Mark Scheme (Results)

January 2017

Pearson Edexcel
International Advanced Subsidiary Level
in Physics (WPH01)
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.

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.

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 e.g. '**and'** when two pieces of information are needed for 1 mark.

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 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.

2.4 Occasionally, it may be decided not to insist on a 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.

2.5 The mark scheme will indicate if no unit error is to be applied by means of [no ue].

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not be prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 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 mean that one mark will not be awarded. (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

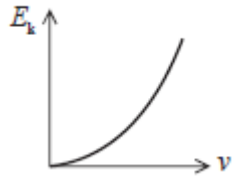
4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

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.

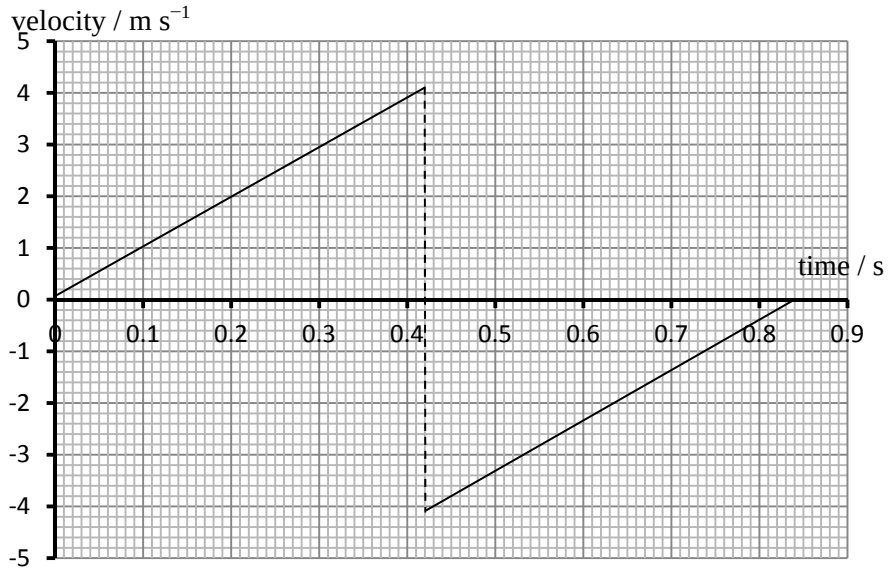
<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1</td><td>D kg m^2 s^{-2}</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – the units for mass × velocity expressed in base units
B – the units for mass × acceleration expressed in base units
C – the units for mass × velocity × distance expressed in base units</td><td></td></tr>
<tr><td>2</td><td>D As $E_k = ½ mv^2$ a graph of E_k against v would have the same shape as a $y = x^2$ graph

</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – this graph assumes E_k is proportional to v
B – this graph assumes E_k is proportional to $-v$
C − this graph assumes E_k is proportional to $-v^2$</td><td></td></tr>
<tr><td>3</td><td>A Fd</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers: (all due to incorrect variables selected from information given)
B – Ft is the impulse on the block due to the applied force F
C – Fv is the power developed by the block
D – mgd would be the work done had the block moved a distance d due to the gravitational force and not the applied force F</td><td></td></tr>
<tr><td>4</td><td>C 40 $\sqrt{20^2 + 20^2}$</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – the distance is incorrect and the displacement is correct
B – the distance is incorrect and the displacement is incorrect
D − the distance is correct and the displacement is incorrect</td><td></td></tr>
<tr><td>5</td><td>C 0.850 m</td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers: a metre rule measures to 3 sf so the final answer must be to 3 sf regardless of the units used
A – answer to 2 sf in cm
B – answer to 2 sf in m
D – answer to 2 sf in m (using standard form)</td><td></td></tr>
<tr><td>6</td><td>C
<table><tr><th colspan="2">Group 1</th><th colspan="2">Group 2</th></tr><tr><th>Reliable</th><th>Valid</th><th>Reliable</th><th>Valid</th></tr><tr><td>×</td><td>✓</td><td>✓</td><td>✓</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>Incorrect Answers:
A – Group 2 is reliable as the results produced using a data logger should produce similar results
B – Group 1’s results are not reliable due to errors using a stopwatch producing a variation in the results however Group 2’s results are reliable. Using a stopwatch is valid for Group 1(and Group 2) as a time measurement is one method to determine g
D – Group 2’s results are reliable.</td><td></td></tr>
</table>

7	**B decreased by $(2.4 \times 10^{-5}) \times (1000) \times (9.81)$**	**1**
	Incorrect Answers: A – this is just the mass of the displaced water C – the reading will decrease and not increase due to the upthrust acting upwards on the object by the weight, and not the mass, of the displaced water (upthrust) D − the reading will decrease and not increase due to the upthrust acting upwards on the object	
8	**B to the left of O**	**1**
	Incorrect Answers: the centre of mass has moved to the left of O. The right-hand half has double the density but half the diameter so the weight is $(2 \times \frac{1}{(2)^2} =) \frac{1}{2}$ the original weight. The pivot needs to be placed under the centre of gravity for the rod to balance. A – O is no longer the position of the centre of gravity C – The centre of gravity is to the left of O and not the right D – There is a balance point but, so that there is equal weight either side of the centre of gravity, its position has moved to the left	
9	**D weak under tension and strong under compression**	**1**
	Incorrect Answers: A – Concrete is not strong under tension B – Concrete is neither strong under tension nor weak under compression C − Concrete is strong under compression	
10	**C 0.71 J**	**1**
	Incorrect Answers: A – mass not multiplied by g to obtain weight i.e. ½ × m × Δx used B – mass not multiplied by g to obtain weight and 3 × original length used as extension D −3 × original length used as extension	

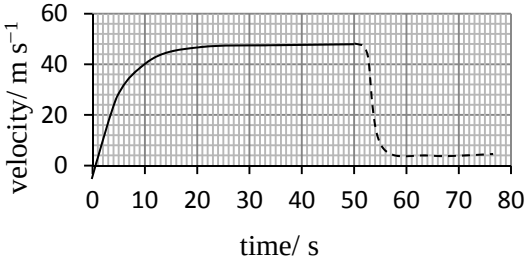
Question Number	Answer		Mark
11	Use of $E_k = ½ mv^2$	**(1)**	
	See or use of: input power = ½ (mass per second) (wind speed)^2 **Or** input power = E_k per unit time (accept candidate's energy/time)	**(1)**	
	Mass = 64 kg s^{-1} **Or** 64 kg	**(1)**	**3**
	Example of calculation 3.2×10^3 W = ½ × (mass per second) × (10 m s^{-1})^2 Mass per second = 64 kg s^{-1}		
	Total for question 11		**3**

Question Number	Answer		Mark
12(a)	Extension is (directly) proportional to force	(1)	
	if the limit of proportionality is not exceeded	(1)	**2**
12(b)	**Max 2** There is a greater extension for the same change/increase in force	(1)	
	The extension is not proportional to the (applied) force	(1)	
	Beyond the elastic limit it will plastically deform	(1)	
	Until the elastic limit it will return to its original length/shape when the (applied) force is removed **Or** Beyond the elastic limit it will not return to its original length/shape when the (applied) force is removed	(1)	**2**
	(accept yield point for elastic limit but do **not** accept stress and strain for force and extension)		
	Total for question 12		**4**

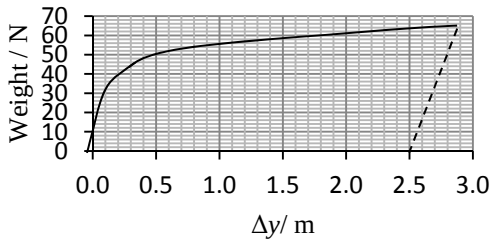
Question Number	Answer		Mark
13	Use of $v = u + at$	(1)	
	Axes scaled correctly (+ and – velocity and time axes scaled appropriately)	(1)	
	Line from (0, 0) to (0.42, 4.1)	(1)	
	Vertical line linking positive and negative velocity (accept use of candidate's velocity, allow 1 square tolerance)	(1)	
	Line from (0.42, −4.1) to (0.84, 0) (accept candidate's velocity)	(1)	**5**

	(accept the negative version of this graph, taking positive as upwards) Example of calculation $v = 0 + (9.81 \text{ N kg}^{-1})(0.42 \text{ s}) = 4.12 \text{ m s}^{-1}$  	
	Total for question 13	**5**

Question Number	Answer		Mark
14(a)	(At low temperature) the glass is <u>brittle</u>	(1)	
	At high temperatures: glass is <u>ductile</u> **Or** the <u>viscosity</u> decreases **Or** the glass is less <u>viscous</u>	(1)	
	(Brittle means) little or no plastic extension **Or** (ductile means) large plastic extension	(1)	**3**
14(b)	(At high(er) temperatures) the viscosity is low(er) **Or** temperature is inversely proportional to the viscosity	(1)	
	The idea that the glass can then <u>flow</u>	(1)	**2**
	Total for question 14		**5**

Question Number	Answer		Mark
***15(a)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** Initially: drag = 0 **Or** $a = g$ **Or** maximum acceleration **Or** initially weight = resultant force **Or** weight is the only force acting	(1)	
	drag increases with velocity/speed **Or** drag is proportional to velocity/speed (squared)	(1)	
	resultant force decreases	(1)	
	Until drag (+ upthrust) = weight **and** acceleration is now zero (so gradient is zero) **Or** resultant force = 0 **and** acceleration is now zero (so gradient is zero)	(1)	**4**
	(MP4 allow velocity is constant or terminal velocity is reached for acceleration is zero)		
15(b)	Sudden decrease in velocity (straight line but not vertical or a curve over maximum of 10 s)	(1)	
	To a new, lower (greater than 0) value of terminal velocity for at least 5 s	(1)	**2**
			
15(c)(i)	Terminal velocity increases as weight/mass increases	(1)	
	A greater drag force is needed to equal the (increased) weight **Or** a greater drag force to make the resultant force zero	(1)	**2**
15(c)(ii)	Increase drag force	(1)	
	The idea that he should make a less streamlined shape as he falls **Or** increase surface area (MP2 cannot be awarded if there is any reference to the parachute)	(1)	**2**
15(d)	The skydiver with the open parachute slows down	(1)	
	The skydiver that is filming remains at constant/terminal velocity/speed **Or** the film shows relative velocity (between the two skydivers)	(1)	**2**
	(MP2 is not awarded if there is a description of the filming skydiver accelerating)		
	Total for question 15		**12**

Question Number	Answer		Mark
16(a)(i)	Pull of box on man **and** pull of man on box	**(1)**	**1**
16(a)(ii)	Difference (act on) different objects **Or** opposite direction	**(1)**	
	Similarity (Same) type of force **Or** (same) line of action **Or** act for same time	**(1)**	**2**
16(b)(i)	Use of $W = mg$	**(1)**	
	See mg – 620	**(1)**	
	See Tsin35 or Tcos55	**(1)**	
	Pull of man (T) = 370 (N)	**(1)**	**4**
	Example of calculation Vertical component of the force of the man on the box = T sin35° Resultant vertical force = (85 kg × 9.81 N kg^{-1}) – 620 N − T sin35° = 0 T = 373 N		
16(b)(ii)	See 370cos35 **Or** (85g – 620)tan55	**(1)**	
	Identify that 370cos35 or (85g – 620)tan55 is the frictional force required	**(1)**	
	Friction = 310 N (ecf for T from (b)(i))	**(1)**	
	Or		
	Use of Pythagoras (with any vertical force and tension from part (b)(i))	**(1)**	
	Use of correct resultant vertical force with Pythagoras	**(1)**	
	Friction = 310 N (ecf for T from (b)(i))	**(1)**	**3**
	(F = 328 N using 'show that value'. Using g = 9.8 gives F = 304 N)		
	Example of calculation Horizontal component of the force of the man on the box =(373 N)cos35° Resultant force = (373 N)(cos35°) − F = 0 F = 305.5 N		
16(b)(iii)	Use of $F = ma$	**(1)**	
	m = 85 kg +90 kg	**(1)**	
	Use of F= friction on man – friction on box	**(1)**	
	Friction on man = 340 N (ecf value from b(ii))	**(1)**	**4**
	(friction on man = 363 N using show that value)		
	Example of calculation F = (85 kg +90 kg) × 0.200 m s^{-2} = 35 N 35 N = friction on man – 306 N Friction on man = 341 N		
	Total for question 16		**14**

Question Number	Answer		Mark
17(a)	Take (multiple) readings along the wire **and** calculate the mean **Or** take (multiple) reading**s** at different orientations **and** calculate the mean	(1)	
	Using a micrometer (screw gauge) **Or** digital callipers	(1)	**2**
17(b)	The idea that the extension is small	(1)	
	The idea that the optical lever magnifies the measurement **Or** the optical lever reduces the percentage uncertainty/error of the Measurement	(1)	**2**
17(c)(i)	Use of a corresponding pair of points within the linear region (up to $\Delta y = 0.25$ m) **Or** uses gradient of linear region	(1)	
	Correct substitution into $\Delta l = \frac{d\Delta y}{2D}$	(1)	
	Use of $\sigma = F/A$ **and** $\varepsilon = \Delta l/l$ (F and Δl must be corresponding values for MP3)	(1)	
	Use of $E = \sigma/\varepsilon$	(1)	
	Young modulus = (1.0 – 1.2) × 10^{11} Pa	(1)	**5**
	Example of calculation Using points (0.22m, 30 N) $\Delta l = \frac{0.055\text{ m} \times 0.22\text{ m}}{2 \times 7.0\text{ m}} = 8.64 \times 10^{-4}$ m $\sigma = \frac{30\text{ N}}{2.0 \times 10^{-7}\text{m}^2} = 1.50 \times 10^{8}$ Pa $\varepsilon = \frac{8.64 \times 10^{-4}\text{ m}}{0.65\text{ m}} = 1.33 \times 10^{-3}$ $E = \frac{1.50 \times 10^{8}\text{Pa}}{1.33 \times 10^{-3}} = 1.13 \times 10^{11}$ Pa		
17(c)(ii)	**Added line must join end of given graph and have a positive, non-vertical gradient to score either mark**.		
	Added graph a straight line (ignore the value of the gradient of the straight line and allow a slight curve at the top)	(1)	
	Final displacement greater than 0 m for zero added mass (i.e. permanent deformation)	(1)	**2**
			
	Total for question 17		**11**

***18(a)**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** (A lower start height would) decrease the (initial) GPE (1) At take-off KE is lower. (1) Travels less distance **Or** (take off)velocity lower **Or** velocity (during flight) is lower (1) Landing velocity/force/impact is lower (and the jump is safer.) (1)	**4**
18(b)(i)	Use of $v = u + at$ for vertical motion (1) Vertical component of velocity after 4.0 s = 39.2 (m s^{-1}) (1) Use of trigonometry with two velocities to obtain direction (1) Direction = 54° to 55 ° (1) <u>Example of calculation</u> $v = 0 + (9.81\ \text{N kg}^{-1})(4.0\ \text{s})$ $v = 39.2\ \text{m s}^{-1}$ direction to horizontal = $\tan^{-1}\left(\frac{39.2\ \text{m s}^{-1}}{28\ \text{m s}^{-1}}\right)$ direction to horizontal = 54.46°	**4**
18(b)(ii)	**Either** Use of $s_v = ½\ gt^2$ **Or** use $s_H = v_H t$ (1) Use of trig or Pythagoras to obtain the distance along the slope of landing from start position (1) Subtract 120 from distance along slope (1) Points = 89 to 91 (points) (1) **Or** use $s_H = v_H t$ (1) calculates horizontal distance to k-point s_k (120 cos 35) (1) use of (s_H - s_k) / cos 35 (1) Points = 89 to 91 (points) (1) <u>Example of calculation</u> $s = 0 + (½ \times 9.81\ \text{N kg}^{-1} \times (4.0\ \text{s})^2) = 78.5\ \text{m}$ Distance travelled along slope = 78.5/sin 35 = 136.9 m Distance travelled beyond K-point = 136.9 m – 120 m = 16.9 m points scored = 60 + (1.8 × 16.9) = 90.4 points	**4**

18(c)	**Either** Air resistance **Or** drag **Or** friction due to the air (allow 'friction' unless they have stated it is between skis and snow)	(1)	
	Vertical acceleration reduced **Or** causes a horizontal deceleration	(1)	
	velocity reduced	(1)	
	Shorter distance travelled (so lands higher up)	(1)	
	Or Lift	(1)	
	Air exerts upward force on skis	(1)	
	Vertical acceleration is lower	(1)	
	Greater distance travelled so landing position lower down	(1)	**4**
	Total for question 18		**16**

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