Mark Scheme (Results)

January 2015

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH01) Paper 01

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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] **3**
[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

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.

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

Question Number	Answer	Mark
11(a)	Use of $W = mg$ (1) Use of $F = (-)\,kx$ (1) $k = 123$ (N m^{-1}) (1) (use of $g = 10$ N kg^{-1} → 125 (N m^{-1}) scores 2 marks) <u>Example of calculation</u> $W = 0.1$ kg × 9.81 N kg^{-1} = 0.981 N (−) 0.981 N = (−) k × 0.008 m $k = 122.6$ N m^{-1}	**3**
11(b)	(If the load is too high) the <u>elastic limit</u> (of the spring) will be exceeded **Or** the maximum load is at the <u>elastic limit</u> (1) (accept 1.2 kg/12 N for maximum load) The spring will not return to its original length/position **Or** the spring will be permanently deformed (1) The idea that the calibrations of the scale will not be correct e.g. the calibration/scale is now incorrect/inaccurate **Or** the spring constant will change (1) (Accept converse argument for keeping the load below the maximum load)	**3**
	Total for question 11	**6**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>12(a)</td><td>
<table>
<tr><th>Stage of jump</th><th>Energy transfer</th></tr>
<tr><td>freefall jump</td><td>Gravitational potential energy → kinetic energy</td></tr>
<tr><td>deceleration as the bungee rope stretches</td><td>Gravitational potential energy and/or kinetic energy→ elastic potential/strain energy</td></tr>
<tr><td>upwards motion as the bungee rope contracts</td><td>Elastic potential/strain energy → gravitational potential energy and kinetic energy</td></tr>
</table>
(Ignore any additional energy transfers e.g. due to the effects of air resistance)
(Only penalise once for an omission of potential or strain with elastic or gravitational potential energy)</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>12(b)(i)</td><td>Use of $E_{grav} = mgh$ (with either 65 m or 55 m)
E_{grav} = 29 (kJ)

<u>Example of calculation</u>
$E_{grav} = 54 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 55 \text{ m}$
$E_{grav} = 2.91 \times 10^4 \text{ J}$</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>12(b)(ii)</td><td>Calculation of the extension Or (55 – 23) seen
Use of $E = ½F\Delta x$ to find force
F = 1800 N (ecf from (b)(i))

(Using show that value F = 1875 N)

<u>Example of calculation</u>
Δx= 55 m – 23 m = 32 m
$F = \frac{2 \times 2.9 \times 10^4 \text{ J}}{32 \text{ m}}$
F = 1813 N</td><td>(1)
(1)
(1)</td><td>3</td></tr>
<tr><td></td><td>Total for Question 12</td><td></td><td>7</td></tr>
</table>

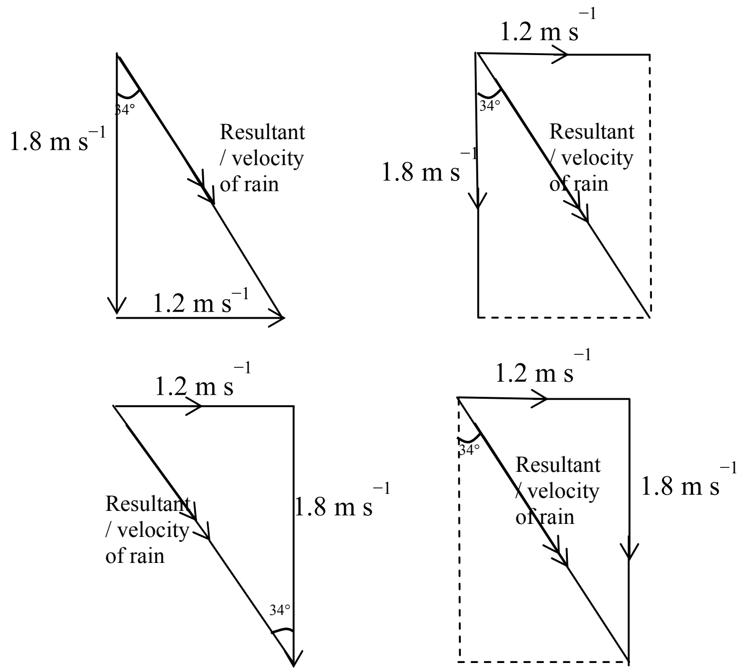
<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>13</td><td>Explanation in terms of N3 (stated or implied)
e.g due to N3, magnet A exerts a force on magnet B
Or magnet A exerts a force on magnet B and magnet B exerts an equal and opposite force on magnet A
Or the magnets exert equal and opposite forces on each other

The idea that the magnets are connected to the same body/each other

There will be no resultant force
Or the two (applied) forces will cancel out
Or forces balance/equilibrium</td><td>(1)

(1)

(1)</td><td>3</td></tr>
<tr><td></td><td>Total for Question 13</td><td></td><td>3</td></tr>
</table>

Question Number	Answer		Mark
14	An attempt at a vector diagram constructed with 1.8 vertically and 1.2 horizontally (accept any labelling in ratio of 3:2)	(1)	
	Correct vector diagram with velocities labelled (as in MP1) and velocities and resultant in the correct direction	(1)	
	Diagram to scale, either scale stated or lengths in ratio 3:2	(1)	
	$v = 2.2\ \text{m s}^{-1} \pm 0.1\ \text{m s}^{-1}$	(1)	
	Direction = 34° ± 1°	(1)	**5**
	<u>Example of calculation</u> $v = \sqrt{1.8^2 + 1.2^2}$ $v = 2.16\ \text{m s}^{-1}$ e.g. for walking to the right (reverse for walking to the left)  		
	Total for Question 14		**5**

Question Number	Answer	Mark
15(a)	Correct trajectory (1) e.g. 	**1**
15(b)(i)	Use of trig function appropriate to calculate the horizontal component of velocity **Or** 2.25 (m s^{-1}) seen (1) Use of $v = s/t$ (1) time = 0.67 (s) (1) <u>Example of calculation</u> $u_h = 4.5\ m\ s^{-1} \times \cos 60° = 2.25\ m\ s^{-1}$ $t = \frac{1.5\ m}{2.25\ m\ s^{-1}}$ $t = 0.67$ s	**3**
15(b)(ii)	Use of trig function appropriate to calculate the vertical component of velocity **Or** 3.9 (m s^{-1}) seen (1) Use of suitable equation(s) of motion to find the vertical displacement from the release point after 0.67 s (1) Displacement from release point = 0.41 **-** 0.42 m (ecf for *t* from (b)(i)) (1) (show that value of 0.7 s gives displacement = 0.32 m – 0.33 m) Statement to explain why the ball will miss/overshoot the ring e.g. the ball passes below the net **Or** the ball will not have reached the height of the ring yet **Or** 0.41 < 0.7 **Or** ball undershoots ring (Explanation must be consistent with the calculated value of displacement) (1) <u>Example of calculation</u> $u_v = 4.5\ m\ s^{-1} \times \sin 60° = 3.9\ m\ s^{-1}$ $s = (3.9\ m\ s^{-1} \times 0.67\ s) + (-½ \times 9.81\ m\ s^{-2} \times (0.67\ s)^2)$ $s = 0.41$ m	**4**
15(b)(iii)	The ball would be travelling with a decreas<u>**ing**</u> (horizontal) speed **Or** there would be a (horizontal) deceleration (1) The (calculated) time would increase (1)	**2**
	Total for question 15	**10**

Question Number	Answer	Mark
16(a)(i)	Can withstand large stress/ force / tension **Or** requires a large stress/force to fracture (1)	**1**
***16(a)(ii)**	(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) **Max 4 (any two properties and corresponding explanations)** Higher elastic limit (1) so will return to its original length/shape if greater forces are applied (if a fly flies into it for the same thickness of silk) (1) Higher ultimate /breaking <u>stress</u> (1) so stronger **Or** higher strength **Or** so the thread could be thinner (so less visible to the fly) **Or** for same (cross-sectional)area can withstand larger force (1) Larger area under the graph (1) so tougher **Or** can absorb more energy (and will not break if a fly stretches the web) (1) Larger gradient **Or** steeper **Or** greater Young modulus **Or** smaller strain/extension for the same stress/force (1) so stiffer (1)	**4**
16(b)(i)	Use of the gradient **Or** correct use of pair of values from linear section of the graph (up to 0.05 for strain) (1) Young modulus = 1.5×10^9 Pa (Accept from 1.45×10^9 Pa to 1.65×10^9 Pa) (1) <u>Example of calculation</u> Gradient = $\frac{88 \times 10^6 \text{ Pa}}{0.059}$ Young Modulus = 1.49×10^9 Pa	**2**
16(b)(ii)	Use of E = σ/ε **Or** uses σ = 44 (MPa) read from graph (1) Use of ε = 0.03 (or lengths equal to this) (1) Use of $\sigma = \frac{F}{A}$ (1) $r = 2.0 \times 10^{-6}$ m (ecf from part (b)(i) for YM) (1) (Accept answers in the range 1.9×10^{-6} m to 2.1×10^{-6} m) <u>Example of calculation</u> Stress = 1.49×10^9 Pa × 0.03 = 4.47×10^7 Pa $A = \frac{580 \times 10^{-6} \text{ N}}{4.47 \times 10^7 \text{ Pa}} = 1.30 \times 10^{-11} \text{ m}^2$ $r = \sqrt{\frac{1.30 \times 10^{-11} \text{ m}^2}{\pi}} = 2.03 \times 10^{-6}$ m	**4**
	Total for question 16	**11**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>17(a)(i)</td><td>Use of work done = force × distance
Work done = 91(J)

<u>Example of calculation</u>
Work done = 65 N × 1.4 m
Work done = 91 J</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>17(a)(ii)</td><td>Use of power = $\frac{\text{work done}}{\text{time}}$

Power = 83 W (ecf from (a)(i))

(Show that value gives P = 82.5 W)

<u>Example of calculation</u>
Power = $\frac{91\ \text{J} \times 55}{60\ \text{s}}$
Power = 83.4 W</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td>*17(b)(i)</td><td>(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)

Velocity is decreasing Or the swimmers are decelerating

Rate of change of velocity decreases Or deceleration/acceleration decreases Or Drag force decreases as speed decreases

Glide 2 has a greater drag/resistance/friction

Explanation of why the drag force of 2 is greater than 1
e.g. cross sectional area is greater Or more turbulent flow Or less streamlined</td><td>(1)
(1)
(1)
(1)</td><td>4</td></tr>
<tr><td>17(b)(ii)</td><td>See: $C \times \text{kg m}^{-3} \times \text{m}^2 \times (\text{m s}^{-1})^2$ (in equation)
See force/ N /LHS = kg m s^{-2}

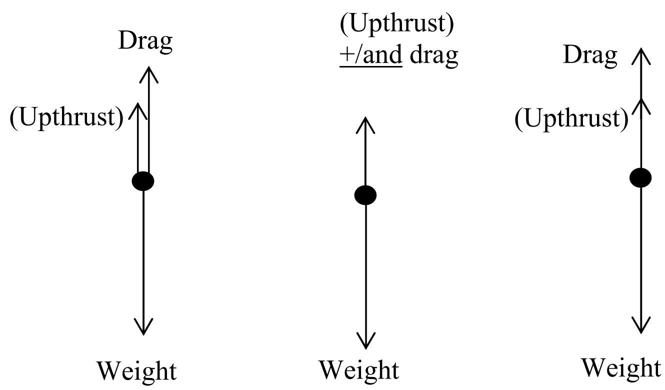
<u>Example</u>
$\text{kg m s}^{-2} = C \times \text{kg m}^{-3} \times \text{m}^2 \times \text{m}^2\ \text{s}^{-2}$
$C = \frac{\text{kg m s}^{-2}}{\text{kg m}^{-3} \times \text{m}^2 \times \text{m}^2 \text{s}^{-2}}$
$C = \frac{\text{kg m s}^{-2}}{\text{kg} \times \text{m} \times \text{s}^{-2}}$</td><td>(1)
(1)</td><td>2</td></tr>
</table>

17(b)(iii)	Wear tight fitting clothes **Or** swimming hats **Or** body shaving **Or** wear fastskins (1) To reduce turbulent flow **Or** the idea that there will be more laminar flow **Or** reduce viscous drag (of water) (1) **Or** Keep their body as flat as possible in the water (1) to keep their cross sectional area as small as possible (1) **Or** Roll the body as they swim (1) To reduce the size of the waves created (1) **Or** Swim at a slower speed (1) as velocity(^{2}) of the swimmer is proportional to the drag (1) (Do not credit references to increasing the temperature of the water, reducing the density of the water, wearing smooth clothes, using oil)	**2**
	Total for question 17	**12**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>18(a)(i)</td><td>Weight Or W Or mg (1)

(Viscous) drag Or (air)resistance Or D (1)

Minus 1 for additional forces except electric forces


</td><td>2</td></tr>
<tr><td>18(a)(ii)</td><td>Drag increases as the velocity increases
Or the velocity of the drop increases and the drag is proportional to velocity(^{2}) (1)

Resultant/total force becomes zero
Or weight − drag − upthrust = 0
Or forces balance (1)
(Do not accept ΣF = 0 unless F is defined)
(ecf incorrect label only but not incorrect direction or forces from (a)(i) in a stated equation)</td><td>2</td></tr>
</table>

18(b)(i)	Use of $v = s/t$ $v = 8.6 \times 10^{-4}$ (m s^{-1}) <u>Example of calculation</u> $v = \frac{10.2 \times 10^{-3}\ \text{m}}{11.9\ \text{s}}$ $v = 8.57 \times 10^{-4}$ m s^{-1}	(1) (1)	**2**
18(b)(ii)	Use of density = m/V **and** $W = mg$ **Or** see $W = \rho V g$ Use of Drag force = $6\pi r \eta v$ See or use of $V = 4/3\pi r^3$ $r = 2.8 \times 10^{-6}$ (m) (ecf for velocity from part (iv)) (Using show that value r = 3.0(1)× 10^{-6} (m)) <u>Example of calculation</u> Weight = drag $4/3\ \pi r^3 \times 920$ kg $m^3 \times 9.81$N $kg^{-1} = 6 \times \pi \times r \times 1.82 \times 10^{-5}$ Pa s $\times 8.57 \times 10^{-4}$ m s^{-1} $r = 2.79 \times 10^{-6}$ m	 (1) (1) (1) (1)	**4**
18(b)(iii)	**Max 2** The drop is too/very small The idea that the drop's shape is easily changed e.g. it is only a drop when falling **Or** if placed on a surface to measure, it would flatten The idea that there is no suitable measuring equipment for a small drop e.g. the precision of most measuring devices is too low for the size of the drop	 (1) (1) (1)	**2**
18(c)	Viscosity (of air) changes with temperature Velocity/drag changes if the temperature/viscosity (of air) changes (To score either mark it must be clear that the viscosity of air is being discussed and not that of the oil/liquid)	(1) (1)	**2**
18(d)	The idea that Stokes law doesn't apply (to ball bearing falling through air) **Or** a statement that laminar flow is needed Ball bearing would: not reach its terminal velocity **Or** be accelerating **Or** need to be dropped from a greater height **Or** need to fall through a medium such as oil	 (1) (1)	**2**
	Total for Question 18		**16**

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