on the recording                  Small – easier to read scale (precisely)</p> <p>(Sphere is not acceptable for a property but statement such as ‘sphere to minimise drag’ can score 2<sup>nd</sup> mark)</p>	<p>(1)</p> <p>(1)</p>	<p><b>2</b></p>								
<p><b>13 (c)</b></p>	<p>Advantage                  Explanation                  (to score both marks the explanation must be linked to the advantage. Accept reverse arguments. Human error is not sufficient for reaction time).</p> <table border="1" data-bbox="258 1057 1311 1402"> <thead> <tr> <th data-bbox="258 1057 488 1093">Advantage</th> <th data-bbox="488 1057 1311 1093">Explanation</th> </tr> </thead> <tbody> <tr> <td data-bbox="258 1093 488 1160">No reaction time</td> <td data-bbox="488 1093 1311 1160">Reduces uncertainties <b>Or</b> (time recorded) more precise/accurate</td> </tr> <tr> <td data-bbox="258 1160 488 1263">Can be paused /stopped to take readings.</td> <td data-bbox="488 1160 1311 1263">Measurements taken at exact times  <b>Or</b> positions against rule recorded more accurately.  <b>Or</b> velocities can be calculated frame by frame (more readings)</td> </tr> <tr> <td data-bbox="258 1263 488 1402">Allows repeated playback <b>Or</b> rewinding</td> <td data-bbox="488 1263 1311 1402">Allows values to be checked/confirmed  <b>Or</b> values obtained are more reliable</td> </tr> </tbody> </table>	Advantage	Explanation	No reaction time	Reduces uncertainties <b>Or</b> (time recorded) more precise/accurate	Can be paused /stopped to take readings.	Measurements taken at exact times <b>Or</b> positions against rule recorded more accurately. <b>Or</b> velocities can be calculated frame by frame (more readings)	Allows repeated playback <b>Or</b> rewinding	Allows values to be checked/confirmed <b>Or</b> values obtained are more reliable	<p>(1)</p> <p>(1)</p>	<p><b>2</b></p>
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<p><b>Total for question 13</b></p>			<p><b>9</b></p>								



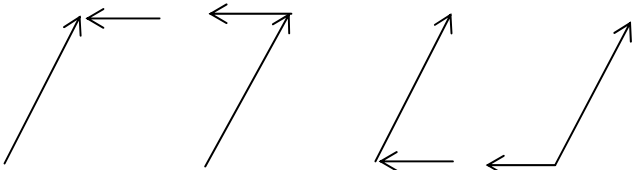
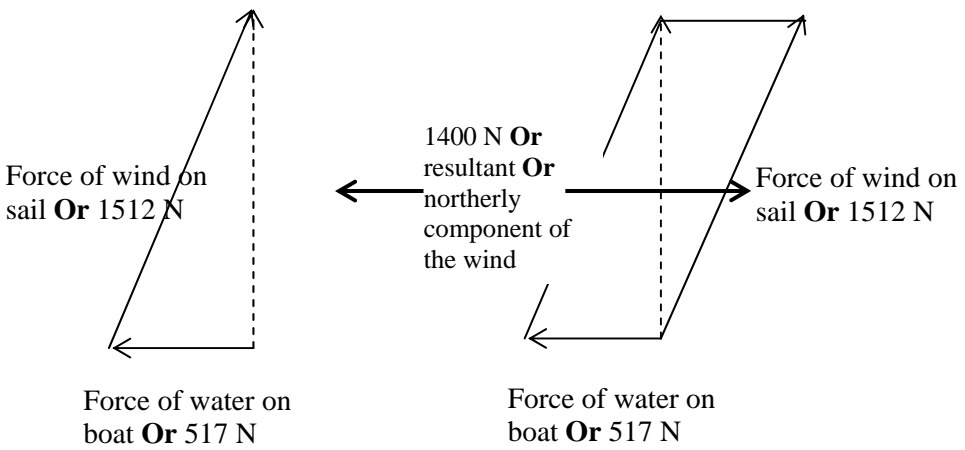
Question Number	Answer		Mark
14*	<p><b>(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)</b>  <b>Max 6</b>                      (marks must be for one earth method and one space method)</p> <p><b>Earth (max 3):</b>                      Weight/downwards force (on person). (1)                      There is an upward force on person (from the floor) <b>Or</b> (normal) reaction/contact force (1)                      No resultant force <b>Or</b> person not accelerating (1)                      (Therefore) the reaction/contact force from the floor upwards = weight <b>Or</b> the person feels an upwards force equal to their weight (1)</p> <p><b>Or</b>  <math>R - mg = ma</math> (1)                      Acceleration = 0 (1)  <math>R = mg</math> (1)</p> <p><b>Space(max 3):</b>                      Must be a resultant /unbalanced force on the person (1)                      Force (exerted) by floor/box on person/foot (1)                      Equal to <math>ma</math> (accept <math>mg</math>) (1)</p> <p><b>Or</b>                      The idea that an unbalanced force acts (1)  <math>\sum F = ma</math> (if seen this scores MP1 and 2) (1)  <math>\sum F = mg</math> (1)</p> <p><b>Comparison:</b>                      In both cases person feels <u>force</u> from floor of <math>mg</math> <b>Or</b> in both cases the feels the same <u>force</u> from the floor (1)</p> <p>(Accept points when they are shown as annotations to the diagram)                      (to be awarded all 6 marks, as this is a QWC question, all letters must be defined)</p>		6
	<b>Total for question 14</b>		<b>6</b>

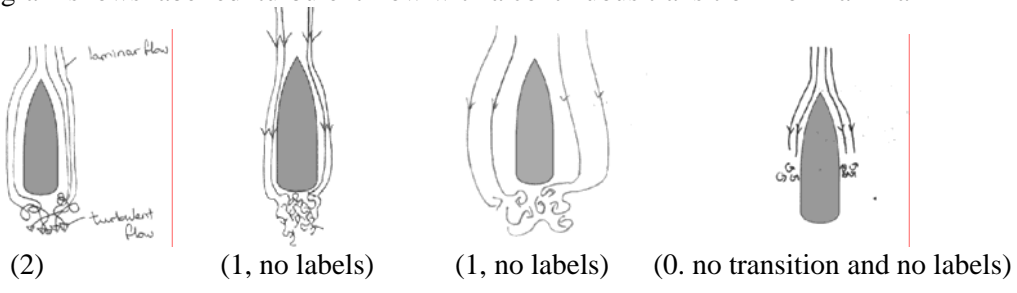
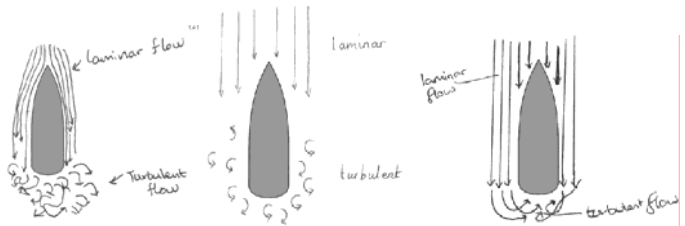
Question Number	Answer		Mark
15(a)	Property of material Linked evidence from graph  Brittle Breaks with no/little plastic deformation <b>Or</b> breaks soon after elastic limit <b>Or</b> breaks soon after limit of proportionality <b>Or</b> Large Young modulus <b>Or</b> stiff Gradient of stress/strain graph is high <b>Or</b> large stress for a small deformation /strain <b>Or</b> Strong Large breaking stress <b>Or</b> Obeys Hooke’s law Straight line graph through the origin <b>Or</b> Stress is directly proportional to strain	(1) (1)	2
15 (b)(i)	Compressive would shorten the bone <b>and</b> tensile would stretch the bone	(1)	1
15(b)(ii)	Gradient of the linear section of the graph <b>Or</b> stress divided by (the corresponding) strain in the linear part of the graph (accept alternative references to the linear section of the graph such as “where the graph obeys Hooke’s law” <b>Or</b> “where the stress is proportional to the strain”)	(1)	1
15(b)(iii)	Use of Stress = Force / Area Answer (62900 N) Use of weight = $mg$ Divide by weight = 71 times (allow 4 marks for arriving at a ratio $\frac{\text{maximum breaking stress}}{\text{stress of person's weight on the bone}} = 71$ )  (max 3 for any reverse show that e.g. $170 \text{ MPa} \times 3.76 \times 10^{-4} \text{ m}^2 = 62900 \text{ N}$ is approx equal to $883 \text{ N} \times 70 = 61\,810 \text{ N}$ <b>Or</b> $883 \text{ N} \times 70 / 3.76 \times 10^{-4} \text{ m}^2 = 167 \text{ (MPa)} \approx 170 \text{ (MPa)}$ (ratio= 68.3 comes from misreading graph and scores 3 marks)  <u>Example of calculation</u> Force = stress $\times$ area Force = $170 \text{ MPa} \times 3.76 \times 10^{-4} \text{ m}^2 = 62900 \text{ N}$ Weight = $mg = 90 \text{ kg} \times 9.81 \text{ m s}^{-2} = 883 \text{ N}$ Force / weight = $62900 \text{ N} / 883 \text{ N} = 71$	(1) (1) (1) (1)	4
15(b)(iv)	Part is trabecular Which is weaker <b>Or</b> has a lower maximum (compressive) stress <b>Or</b> lower breaking stress  <b>Or</b> The effective area of <u>cortical</u> bone is less (than in (iii)) So the force is less  (Reverse arguments may be given)	(1) (1)  (1) (1)	2
<b>Total for question 15</b>			<b>10</b>

Question Number	Answer		Mark
<b>16(a)</b>	<p>Correctly marks position of centre of gravity within grey box below</p>  <p>Point where all of the weight (can be assumed to) act  <b>Or</b> the point at which all the weight is centred upon  <b>Or</b> the point that can be used to represent the whole weight</p>	(1)	
<b>16 (b)</b>	<p>Vertically:  the jumper is accelerating  <b>Or</b> the velocity is increasing  <b>Or</b> Gravity/weight acts vertically (downwards)</p> <p>Horizontally:  the velocity remains constant  <b>Or</b> there is no horizontal acceleration  <b>Or</b> no (resultant) force acts on the man horizontally</p> <p>(ignore all references to air resistance)</p>	(1)	
		(1)	2

<b>16(c)</b>	<p>Use of equations of motion suitable to find time  Time = 2.5 (s)  Picture rate = 3.2 (s<sup>-1</sup>)</p> <p>Candidates may adopt a circuitous route with multiple equations, so check back over apparently incorrect answers, but only credit if they lead to time</p> <p><u>Example of calculation</u>  <math>s = \frac{1}{2}gt^2</math>  <math>t^2 = 2 \times 30 \text{ m} / 9.81 \text{ ms}^{-2}</math>  <math>t = 2.47 \text{ s}</math>  Picture rate = 8 pictures / 2.47 s = 3.2 (s<sup>-1</sup>)</p>	(1) (1) (1)	<b>3</b>
<b>16(d)</b>	<p>Vertical distance range 10.0 cm to 10.4cm. Horizontal distance range 4.3 cm to 4.7 cm  Scale calculation  Horizontal distance 12.4 (m) to 14.1 (m)</p> <p>(Note: numerical values in the mark scheme are based on a full sized examination paper. Enlarged papers or papers printed from pdf etc will give different scale values but the same final answer. )</p> <p><u>Example of calculation</u>  Vertical distance 10.2 cm to horizontal distance 4.5 cm  Scale calculation: 4.5 cm x 30 m / 10.2 cm  Horizontal distance = 13.2 (m)</p>	(1) (1) (1)	<b>3</b>
<b>16(e)</b>	<p>Use of (horizontal) velocity = horizontal distance / time  (Horizontal) velocity = 5.3 m s<sup>-1</sup> (ecf of time from part (c))</p> <p>(Candidates may use their own value for horizontal distance or any value in the range 12 m to 15 m.)</p> <p>Use suitable equation of motion for vertical velocity  Vertical velocity = 24.5 m s<sup>-1</sup> (ecf of time from part (c))</p> <p><u>Example of calculation</u>  Horizontal <math>v = 13.2 \text{ m} / 2.5 \text{ s} = 5.28 \text{ m s}^{-1}</math></p> <p>Vertical <math>v = 0 \text{ m s}^{-1} + (9.81 \text{ m s}^{-2} \times 2.5 \text{ s}) = 24.5 \text{ m s}^{-1}</math></p>	(1) (1)  (1) (1)	<b>4</b>
<b>Total for question 16</b>			<b>14</b>

Question Number	Answer		Mark
<b>17(a)(i)</b>	Use of force = area x force per unit area Correct use of trigonometric function for component of force Force = 1420 (N)  <u>Example of calculation</u> Force = $84 \text{ N m}^{-2} \times 18 \text{ m}^2$ = 1512 (N) component of force = $1512 \text{ N} \times \cos 20^\circ = 1420 \text{ N}$	(1) (1) (1)	<b>3</b>
<b>17(a)(ii)</b>	<u>Wind/air</u> causes boat to push against water Due to Newton's third law the water exerts an opposite force <b>Or</b> force in westerly direction on the boat due to Newton's third law  <b>Or</b> In east-west direction: no acceleration <b>Or</b> no resultant force Water exerts a force on the boat to balance out (component) of wind's force from the east  (A bold statement of N3 without an application to the context scores 0)	(1)  (1)  (1) (1)	<b>2</b>

<p><b>17(a)(iii)</b></p>	<p>The wind and water forces labelled and in the correct directions (2 adjoining labelled lines with arrows)</p> <p>e.g.</p>  <p>(Label for the horizontal line as shown above = Force of water on boat <b>Or</b> 517 N Label for the angled line as shown above = Force of wind on sail <b>Or</b> 1512 N)</p> <p>Triangle or parallelogram completed to show resultant force with direction</p>  <p>(Due to taking some words as being included in the stem the minimum labelling would be: Wind in place of: Force of wind on sail <b>Or</b> 1512 N Water in place of: Force of water on boat <b>Or</b> 517 N)</p>	<p>(1)</p> <p>(1)</p>	<p></p> <p>2</p>
<p><b>17(a)(iv)</b></p>	<p>Use of <math>F = ma</math> Acceleration = <math>3.6 \text{ m s}^{-2}</math> (allow ecf from (a)(i) if answer rounds to 1400 N)</p> <p><u>Example of calculation</u> <math>a = 1420 \text{ N} / 400 \text{ kg} = 3.6 \text{ m s}^{-2}</math></p>	<p>(1)</p> <p>(1)</p>	<p>2</p>

<p><b>17(b)(i)</b></p>	<p>Idea that the relative speed of wind to sail is lower</p> <p>e.g. As the boat is moving at <math>5 \text{ m s}^{-1}</math>, the (relative) speed of the wind on the sail is only <math>5 \text{ m s}^{-1}</math></p>	<p>(1)</p>	<p>1</p>
<p><b>17(b)(ii)</b></p>	<p>Use of <math>s = d/t</math> or use of work done = force <math>\times</math> displacement</p> <p>Rate of energy transfer = <math>1900 \text{ W}</math> or <math>\text{J s}^{-1}</math></p> <p><u>Example of calculation</u>                  Distance = speed <math>\times</math> time  <math>= 5 \text{ m s}^{-1} \times 1 \text{ s} = 5 \text{ (m)}</math>                  Power = <math>380 \text{ N} \times 5 \text{ m} / 1 \text{ s} = 1900 \text{ W}</math>                  (accept <math>P = 380 \text{ N} \times 5 \text{ m s}^{-1} = 1900 \text{ W}</math>)</p>	<p>(1)</p> <p>(1)</p>	<p>2</p>
<p><b>17(b)(iii)</b></p>	<p>Diagram shows labelled laminar flow</p> <p>Diagram shows labelled turbulent flow with a continuous transition from laminar</p>  <p>(2) (1, no labels) (1, no labels) (0. no transition and no labels)</p>  <p>(all score 1, no transition)</p> <p>(Unlabelled diagram with the correct flow lines 1 mark max. Laminar and turbulent wrong way round but fully labelled scores 1 max)</p>	<p>(1)</p> <p>(1)</p>	<p>2</p>
<p><b>Total for question 17</b></p>			<p>14</p>

Question Number	Answer		Mark
18(a)(i)	Finds extension = 3.4 (cm) <b>Or</b> line on graph at 3.4 cm Force = 3.2 (N) (accept range between 3.10 and 3.25 N)	(1) (1)	2
18(a)(ii)	An attempt to find an area under the graph <b>Or</b> use of $\frac{1}{2} F\Delta x$  A calculation of the correct area using counting squares or trapezium for a extension of 3.0 - 3.4 cm (ecf their extension from (a)(i))  (counting 1 cm squares is approximately 51 - 52 squares)  <u>Example of calculation</u> Using counting cm squares: energy = (51 squares $\times$ 1.25 $\times 10^{-3}$ J) = 0.064 (J)	(1)  (1)	2
18(a)(iii)	Use of $gpe = mgh$ <b>Or</b> equations that would allow $h$ to be calculated Height = 1.7 (m) (ecf) (0.06 J $\rightarrow$ 1.61 m, 0.054 J $\rightarrow$ 1.45 m)  (Candidates may use the longer route of $0.063 \text{ J} = \frac{1}{2} mv^2$ to find $v = 5.78 \text{ m s}^{-1}$ and then use $mgh = \frac{1}{2} mv^2$ to give $h = 1.7 \text{ m}$ )  <u>Example of calculation</u> $0.063 \text{ J} = 0.0038 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times h$ $h = 1.7 \text{ (m)}$	(1) (1)	2
18(b)(i)	25.8 cm an anomaly (accept outlier in place of anomaly)  excluded from the mean <b>Or</b> mean of the remaining three numbers is 30.0 cm <b>Or</b> $(30.0 + 30.3 + 29.7)/3 = 30.0 \text{ (cm)}$	(1)   (1)	2
18(b)(ii)	The block moves Some energy is transferred to the block <b>Or</b> acceleration (of marble) is less <b>Or</b> launch velocity is less  <b>Allow one mark only for one of the following if no mention of block moving</b> Energy transferred due to friction <b>Or</b> energy transferred due to air resistance <b>Or</b> friction was acting between moving parts <b>Or</b> air resistance was acting on the marble <b>Or</b> energy transferred to internal energy in the band <b>Or</b> energy transferred to thermal energy of the surroundings <b>Or</b> energy dissipated as heat	(1) (1)      (1)	2



<b>18(b)(iii)</b>	Any <b>one</b> from Use additional rubber band(s) Double up rubber band Use a longer channel Use a lighter block/type of wood Replace elastic band with a stiffer, shorter or wider one Any sensible practical idea to reduce friction e.g. use a lubricant/oil <b>Or</b> a material with lower friction e.g. plastic	<b>(1)</b>	<b>1</b>
	<b>Total for question 18</b>		<b>11</b>
	<b>Total for this paper</b>		<b>80</b>

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