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
1	A	**1**
2	A	**1**
3	D	**1**
4	B	**1**
5	A	**1**
6	C	**1**
7	A	**1**
8	C	**1**
9	D	**1**
10	D	**1**

Question Number	Answer		Mark
11	Statement describing the relationship between viscosity and temperature. e.g. Viscosity increases with decreasing temperature **Or** viscosity decrease with increasing temperature **Or** viscosity is inversely proportional to temperature 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 **Or** if too hot, the oil would run off **Or** if too hot oil would not stick to parts	(1) (1)	**2**
	Total for question 11		**2**

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

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>13 (a) (i)</td><td>Each row of the table contains a suitable method.
One mark for each column, do not allow a mix and match of methods (rows)

<table>
<tr><th>Distance measured with the metre rule</th><th><u>Corresponding</u> time</th><th><u>Correct</u> use of measurements referred to in columns 1 and 2</th><th>To calculate g use:

(formula/expression seen)</th></tr>
<tr><td>Record the position on the rule for each frame</td><td>Time between frames</td><td>Plot distance against t^2</td><td>g = 2 x gradient</td></tr>
<tr><td>Measure distance between (successive) frames against a metre rule</td><td>Time between frames</td><td>Calculate the speed each frame using distance /time and plot against time</td><td>g = gradient</td></tr>
<tr><td>Use metre rule to measure: (total) distance ball falls through Or height from which the ball was dropped (e.g. 1 m)</td><td>Number of frames × time between frame Or total time of journey recorded/found</td><td>Use of:
$s = ut + ½ at^2$
Or
$s = ½ at^2$
Or
$s = ½ gt^2$</td><td>$g = 2s/t^2$
Or
Re-arrange $s = ½ gt^2$ substituting in s and t to find g.</td></tr>
<tr><td>Measure distance between frames (at beginning and) end of drop using the rule</td><td>Time between frames known and count frames
Or if stated u = 0 then time for ball to fall and the time between frames.</td><td>Use speed = $\Delta s/\Delta t$ to find their final velocity using correct time interval
[may take u as 0]</td><td>$g = (v-u)/t$

Or $a = (v-u)/t$</td></tr>
<tr><td>Record the position on the rule each frame</td><td>Time between frames</td><td>Calculate the speed each frame using d/t and plot a graph of v^2 against s.</td><td>Gradient/2 = acceleration</td></tr>
</table>
Accept metre stick or ruler in place of metre rule
(The candidate may refer to the acceleration of free fall as ‘a’ or ‘g’)</td><td>(1)
(1)
(1)
(1)</td><td>4</td></tr>
</table>

<table>
<tr><td>13 (a) (ii)</td><td>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)
Or ball released before the 1st image so u is not 0
Or the ruler is not vertical/straight
Or the idea that the camera has not been calibrated correctly i.e. runs too fast/slow
Or the idea that there is a parallax error from camera to object

(Parallax alone is insufficient)
(Do not award a mark for air resistance)</td><td>(1)</td><td>1</td></tr>
<tr><td>13 (b)</td><td>Small / dense / streamlined shape / smooth surface / shiny

Correct explanation, e.g.:
Small surface area– minimise drag
Dense – weight > upthrust Or weight > drag
Streamlined /aerodynamic– minimise drag Or ensure laminar flow
Smooth surface – minimise drag Or ensure laminar flow
Shiny – easy to see on the recording
Small – easier to read scale (precisely)

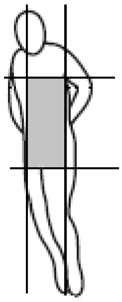
(Sphere is not acceptable for a property but statement such as ‘sphere to minimise drag’ can score 2nd mark)</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td>13 (c)</td><td>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).

<table>
<tr><th>Advantage</th><th>Explanation</th></tr>
<tr><td>No reaction time</td><td>Reduces uncertainties Or (time recorded) more precise/accurate</td></tr>
<tr><td>Can be paused /stopped to take readings.</td><td>Measurements taken at exact times
Or positions against rule recorded more accurately.
Or velocities can be calculated frame by frame (more readings</td></tr>
<tr><td>Allows repeated playback Or rewinding</td><td>Allows values to be checked/confirmed
Or values obtained are more reliable</td></tr>
</table>
</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td></td><td>Total for question 13</td><td></td><td>9</td></tr>
</table>

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

Question Number	Answer		Mark
15(a)	Property of material Linked evidence from graph Brittle Breaks with no/little plastic deformation **Or** breaks soon after elastic limit **Or** breaks soon after limit of proportionality **Or** Large Young modulus **Or** stiff Gradient of stress/strain graph is high **Or** large stress for a small deformation /strain **Or** Strong Large breaking stress **Or** Obeys Hooke's law Straight line graph through the origin **Or** Stress is directly proportional to strain	**(1)** **(1)**	**2**
15 (b)(i)	Compressive would shorten the bone **and** tensile would stretch the bone	**(1)**	**1**
15(b)(ii)	Gradient of the linear section of the graph **Or** 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" **Or** "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 MPa × 3.76 × 10^{-4} m^2 = 62900 N is approx equal to 883 N x 70 = 61 810 N **Or** 883N x 70 /3.76 × 10^{-4} m^2 = 167 (MPa) <u>≈ 170 (MPa)</u>) (ratio= 68.3 comes from misreading graph and scores 3 marks) <u>Example of calculation</u> Force = stress × area Force = 170 MPa × 3.76 × 10^{-4} m^2 = 62900 N Weight = mg = 90 kg × 9.81 m s^{-2} = 883 N Force / weight = 62900 N / 883 N = 71	**(1)** **(1)** **(1)** **(1)**	**4**
15(b)(iv)	Part is trabecular Which is weaker **Or** has a lower maximum (compressive) stress **Or** lower breaking stress **Or** 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**
	Total for question 15		**10**

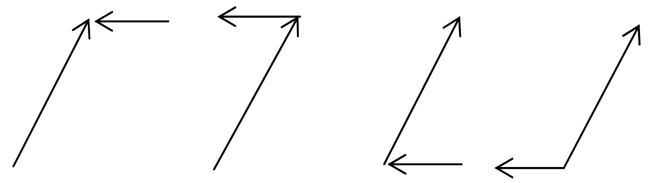
Question Number	Answer		Mark
16(a)	Correctly marks position of centre of gravity within grey box below  Point where all of the weight (can be assumed to) act **Or** the point at which all the weight is centred upon **Or** the point that can be used to represent the whole weight	**(1)** **(1)**	**2**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

16(c)	Use of equations of motion suitable to find time Time = 2.5 (s) Picture rate = 3.2 (s^{-1}) Candidates may adopt a circuitous route with multiple equations, so check back over apparently incorrect answers, but only credit if they lead to time <u>Example of calculation</u> $s = ½ gt^2$ $t^2 = 2 \times 30\ m / 9.81\ ms^{-2}$ $t = 2.47\ s$ Picture rate = 8 pictures / 2.47 s = 3.2 (s^{-1})	**(1)** **(1)** **(1)**	**3**
16(d)	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) (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.) <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)	**(1)** **(1)** **(1)**	**3**
16(e)	Use of (horizontal) velocity = horizontal distance / time (Horizontal) velocity = 5.3 m s^{-1} (ecf of time from part (c)) (Candidates may use their own value for horizontal distance or any value in the range 12 m to 15 m.) Use suitable equation of motion for vertical velocity Vertical velocity = 24.5 m s^{-1} (ecf of time from part (c)) <u>Example of calculation</u> Horizontal v = 13.2 m / 2.5 s = 5.28 m s^{-1} Vertical v = 0 m s^{-1} +(9.81 m s^{-2} x 2.5 s) = 24.5 m s^{-1}	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 16		**14**

Question Number	Answer		Mark
17(a)(i)	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 N m^{-2} x 18 m^2 = 1512 (N) component of force = 1512 N x cos 20º = 1420 N	**(1)** **(1)** **(1)**	**3**
17(a)(ii)	<u>Wind/air</u> causes boat to push against water Due to Newton's third law the water exerts an opposite force **Or** force in westerly direction on the boat due to Newton's third law **Or** In east-west direction: no acceleration **Or** 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)**	**2**

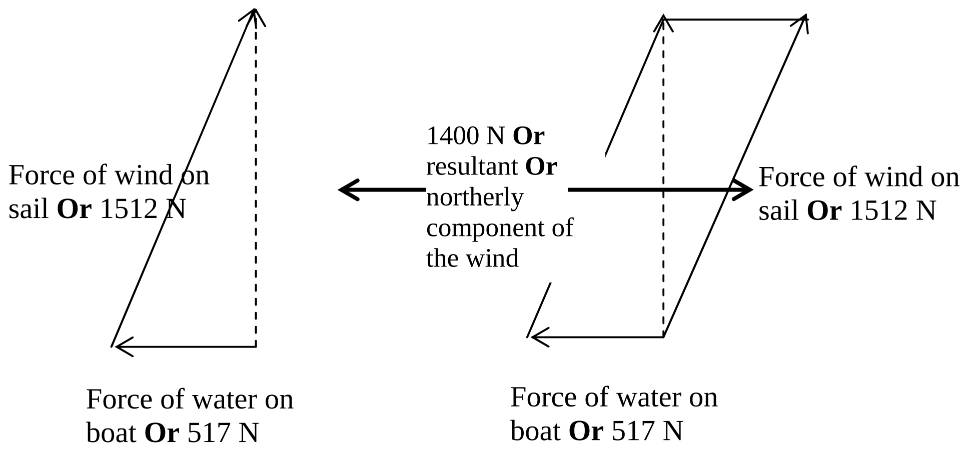
<table>
<tr>
<td>17(a)(iii)</td>
<td>The wind and water forces labelled and in the correct directions
(2 adjoining labelled lines with arrows)

e.g.



(Label for the horizontal line as shown above = Force of water on boat Or 517 N
Label for the angled line as shown above = Force of wind on sail Or 1512 N)

Triangle or parallelogram completed to show resultant force with direction

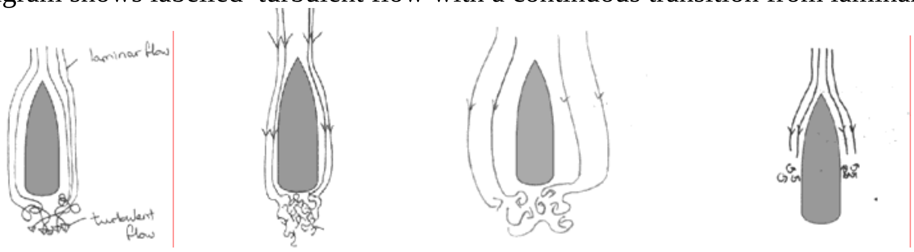
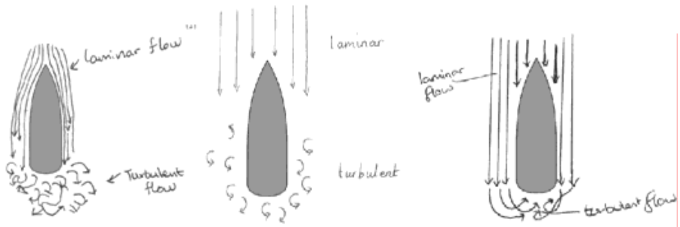


(Due to taking some words as being included in the stem the minimum labelling would be:
Wind in place of: Force of wind on sail Or 1512 N
Water in place of: Force of water on boat Or 517 N)</td>
<td>(1)

(1)</td>
<td>

2</td>
</tr>
<tr>
<td>17(a)(iv)</td>
<td>Use of $F = ma$
Acceleration = 3.6 m s^{-2} (allow ecf from (a)(i) if answer rounds to 1400 N)

<u>Example of calculation</u>
a = 1420 N / 400 kg = 3.6 m s^{-2}</td>
<td>(1)
(1)</td>
<td>
2</td>
</tr>
</table>

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

Question Number	Answer		Mark
18(a)(i)	Finds extension = 3.4 (cm) **Or** 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 **Or** use of ½ $F\Delta x$ 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 × 1.25 × 10^{-3} J) = 0.064 (J)	**(1)** **(1)**	**2**
18(a)(iii)	Use of gpe = mgh **Or** equations that would allow h to be calculated Height = 1.7 (m) (ecf) (0.06 J → 1.61 m, 0.054 J → 1.45 m) (Candidates may use the longer route of 0.063 J = ½ mv^2 to find v = 5.78 m s^{-1} and then use $mgh = 1/2mv^2$ to give h = 1.7 m) <u>Example of calculation</u> 0.063 J = 0.0038 kg x 9.81 N kg^{-1} x h h = 1.7(m)	**(1)** **(1)**	**2**
18(b)(i)	25.8 cm an anomaly (accept outlier in place of anomaly) excluded from the mean **Or** mean of the remaining three numbers is 30.0 cm **Or** (30.0 + 30.3 + 29.7)/3 = 30.0 (cm)	**(1)** **(1)**	**2**
18(b)(ii)	The block moves Some energy is transferred to the block **Or** acceleration (of marble) is less **Or** launch velocity is less **Allow one mark only for one of the following if no mention of block moving** Energy transferred due to friction **Or** energy transferred due to air resistance **Or** friction was acting between moving parts **Or** air resistance was acting on the marble **Or** energy transferred to internal energy in the band **Or** energy transferred to thermal energy of the surroundings **Or** energy dissipated as heat	**(1)** **(1)** **(1)**	**2**

18(b)(iii)	Any **one** 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 **Or** a material with lower friction e.g. plastic	**(1)**	**1**
	Total for question 18		**11**
	Total for this paper		**80**

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