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Mark Scheme (Results)

January 2014

IAL Physics (WPH01/01)

Unit 1: 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.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Mark Scheme Notes

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:

(iii)	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.]	✓	1

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

1. Mark scheme format
   - 1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'
   - 1.2 Bold lower case will be used for emphasis.
   - 1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
   - 1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties
   - 2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.
   - 2.2 Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.
   - 2.3 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, for example in a spreadsheet.
   - 2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).
   - 2.5 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.
   - 2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures
   - 3.1 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.
   - 3.2 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

4. Calculations
   4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
   4.2 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.
   4.3 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.
   4.4 recall of the correct formula will be awarded when the formula is seen or implied by substitution.
   4.5 The mark scheme will show a correctly worked answer for illustration only.
   4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight Use of L × W × H Substitution into density equation with a volume and density Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] [If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark] [Bald answer scores 0, reverse calculation 2/3] Example of answer: 80 cm × 50 cm × 1.8 cm = 7200 cm^3 7200 cm^3 × 0.70 g cm^{-3} = 5040 g 5040 × 10^{-3} kg × 9.81 N/kg = 49.4 N	✓ ✓ ✓	3

5. Quality of Written Communication
   5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.
   5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

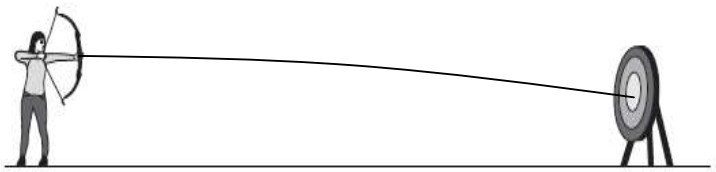
6. Graphs
   6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.
   6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.
   6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.
   6.4 Points should be plotted to within 1 mm.
      - Check the two points furthest from the best line. If both OK award mark.
      - If either is 2 mm out do not award mark.
      - If both are 1 mm out do not award mark.
      - If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.
   6.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

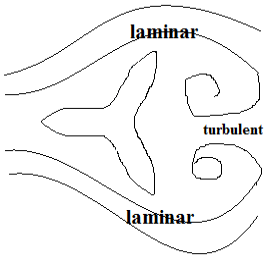
Question Number	Answer	Mark
1	D	**1**
2	D	**1**
3	C	**1**
4	B	**1**
5	B	**1**
6	C	**1**
7	B	**1**
8	C	**1**
9	D	**1**
10	C	**1**

Question Number	Answer		Mark
11	**Applied force:** The 25° slope requires a smaller force (accept converse) **Or** Use of trig to calculate the component of weight along either slope (350 (N) for 25° slope or 480 (N) for 35° slope) **Distance travelled:** The distance travelled is greater for the 25° slope (accept converse) **Or** Use of trig to calculate the distance along either slope (860 – 870 (m) for 25° slope or 630 – 640(m) for 35° slope) **Work done:** The 25° side uses smaller force over greater distance (accept converse) **Or** The work done (against gravity) is the same **Or** Correctly calculate work done to reach top (either vertically or along slope) (Work done = 3.0×10^5 (J) or 3.1×10^5 (J)) Example of calculation F_{25}= 85 kg × 9.81 N kg^{-1} × cos (90° - 25°) = 352.4 N F_{35} = 85 kg × 9.81 N kg^{-1} × cos (90° - 35°) = 478.3 N $d_{25°}$ = 365 m/sin25° = 864 m $d_{35°}$ = 365 m / sin 35° = 636 m Work done $_{25}$ = 352 N × 864 m = 3.04×10^5 J **and** Work done $_{35}$ = 478 N × 636 m = 3.04×10^5 J Work done = 85 kg × 9.81 N kg^{-1} × 365 m = 3.04×10^5 J	**(1)** **(1)** **(1)**	**3**
	Total for Question 11		**3**

Question Number	Answer		Mark
12	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** As the lava cools, its viscosity increases Rhyolite's viscosity is greater than basalt's Rhyolite flows more slowly than basalt **Or** high viscosity gives low flow rate Basalt flows a long way before solidifying /cooling (so shield shape) **Or** rhyolite flows a short distance before solidifying /cooling (so cone shape)	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for Question 12		**4**

Question Number	Answer		Mark
***13(a)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Measure the initial length (of the spring) **Or** record position of a 'fixed point' **Or** record the position of the bottom of the spring (with no masses on the spring) Add mass/weight and record the new length/position Repeat for a range of masses/weights Reference to a precaution taken to ensure measurements were accurate e.g. use of set square, method to reduce parallax, hang spring close to rule, do not exceed proportional/elastic limit	**(1)** **(1)** **(1)** **(1)**	**4**
13(b)	Plot appropriate graph of extension/length and force/mass Calculate the gradient (of linear region) Appropriate method to find k from their graph (**Max 1** if no graph is suggested i.e. use $k = F/\Delta x$ and average k)	**(1)** **(1)** **(1)**	**3**
13(c)	k would not be constant for the spring **Or** the graph would not be a straight line **Or** the idea that Hooke's law would not be obeyed **Or** $F = k\ (\Delta)x$ does not apply	**(1)**	**1**
	Total for Question 13		**8**

Question Number	Answer		Mark
14(a)(i)	Correct arched trajectory drawn (arrow may reach the ground before the target) 	**(1)**	**1**
14(a)(ii)	Use of $v = \frac{d}{t}$ time = 0.42 (s) <u>Example of calculation</u> $t = \frac{13\text{ m}}{86\text{ m s}^{-1}} = 0.42\text{ s}$	**(1)** **(1)**	**2**
14(a)(iii)	Use of $s = ut + ½\ at^2$ **Or** use of $v = u + at$ **and** $v^2 = u^2 + 2as$ (using vertical data only) s = 0.87 m (accept from s = 0.8 to 0.9 m) height above ground = 0.63 m (ecf from (a)(ii) for time of flight) <u>Example of calculation</u> $s = 0 + ½ \times 9.81\text{ m s}^{-2} \times (0.42\text{ s})^2$ s = 0.87 m Height = 1.5 m – 0.87m = 0.63 m	 **(1)** **(1)** **(1)**	 **3**
14(b)	Arrow hits target higher up **Or** answer to part (a)(iii) would increase (As the) time (of flight) decreases	 **(1)** **(1)**	 **2**
	Total for Question 14		**8**

Question Number	Answer		Mark
15(a)	Reaction/ *R*/ (normal) contact force/ force of floor/force of lift (on passenger) etc. (not normal/*N*)	**(1)**	
	 Weight/*W*/*mg*	**(1)**	**2**
	(Subtract 1 mark for each additional force/arrow if more than 2 forces on diagram. Arrows must begin on the dot)		
15(b)(i)	Calculates the difference between scale readings e.g (73g – 60g) or (73 – 60) or 128 (N) or 13 (kg) seen	**(1)**	
	Use of $F = ma$ to find a	**(1)**	
	Acceleration = 2.1 (m s^{-2})	**(1)**	**3**
	<u>Example of calculation</u> Resultant force =(73 kg × 9.81 N kg^{-1})–(60 kg × 9.81 N kg^{-1}) = 127.5 N 127.5 N = 60 kg × a a = 2.13 (m s^{-2})		
15(b)(ii)	Use of $a = \frac{v-u}{t}$	**(1)**	
	a = (−) 1.9 m s^{-2}	**(1)**	**2**
	<u>Example of calculation</u> $a = \frac{0-10\ m\ s^{-1}}{5.3\ s} = -1.89$ m s^{-2}		
15(c)	Arrows not required 		
	Labelled region of laminar flow showing parallel streamlines.	**(1)**	
	Labelled region of turbulent flowing showing adjacent streamlines crossing and/or eddies.	**(1)**	**2**
	Total for Question 15		**9**

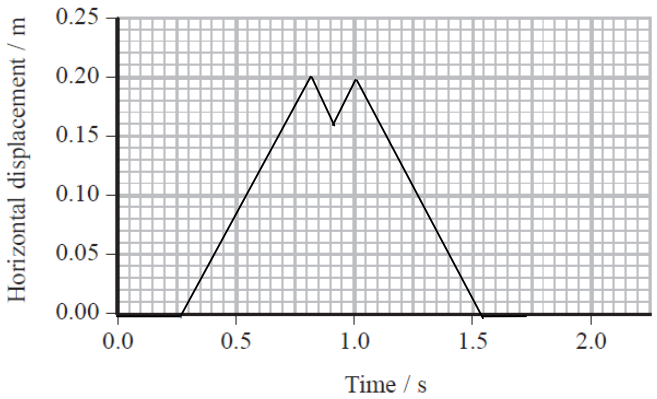
<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>16(a)(i)</td><td>Brittle = A
Ductile = B and /or C
Strongest = A
Least stiff = C</td><td>(4)</td><td>4</td></tr>
<tr><td>16(a)(ii)</td><td>A = Glass
B =Steel
C = Copper

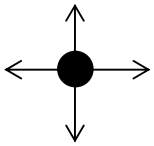
3 correct = 2 marks, 1 or 2 correct = 1 mark</td><td>(2)</td><td>2</td></tr>
<tr><td>16(b)</td><td>One property stated
One behaviour stated
The property and behaviour from the same row in the table and clearly linked in the candidate's response
<table>
<tr><th>Property</th><th>Behaviour</th></tr>
<tr><td>High UTS Or strong Or not brittle</td><td>Will not break when opened/
Will not break when force/stress applied</td></tr>
<tr><td>High Young Modulus or stiff</td><td>Grips paper (firmly)</td></tr>
<tr><td>Ductile</td><td>Can be drawn into wires</td></tr>
<tr><td>Malleable</td><td>Can be bent into shape</td></tr>
<tr><td>Elastic</td><td>Will close after being opened</td></tr>
</table></td><td>(1)
(1)

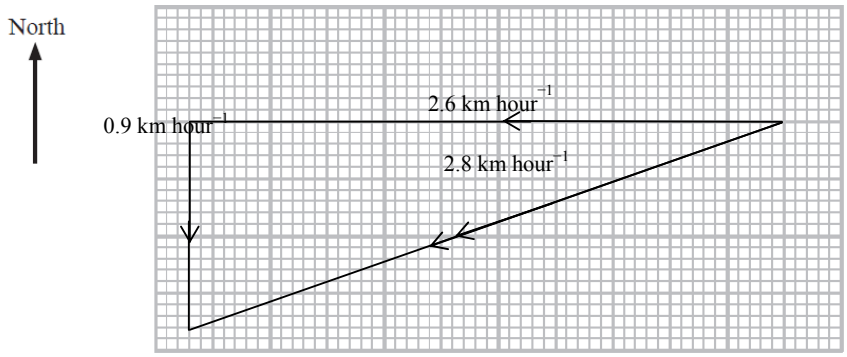
(1)</td><td>3</td></tr>
<tr><td>16(c)</td><td>X = yield point

Point at which material shows a large (increase in) strain for a small/no increase in stress
(Accept the point at which plastic deformation/behaviour/property begins)</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td></td><td>Total for Question 16</td><td></td><td>11</td></tr>
</table>

Question Number	Answer		Mark
17(a)(i)	Use of gradient Velocity = 0.062 (m s^{-1}) (accept 0.052 – 0.068) <u>Example of calculation</u> Velocity = $\frac{0.46\text{ m} - 0.39\text{ m}}{1.49\text{ s} - 0.38\text{ s}}$ = 0.062 (m s^{-1})	**(1)** **(1)**	**2**
17(a)(ii)	 Displacement starts **and** ends at 0 Straight, diagonal line of increasing displacement from $s = 0$ Maximum displacement(s) of 0.2 m between times of 0.5 s and 1.25 s Dip in displacement near the middle of graph	**(1)** **(1)** **(1)** **(1)**	**4**
17(a)(iii)	0 (m s^{-1}), zero	**(1)**	**1**
17(b)	Reduces uncertainties Or measurements more precise/accurate **Max 2** No reaction time Can be paused/playback/rewound Can take a reading every frame Or more readings (in a given time) Allows values to be checked You can zoom in	**(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for Question 17		**10**

Question Number	Answer		Mark
18(a)(i)	Upthrust/U  Tension/T/ Pull of (tug) boat	**(1)** **(1)**	**2**
18(a)(ii)	Tension (in ropes) = drag force **Or** force (on iceberg) from tug boat = drag force Use of drag force = 2Tcosθ (with either 15° or 30°) Correct answer = 1.7×10^5 (N) <u>Example of calculation</u> $2T \times \cos 15^\circ = 3.3 \times 10^5$ N $T = 1.7 \times 10^5$ N	**(1)** **(1)** **(1)**	**3**
18(a)(iii)	Use of work done = force × distance Work done = 1.7×10^{10} J (ecf) <u>Example of calculation</u> Work done = 3.3×10^5 N × 50×10^3 m Work done = 1.65×10^{10} J (Accept $2 \times 1.7 \times 10^5$ N × cos 15° x 50×10^3 m = 1.64×10^{10} J **Or** $2 \times 2 \times 10^5$ N × cos 15° x 50×10^3 m = 1.93×10^{10} J)	**(1)** **(1)**	**2**
18(a)(iv)	No effect on the motion **Or** the iceberg will travel at the same speed The tug applies the same forward force on the iceberg **Or** the resultant tension is the same **Or** tension (in each rope) decreases	**(1)** **(1)**	**2**

18(b)	 2 velocity lines with a resultant (an attempt at either triangle or parallelogram vector diagram) Correct complete vector diagram to scale with arrows Magnitude of velocity of 2.8 km hour^{-1} (Accept 2.5 to 3.0 km hour^{-1}) **And** direction of 71° (± 2°) **Or** 19°(± 2°) **Or** 251 ° (± 2°) (The third marking point may be awarded even if no vector diagram drawn)	**(1)** **(1)** **(1)**	**3**
18(c)	Upthrust = weight (of iceberg) **Or** upthrust = weight (of water displaced) **Or** weight of iceberg = weight of water displaced State or use of upthrust/weight = density × V × g **Or** Calculation of both volumes using the mass = 3×10^9 kg ($V_{iceberg} = 3.3 \times 10^6$ m^3 **and** $V_{submerged} = 2.9 \times 10^6$ m^3) Proportion = 0.89 <u>Example of calculation</u> Upthrust = 1030 kg m^{-3} × $V_{submerged}$ × g 1030 kg m^{-3} × $V_{submerged}$ × g = 920 kg m^{-3} × $V_{iceberg}$ × g $V_{submerged}/V_{iceberg}$ = 920 kg m^{-3} /1030 kg m^{-3} = 0.89	**(1)** **(1)** **(1)**	**3**
18(d)	<table><tr><th>Physical Quantity</th><th>Relative effect</th></tr><tr><td>Sea temperature</td><td>Increases</td></tr><tr><td>Viscosity</td><td>Decreases</td></tr><tr><td>Density of sea water</td><td>Decreases</td></tr><tr><td>Position in the water of the iceberg</td><td>Lower/sinks</td></tr></table> All 4 statements correct - 2 marks 2 or 3 statements correct – 1 mark only	**(2)** **(1)**	**2**
	Total for Question 18		**17**

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