Mark Scheme (Results)

June 2017

Pearson Edexcel
GCE Advanced Subsidiary in Physics (6PH01)
Paper 01 Physics on the Go

June 2017
Publications Code 6PH01_01_MS_1706*

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:

<u>'Show that' calculation of weight</u>

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] 3

Example of answer:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$

$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$

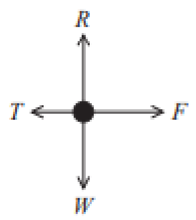
$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$

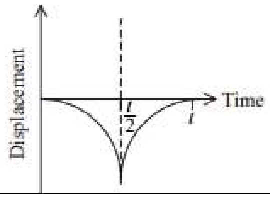
$= 49.4 \text{ N}$

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.

For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1</td><td>D<table><tr><th>Vector</th><th>Scalar</th></tr><tr><td>displacement</td><td>mass</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – both force and displacement are vectors
B – time is a scalar and force is a vector
C – both mass and time are scalar</td><td></td></tr>
<tr><td>2</td><td>C drag + weight – upthrust = 0</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – incorrect re-arrangement of correct equation
B – incorrect re-arrangement of correct equation
D − incorrect re-arrangement of correct equation</td><td></td></tr>
<tr><td>3</td><td>A 38 m</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
B – $\frac{1}{2}$ × 15 m s^{-1} × 6 s = 45 m i.e. area under graph if approximated to a triangle
C – ($\frac{1}{2}$ × 15 m s^{-1} × 6 s) + (15 m s^{-1} × 1 s) = 45 m i.e. area under entire graph
D – 15 m s^{-1} × 5 s = 75 m i.e. factor of ½ left out of area calculation</td><td></td></tr>
<tr><td>4</td><td>B<table><tr><th>Pico (p)</th><th>Giga(G)</th></tr><tr><td>10^{-12}</td><td>10^{9}</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – 10^{-9} (nano) and 10^{9} (giga)
C − 10^{-9} (nano) and 10^{6} (mega)
D − 10^{-12} (pico) and 10^{6} (mega)</td><td></td></tr>
<tr><td>5</td><td>C<table><tr><th>Gain in gravitational potential energy</th><th>Power developed</th></tr><tr><td>same for P and Q</td><td>greater for P than Q</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – incorrect gain in GPE but correct power developed
B – incorrect gain in GPE and incorrect power developed
D – correct gain in GPE but incorrect power developed</td><td></td></tr>
<tr><td>6</td><td>D

</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – Tension and friction the wrong way round but the relative sizes are correct
B – Tension and friction the wrong way round and the relative sizes are incorrect
C – Tension and friction the correct way round but the relative sizes are incorrect</td><td></td></tr>
</table>

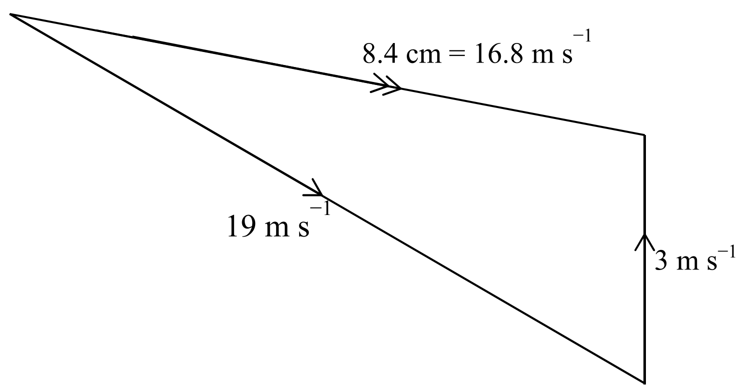
7	**B**  	**1**
	Incorrect Answers: A – Correct shape graph but, relative to the given *v-t* graph the direction is incorrect C – Initial direction incorrect but final direction correct D – Initial direction correct but final direction incorrect	
8	**D There are sudden changes in speed and direction**	**1**
	Incorrect Answers: A – statement describing laminar flow B – statement describing laminar flow C – statement describing laminar flow	
9	**A increase but then remain constant**	**1**
	Incorrect Answers: the reading on the scales (assuming it is in newtons) = $ma + mg$. There is only a change in the reading as the lift starts its motion i.e. the reading goes from mg to $mg + ma$ B – reading increases from mg to $mg + ma$ at the instant it starts to accelerate only C – reading will increase and not decrease (and then remain constant) D – reading will increase and not decrease	
10	**A 4σ**	**1**
	Incorrect Answers: $\sigma \propto 1/A$ so if the thinner string has half the diameter, its cross-sectional area will be ¼ that of the thicker string. 1 ÷ ¼ = 4 so σ is 4 times larger B – factor of ½ not squared when diameter squared in area equation C – inverse of distractor B, assumes $\sigma \propto$ diameter D − inverse of correct answer, assumes $\sigma \propto$ area	

Question Number	Answer	Mark
11(a)	Plot a graph of the force/mass/weight of the load against length/extension **Or** plot a graph of length/ extension against force/mass/weight of the load **(1)** Calculate the gradient (of the linear section of the graph) **(1)** Multiple the gradient by *g* to obtain the spring constant **Or** other method consistent with graph plotted to obtain *g* **(1)**	**3**
11(b)	Pointer to reduce parallax **(1)** Graph plotted to identify/remove anomalous results **Or** graph acts as an averaging tool **(1)**	**2**
	Total for question 11	**5**

Question Number	Answer	Mark
*12	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** **Either** Glass is brittle **(1)** Break/shatters under impact forces **Or** breaks with little or no plastic deformation **(1)** **Or** Glass is stiff **(1)** as it cannot bend to temporarily absorb shock **(1)** **Either** Aluminium is showing elastic behaviour **(1)** Will return to the original shape once the force has been removed **(1)** **Or** the aluminium is hard **(1)** so it is resistant to indentation /scratching **(1)** **Or** Aluminium is strong **(1)** A large force/stress is required for fracture **(1)** **Or** Aluminium is tough **(1)** It can absorb the energy of the fall (without breaking) **(1)** **Or** Aluminium is malleable **(1)** Force of the impact will cause it to be dented **(1)**	**4**
	Total for question 12	**4**

Question Number	Answer		Mark
13(a)	There is a force from the spring on the block **Or** there is a tension in the spring The idea that the resultant force on the block is lower than 15 N **Or** the idea that work is done on the spring	**(1)** **(1)**	**2**
13(b)	Use of $E_k = ½ mv^2$ **Or** use of $E_{el} = ½F\Delta x$ Work done on the block by the spring = gain in Kinetic energy of the block $v = 1.6$ m s^{-1} <u>Example of calculation</u> $½ \times 18$ N $\times 0.060$ m $= ½ \times 0.40$ kg $\times v^2$ $v = 1.64$ m s^{-1}	**(1)** **(1)** **(1)**	**3**
	Total for question 13		**5**

Question Number	Answer		Mark
14(a)	Volume/weight of displaced fluid/magma increases (as the bubble expands) Upthrust increases (while the weight of the bubble remains constant) There is now a greater upwards resultant force	**(1)** **(1)** **(1)**	**3**
14(b)	Basaltic because it has the lowest viscosity Low(est) drag force (on the bubbles)	**(1)** **(1)**	**2**
14(c)	Cooling will increase the viscosity	**(1)**	**1**
	Total for question 14		**6**

Question Number	Answer	Mark
15(a)(i)	As the same volume of water is entering as leaving (the jet ski per second) **Or** as the flow rate of water must be constant **(1)** To create a resultant forward force **Or** for a narrower pipe the force (per second) on the water will be greater **Or** for a narrower pipe the velocity will be greater **(1)**	**2**
15(a)(ii)	Jet ski applies a force to the ejected water **(1)** Water applies an equal and opposite force (on the jet ski) due to N3 **(1)** According to N1/2 the resultant force acting on Jet Ski causes it to accelerate **(1)**	**3**
15(b)	3 cm vertical line drawn at either end of the 19 m s^{-1} line **(1)** with an upwards arrow **(1)** Correct resultant drawn on to the vector diagram, either to create a triangle of forces or a parallelogram with correct direction shown **(1)** Resultant velocity = 16-17 m s^{-1} **(1)** Direction of the resultant velocity = 12 ° to 14º south of east **(1)** 	**5**
	Total for question 15	**10**

Question Number	Answer		Mark
*16(a)(i)	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Increase the release speed Increase the launch angle Increases the vertical component of the initial velocity **Or** increases $u\sin\theta$ So the ball goes higher	 **(1)** **(1)** **(1)** **(1)**	**4**
16(a)(ii)	Use of $E_k = ½ mv^2$ (using v = 38 m s^{-1}) Use of $P = E/t$ P = 47 W Example of calculation Power = $\frac{\frac{1}{2} \times 0.058 \text{ kg} \times (38 \text{ m s}^{-1})^2}{0.90 \text{ s}}$ = 46.5 W	**(1)** **(1)** **(1)**	**3**
16(b)(i)	Only a component of the (initial) velocity will be in the direction OA The detector does not detect the (perpendicular) component of the velocity	**(1)** **(1)**	**2**
16(b)(ii)	**Either** Use of trig to determine the direction of the serve Use of trig to determine component of the velocity(v_{OA}) in the direction OA Percentage error = 2.4 % **Or** v_{OA} = 0.98 of the initial velocity **Or** Use of Pythagoras to determine the distance OB **and** OB – OA Use of (OB – OA)/OB Percentage error = 2.4 % Example of calculation Direction of serve along OB = $\tan^{-1}(\frac{4.1 \text{ m}}{18.3 \text{ m}})$ = 12.6° Component of initial (horizontal) velocity in direction of camera = $u\cos 12.6° = 0.976u$ percentage error = $\left(\frac{u-0.98u}{u}\right) \times 100$ = 2.4 %	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for question 16		**12**

Question Number	Answer	Mark
17(a)	At terminal velocity, the drag is the same for both position X and position Y **(1)** Identify that the terminal velocity v and the cross-sectional area A are the only variables **Or** $A \propto 1/v^2$ **(1)** Vertical position X has a greater cross-sectional area (so will have the smaller terminal velocity) **(1)**	**3**
17(b)(i)	Use of surface area of coin = $\pi(d/2)^2$ **(1)** See or use of $mg = \frac{1}{2} C\rho A v^2$ **(1)** v = 14.5 (m s^{-1}) **(1)** Example of calculation Cross sectional area of coin = $\pi \times (\frac{0.021 \text{ m}}{2})^2 = 3.46 \times 10^{-4}$ m^2 At terminal velocity weight = drag $0.048 \text{ N} = \frac{1}{2} C\rho A v^2$ $0.048 \text{ N} = \frac{1}{2} \times 1.1 \times 1.2 \text{ kg m}^{-3} \times 3.46 \times 10^{-4} \text{ m}^2 \times v^2$ $v = \sqrt{210.2} = 14.5 \text{ m s}^{-1}$	**3**
17(b)(ii)	Use of $v = s/t$ with the terminal velocity to calculate the approximate time for the coin to reach the ground **(1)** Use of $v = s/t$ to calculate the horizontal distance travelled **(1)** s = 13 m (ecf from (b)(i)) **(1)** Example of calculation Time to reach the ground = $\frac{305 \text{ m}}{14.5 \text{ m s}^{-1}} = 21.0$ s Horizontal distance travelled = 0.60 m s^{-1} × 21.0 s = 12.6 m	**3**
17(c)	Use of $v^2 = u^2 + 2as$ with $u = 0$ **(1)** v = 77.4 m s^{-1} **(1)** Ratio of speeds = 5.3 (ecf from (b)(i)) **(1)** Example of calculation $v^2 = 0 + (2 \times 9.81 \text{ N kg}^{-1} \times 305 \text{ m})$ $v = 77.4 \text{ m s}^{-1}$ Ratio of speeds = $\frac{77.4 \text{ m s}^{-1}}{14.5 \text{ m s}^{-1}} = 5.3$	**3**
	Total for question 17	**12**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>18(a)(i)</td><td>Correct use of trig Or see 18sin20
Total force of wire on tooth = 12 N

<u>Example of calculation</u>
Total force = 2 × 18 N × sin 20 = 12.3 N</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>18(a)(ii)</td><td>Correct use of trig to determine perpendicular component of tension
Or see 18cos 20
Or see 17 N
Or a statement that the perpendicular components have the same magnitude

Addition of the two perpendicular components with a correct conclusion
Or a statement identifying that the perpendicular forces are in opposite directions so will cancel out.
e.g. 17 N – 17 N = 0 so there will be no force (and no movement) in a perpendicular direction.</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td>18(b)</td><td>Use of $\sigma = F/A$ Or $\varepsilon = \Delta x/x$ Or see $E = \frac{Fx}{A\Delta x}$

Use of $E = \sigma/\varepsilon$ Or use of $E = \frac{Fx}{A\Delta x}$

$\Delta x = 2.8 \times 10^{-4}$ m

<u>Example of calculation</u>
$\sigma = \frac{18\text{ N}}{(7.1 \times 10^{-8}\text{ m}^2)} = 2.54 \times 10^8$ Pa
$\varepsilon = \frac{\Delta x}{(8.4 \times 10^{-2}\text{ m})}$

$7.5 \times 10^{10}\text{ Pa} = \frac{(2.54 \times 10^8\text{ Pa})}{\Delta x/(8.4 \times 10^{-2}\text{ m})}$
$\Delta x = 2.84 \times 10^{-4}$ m</td><td>(1)

(1)

(1)</td><td>3</td></tr>
<tr><td>18(c)(i)</td><td>Comparison of a property linked to correct evidence from graph
<table>
<tr><th>Comparison of properties</th><th>Evidence from graph</th></tr>
<tr><td>steel is stiffer or steel has a greater young modulus</td><td>steeper gradient</td></tr>
<tr><td>Steel is stronger</td><td>greater breaking stress</td></tr>
<tr><td>Steel is not as tough</td><td>Smaller area under the graph</td></tr>
<tr><td>Nickel titanium is more elastic</td><td>Nickel-titanium has a greater strain before/at elastic limit</td></tr>
<tr><td>Nickel-titanium is more ductile</td><td>Greater stress/strain in plastic region</td></tr>
</table></td><td>(1)(1)
(1)(1)
(1)(1)
(1)(1)</td><td>6</td></tr>
<tr><td>18(c)(ii)</td><td>Steel would be used for: teeth that are difficult to move
Or steel would be used if a greater force is required

Nickel-titanium would be used if the teeth have to move large distances

Steel applies a greater stress at the elastic limit
Or Nickel-titanium has a greater strain at the elastic limit</td><td>(1)

(1)

(1)</td><td>3</td></tr>
<tr><td></td><td>Total for question 18</td><td></td><td>16</td></tr>
</table>

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