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Mark Scheme (Results)

January 2016

Pearson Edexcel International Advanced 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.

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

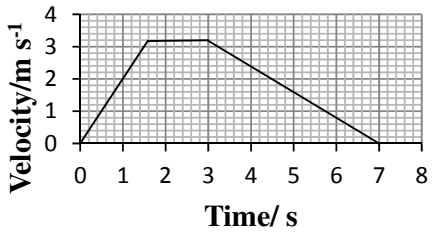
Question Number	Answer	Mark
11(a)	work done = energy transferred **Or** Work done (against gravity) is equal to the (gain in) gravitational potential energy (1) The distance moved is the height the box is raised by **and** the force to be used must be equal to the weight **Or** $\triangle h = \triangle$s **and** $F = mg$ (1)	**2**
11(b)	Use of $\Delta E_{grav} = mg\Delta h$ (1) $\Delta E_{grav} = 74$ J (1) Example of calculation $\Delta E_{grav} = 5.0 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 1.5 \text{ m}$ $\Delta E_{grav} = 73.6$ J	**2**
	Total for Question 11	**4**

Question Number	Answer		Mark
12(a)	$mg = ma$ either leading to a = g or a statement that the masses cancel	(1)	**1**
	Example of answer $F = ma$ and $W = mg$ $mg = ma$ $a = g$		
12(b)(i)	$s = ½at^2$ **Or** $a = 2s/t^2$ **Or** $s = ut + ½ at^2$ **and** $u = 0$	(1)	**1**
	(allow g for a and h for s)		
12(b)(ii)	**Either**		
	Parallax(in measuring s) **Or** the ruler was not vertical/perpendicular	(1)	
	Giving a larger value for s (than the actual value)	(1)	
	Or		
	The frame rate was incorrect **Or** the idea that the initial velocity of the ball was not zero	(1)	
	Giving a lower value for the measured time	(1)	**2**
	Examples The ball was dropped before the camera started recording or the ball was dropped before the first frame or the ball was dropped from above the ruler. (Do not accept ball was thrown)		
	Total for Question 12		**4**

Question Number	Answer		Mark
13(a)(i)	Stress needed to fracture/break (do not accept a definition of strong)	(1)	**1**
13(a)(ii)	Resistance to indentation/scratching **Or** resistance to plastic deformation of the surface	(1)	**1**
13(b)	**Max 4** (Brass is) strong **Or** high breaking stress (accept high breaking force) **Or** breaking stress is much greater than 10 MPa. so the key will not break (Conditional on MP1) (10MPa/stress) is below the elastic limit **Or** the elastic limit is at about 300(± 50) MPa **Or** the plastic deformation starts at about 300(± 50) MPa The key would keep its shape (when the force is removed) **Or** the key would not plastically deform **Or** any deformation of the key would be elastic (Conditional on MP3) Stiff **Or** high Young's modulus The key would not change shape (as it is being used) (Conditional on MP5) (ignore references to tough and limit of proportionality and accept yield point for elastic limit)	(1) (1) (1) (1) (1)	**4**
	Total for Question 13		**6**

Question Number	Answer	Mark
***14**	**(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)** New design: is more streamlined **Or** more curved **Or** more aerodynamic (1) reduces turbulent air flow **Or** fewer eddy currents **Or** increases laminar air flow (1) less (air) resistance/drag/friction (1) less energy transferred to the air (from the lorry) **Or** less work done against (air)resistance **Or** less power/energy/work needs to be supplied to the lorry (to maintain the same speed) (1) Allow converse argument for references to the traditional trailer.	**4**
	Total for Question 14	**4**

Question Number	Answer	Mark
15(a)	See stress = $\frac{\text{N}}{\text{m}^2}$ **Or** stress = N m^{-2} (1) See strain = $\frac{\text{m}}{\text{m}}$ (1)	**2**
15(b)(i)	see $\sigma = \frac{50}{7.0(\times 10^{-2}) \times 7.0(\times 10^{-2})}$ **Or** see $E = \frac{Fx}{A\Delta x}$ (1) see $\varepsilon = \frac{2.0(\times 10^{-2})}{7.0(\times 10^{-2})}$ **Or** substitution into $E = \frac{Fx}{A\Delta x}$ with $\Delta x = 2$ ($\times 10^{-2}$ m) (1) E = (3.5 or 3.6) $\times 10^4$ Pa (1) <u>Example of calculation</u> $\sigma = \frac{50 \text{ N}}{(0.070 \text{ m})^2} = 10\,204$ Pa $\varepsilon = \frac{0.020 \text{ m}}{0.070 \text{ m}} = 0.286$ $E = \frac{10\,204 \text{ Pa}}{0.286} = 35\,678$ Pa	**3**
15(b)(ii)	The (cross sectional) area would get bigger (1) (do not allow surface area) Effect: This would give a smaller value for the Young modulus **Or** the value already calculated is too large. (1) (If the candidate just states 'YM will get smaller' without any justification, do not award any marks) (MP2 only for (cross sectional) area gets smaller leading to increase in Young modulus)	**2**
	Total for Question 15	**7**

Question Number	Answer	Mark
16(a)	Use of $v = u + at$ **Or** use of area under the graph (for either area) (1) $v = 3.2$ (m s^{-1}) (1) Example of calculation $v = 0 + (2 \text{ m s}^{-2} \times 1.6 \text{ s})$ $v = 3.2$ m s^{-1}	**2**
16(b)	Diagonal line from 0 to 3.2 m s^{-1} over first 1.6 s (1) (allow show that value or candidate's values for v and t from (a)) Region of constant, non-zero velocity (from 1.6 s to 3 s) (1) Deceleration from candidate's maximum positive velocity to 0 over last 4 s (1)  	**3**
16(c)	Use of area under their graph in (b) **Or** use of correct equation(s) of motion (1) Correct values substituted into a method for calculating the area under their graph e.g. trapezium method $3.2 \times \frac{1.4+7}{2}$ (1) $s = 13$ m (Full ecf from (b)) (1) ($s = 12.6$ m using the show that value of 3 m s^{-1} for max velocity) Example of calculation $s = (\frac{1}{2} \times 3.2 \text{ m s}^{-1} \times 1.6 \text{ s}) + (3.2 \text{ m s}^{-1} \times 1.4 \text{ s}) + (\frac{1}{2} \times 3.2 \text{ m s}^{-1} \times 4 \text{ s})$ $s = 2.56 + 4.48 + 6.4 = 13.4$ m	**3**
16(d)(i)	Use of $E_k = \frac{1}{2} mv^2$ (1) $E_k = 0.61$J (ecf for velocity from (a)) (1) (Show that value gives 0.54 J) Example of calculation $E_k = \frac{1}{2} \times 0.12 \text{ kg} \times (3.2 \text{ m s}^{-1})^2$ $E_k = 0.61$ J	**2**
16(d)(ii)	Use of power = energy/time (1) $P = 0.38$ W (ecf from (d)(i)) (1) ($P = 0.34$ W using the show that value of $v = 3$ m s^{-1}) Example of calculation $P = \frac{0.61 \text{ J}}{1.6 \text{ s}}$ $P = 0.38$ W	**2**
	Total for Question 16	**12**

Question Number	Answer		Mark
17(a)(i)	(For upward motion) the upthrust > weight (+drag) **Or** there is a resultant upward force	(1)	
	(This is because) greater volume/mass of liquid is displaced (Accept more liquid displaced)	(1)	
	Upthrust increases (and mass/weight of wax drop is constant)	(1)	**3**
17(a)(ii)	Upthrust, weight and (viscous) drag identified as the three forces	(1)	
	Correct equation e.g. upthrust = weight + drag **Or** upthrust − weight –drag = 0	(1)	**2**
	(Max 1 for undefined symbols used)		
17(b)	**Either** Temperature decreases Density of drop increases Upthrust reduces	(1) (1) (1)	
	Or Temperature decreases Viscosity (of clear liquid) greater Drag will be greater (at the top)	(1) (1) (1)	**3**
	Total for question 17		**8**

Question Number	Answer	Mark
18(a)(i)	So that it can store/transfer elastic/strain (potential) energy **Or** to produce a (restoring) force on the arm (1) (accept pull for force i.e. 'pull arm up')	**1**
18(a)(ii)	Elastic/strain (potential) energy → E_{grav} +/and E_k (+/and thermal energy) (1)	**1**
***18(b)(i)**	(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) **Either** (the greater the angle) the greater the energy (stored) (1) greater kinetic energy (transferred to projectile/arm) (1) greater (initial) (horizontal) velocity of the projectile (1) $s = ut$ linked to a greater range (1) **Or** the greater the angle the greater the force/stress/tension (1) the greater the acceleration (of the arm/projectile) (1) greater (initial) (horizontal) velocity of the projectile (1) $s = ut$ linked to a greater range (1) (Accept symbols for words)	**4**
18(b)(ii)	Increases acceleration **Or** increases (initial) velocity (of the projectile) (1)	**1**

<table>
<tr><td>18(b)(iii)</td><td>One modification (1)
One reason (1)
(Modification and reason must be linked for both marks to be awarded)

<table><tr><th>Modification</th><th>Reason</th></tr><tr><td>Double up or increase number of bands</td><td>Would increase the force/tension
Or would increase energy (stored)
Or would increase the work done</td></tr><tr><td>Replace with bands that are: stiffer or shorter or wider or have greater k (not smaller)</td><td>Would increase the force/tension
Or would increase energy (stored)
Or would increase the work done</td></tr><tr><td>Use a longer arm or raise the device to a greater height</td><td>Greater (vertical) distance to fall</td></tr><tr><td>Tilt the model or cross bar</td><td>Projectile launched with an upwards component of velocity or at an angle</td></tr></table></td><td>2</td></tr>
<tr><td>18(c)(i)</td><td>Use of $s = ut + ½\ at^2$ (1)
$t = 0.13$ (s) (1)

<u>Example of calculation</u>
$0.08\ \text{m} = ½ \times 9.81\ \text{m s}^{-2} \times t^2$
$t = 0.128$ s</td><td>2</td></tr>
<tr><td>18(c)(ii)</td><td>Use of $v = s/t$ to calculate horizontal speed Or see 10.6 (m s^{-1}) (1)
Use of $s = 10.6 \times t$ (1)
$s = 1.4$ m ecf for time from (i) (1)

(using show that value $s = 1.06$ m)

<u>Example of calculation</u>
$u_{\text{horizontal}} = \frac{1.70\ m}{0.16\ s} = 10.6\ \text{m s}^{-1}$
$s = 10.6\ \text{m s}^{-1} \times 0.13$ s
$s = 1.38$ m</td><td>3</td></tr>
<tr><td></td><td>Total for question 18</td><td>14</td></tr>
</table>

Question Number	Answer		Mark
19(a)(i)	Use of $v^2 = u^2 + 2as$ $a = 2.9$ (m s^{-2}) Example of calculation $a = \frac{(15\text{ m s}^{-1})^2 - (0\text{ m s}^{-1})^2}{2 \times 39\text{ m}}$ $a = 2.88$ m s^{-2}	(1) (1)	**2**
19(a)(ii)	Use of $F = ma$ to find a or F Maximum $a = 3.2$ m s^{-2} **Or** Force in (a)(i) $F = 580$ N(or 600 N) (3.2 m s^{-2} is the maximum acceleration because) the box must have the same acceleration as the lorry Example of calculation $a = 630\text{N}/200\text{ kg}$ $a = 3.15$ m s^{-2}	(1) (1) (1)	**3**
19(b)(i)	$W_{\text{parallel}} = W\sin\theta$ $W_{\text{perpendicular}} = W\cos\theta$ (Accept *mg*, 200*g* or 1962 for *W)*	(1) (1)	**2**
19(b)(ii)	$F = W\sin\theta$ **Or** $F = W_{\text{parallel}}$ **Or** $R = W\cos\theta$ **Or** $R = W_{\text{perpendicular}}$ Substitute $F = 0.32R$ into candidate's equation for F or R Use of $\sin\theta/\cos\theta = \tan\theta$ $\theta = 18°$	(1) (1) (1) (1)	**4**
	Total for question 19		**11**

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