Mark Scheme (Results)

Summer 2016

Pearson Edexcel AS
in Physics (8PH0 / 01)
Paper 01 – Core Physics I

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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

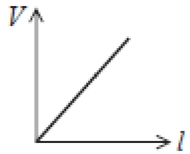
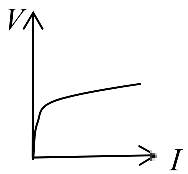
The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

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.

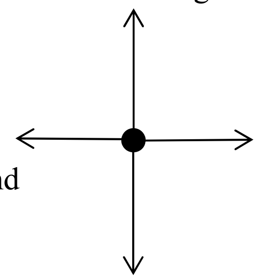
4. **Calculations**
   4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
   4.2 If a 'show that' question is worth 2 marks, then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.
   4.3 **use** of 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.

Question Number	Acceptable Answer		Additional Guidance	Mark
1	**B**	Average speed		**1**
2	**D**	−0.60 kg m s^{-1}		**1**
3	**A**			**1**
4	**D**	Work done per unit charge to move a charge around a circuit.		**1**
5	**D**	kg m s^{-2}		**1**
6	**C**	Rolling up one ramp and down a second ramp.		**1**
7	**D**			**1**
8	**C**			**1**

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
9	• Use of $P = VI$ **Or** use of $\triangle E_{grav} = mg\triangle h$ **(1)** • Use of efficiency = $\frac{\text{useful power output}}{\text{total power input}}$ **(1)** • Efficiency = 0.75 to 0.78 (or 75 % to 78%) **(1)**	Accept use of efficiency = $\frac{\text{useful energy output}}{\text{total energy input}}$ with corresponding times <u>Example of calculation</u> P_{motor} = (85×10^{-3}) A × 3.0 V = 0.255 W P_{block} = 0.05 kg × 9.81 N kg^{-1} × 0.40 m s^{-1} = 0.196 W Efficiency = $\frac{0.196\ \text{W}}{0.255\ \text{W}}$ = 0.77 (no unit)	**3**

(Total for Question 9 = 3 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
10(a)	Four forces correctly labelled (1 force correctly labelled scores one mark 2 or 3 forces correctly labelled scores two marks 4 forces correctly labelled scores three marks)		**3**

***10(b)**	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.	The following table shows how the marks should be awarded for structure and lines of reasoning	
	Indicative content • The idea that the rope is under tension	Accept tension for 'force of rope on team'	
	• Team A exerts a force on the rope and due to N3 the rope exerts a force on Team A		
	• Force of rope on team A > frictional force for Team A		
	• Team A now has a resultant force (to the right)	MP4: accept 'unbalanced' for 'resultant'	
	• Team A accelerates (to the right) due to N1/2		
	• (This is because) the frictional force between Team B and the ground is larger **Or** Team B applies a greater force (on the rope) than team A	Accept converse for MP6 but a reference to both Team A and Team B is required for MP6	**6**

Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points
6	4
5-4	3
3-2	2
1	1
0	0

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

(Total for Question 10 = 9 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
11(a)	• Use of $W = mg$ **(1)** • $W = 868$ (N) **(1)**	<u>Example of calculation</u> Mass of water = 85.0 litres × 1 kg = 85.0 kg Mass of base and water = 85.0 kg + 3.50 kg = 88.5 kg Weight of base = 88.5 kg × 9.81 N kg^{-1} = 868.2 N	**2**
11(b)	• See 868 N × 0.45 m × cos 15 (= 377.3 N m) **(1)** • See 27 N ×2.0 m × cos 75 (= 13.98 N m) **(1)** • See F_w ×2.4 m × cos 15 (= 2.31F_w) **(1)** • Use of principle of moments e.g. substitution into: moment of weight of base = moment of weight of post arrangement + moment of wind **(1)** • F_w = 157 or 158 N **(1)**	MP1 accept sin75 for cos15 MP2 accept sin15 for cos75 MP3 accept sin75 for cos15 MP4, accept > correctly used in place of = to indicate the point at which it will tip and ecf for W from 11 (a) <u>Example of calculation (using perpendicular forces)</u> Moment of weight of base = 868 N × cos 15 × 0.45 m = 377.29 Nm Moment of the post arrangement = 27.0 N × cos 75 × (2.80 m – 0.80 m) = 13.98 N m Moment of the wind = F_w × cos 15 × 2.40 m = 2.31 F_w 377.29Nm = 13.98 Nm + 2.31 F_w F_w = 157.28 N <u>Example of calculation (using perpendicular distances)</u> (868 N × 0.45 m × cos 15) = (27 N ×2.0 m × cos 75) + (F_w ×2.4 m × cos 15) F_w = 156.72 N	**5**

11(c)	• F_w would increase **(1)** • The <u>weight</u> of the base would be heavier/increase **(1)** • This increases the clockwise moment **Or** this increases the moment of the (weight of the) base **(1)**		**3**

(Total for Question 11 = 10 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
12(a)	An explanation that makes reference to the following: • The idea that the <u>electrons</u> gain energy from the light • (As the lamp is moved towards the LDR) the intensity/brightness/illumination of light falling on the LDR increases • This increased the number of (conduction) electrons • Which reduced the resistance of the LDR • decreasing the potential difference across the LDR **Or** increasing the potential difference across the fixed resistor/voltmeter	**(1)** **(1)** **(1)** **(1)** **(1)**	MP1 e.g. If the frequency of the light is high enough the electrons will gain energy from the light (and jump to the conduction band) MP2 assume the answer is in terms of the lamp moving towards the LDR unless stated otherwise MP3 accept charge carrier (density) for electrons	**5**

12(b)	• potential difference across the LDR = 3.6 V **Or** $\frac{R}{(R+75\ \Omega)}$ seen **Or** $\frac{75\ \Omega}{(R+75\ \Omega)}$ seen **(1)** • Use of $V = IR$ **(1)** **Or** resistance ratio × 6.0 V = corresponding p.d. • $R = 110\ \Omega$ **(1)**	MP2 use of $V = IR$ with 2.4 V or 3.6 V only <u>Example of calculation</u> $I = 2.4\ \text{V}/75\ \Omega = 0.032\ \text{A}$ Voltage across LDR = 6.0 V – 2.4 V = 3.6 V $R = \frac{3.6\ \text{V}}{0.032\text{A}}$ $R = 112.5\ \Omega$ **Or** use of ratios $\frac{75\ \Omega}{(R+75\ \Omega)} \times 6.0\ \text{V} = 2.4\ \text{V}$ $R = 112.5\ \Omega$	**3**
12(c)	An explanation that makes reference to the following: • Combined resistance of (light) bulb and LDR is about 3 Ω (in the dark) **Or** the combined resistance is less than the resistance of bulb/LDR **(1)** • The combined resistance is always much less than the (75 Ω) fixed resistance **(1)** • The p.d. across the bulb will be much less than 3 V and so the bulb will **not** come on (in the dark). **(1)**	MP3: accept the idea that the p.d. across the bulb is never high enough to make the bulb come on in the dark	**3**

(Total for Question 12 = 11 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
13(a)	**Either (Energy route)** • Use of $E_k = ½\ mv^2$ **and** use of $W = Fd$ • Use of $W = E_k$ • Length of the road train = 194 (m) **Or (suvat route)** • Use of $v^2 = u^2 + 2as$ with $v = 0$ to calculate the deceleration • Use of $v^2 = u^2 + 2as$ with $u = 25\ \mathrm{m\ s^{-1}}$ and calculated a • Length of the road train = 194 or 195 (m) (Do not award MP3 using suvat route for a substitution with u and v the wrong way round i.e. a positive value for a)	(1) (1) (1) (1) (1) (1)	<u>Example of calculation</u> $E_k = ½ \times m \times (15\ \mathrm{m\ s^{-1}})^2$ $½ \times m \times (15\ \mathrm{m\ s^{-1}})^2 = F \times 70\ \mathrm{m}$ $m = 0.62F$ $½ \times m \times (25\ \mathrm{m\ s^{-1}})^2 = F \times \mathrm{d}$ $½ \times 0.62F \times (25\ \mathrm{m\ s^{-1}})^2 = F \times \mathrm{d}$ $d = 194\ \mathrm{m}$ <u>Example of calculation</u> $0 = (15\ \mathrm{m\ s^{-1}})^2 + (2\times a \times 70\ \mathrm{m})$ $a = -\ 1.61\ \mathrm{m\ s^{-2}}$ $0 = (25\ \mathrm{m\ s^{-1}})^2 + (2\times (-1.61\ \mathrm{m\ s^{-2}}) \times \mathrm{s})$ $s = 194\ \mathrm{m}$ (Reverse show that max 2 for either route)	**3**
13(b)	• Use of $\mathrm{m\ s^{-1}} = \frac{3600}{1000}\ \mathrm{km\ h^{-1}}$ • Use of correct equation(s) of motion to obtain the displacement • $s = 55\ \mathrm{m}$	(1) (1) (1)	(MP2 independent of MP1 and is for use of the equations using the speed in $\mathrm{m\ s^{-1}}$ or $\mathrm{km\ h^{-1}}$) <u>Example of calculation</u> $(\frac{130\ \mathrm{km\ h^{-1}} \times 1000\ \mathrm{m}}{3600\ \mathrm{s}})^2 = (30\ \mathrm{m\ s^{-1}})^2 + (2\times 3.7\ \mathrm{m\ s^{-2}} \times s)$ $s = 54.6\ \mathrm{m}$	**3**

13(c)	• As the speed increases, drag increases **(1)** • There is greater fuel consumption to maintain a higher constant speed **Or** the fuel economy reduces at higher speeds to maintain a constant speed **(1)** • Statement linking fuel economy to engine efficiency **(1)**		MP1: accept ‘air resistance’ for ‘drag’ MP3 e.g. The efficiency of the engine may increase (with speed) but the fuel economy decreases **Or** you can’t compare efficiency which is a ratio with fuel consumption/economy which is a volume	**3**

(Total for Question 13 = 9 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
14(a)(i)	Use of 3600 × W h to give energy stored = 24 900 (J)	**(1)**	<u>Example of calculation</u> 6.91 W h = 6.91 × 3600 s = 24 876 J	**1**
14(a)(ii)	• Use of $V = W/Q$ • Q = 6510 C	**(1)** **(1)**	<u>Example of calculation</u> $Q = \frac{24\,876\text{ J}}{3.82\text{ V}} = 6512$ C (ecf for calculated energy from (a)(i)) (show that value gives Q = 6545 C)	**2**
14(a)(iii)	• Use of $Q = It$ **Or** $W = VIt$ • Use of $\frac{\text{time in seconds}}{3600}$ • t = 2.0 (h)	**(1)** **(1)** **(1)**	<u>Example of calculation</u> $t = \frac{6512\text{ C}}{0.9\text{ A}} = 7235.6$ s $t = \frac{7235.6\text{ s}}{3600} = 2.01$ h (ecf for calculated charge from (a)(i)) (show that value gives t = 2.02 h)	**3**
14(b)	• The replacement charger will still have to supply the same charge (6510 C) • The replacement charging plug takes more time to charge **Or** the old charging plug takes less time to charge • Replacement charging plug uses a lower current therefore reduces heating effect • The phone may try and draw a current of 1 A which may damage the charging plug	**(1)** **(1)** **(1)** **(1)**	MP1: may be awarded for use of 6510 C in a calculation for MP2 MP2 calculation to support this using t = Q/I Or if the phone uses 1A the time to charge will be the same	**4**

(Total for Question 14 = 10 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
15(a)	• Comparison to $y = mx + c$ • Identify that η, ρ_s, ρ_f and g are constants • $c = 0$ so the graph passes through the origin **Or** when $d^2 = 0$, $v = 0$ so would pass through the origin	**(1)** **(1)** **(1)**	MP1 e.g. $y = mx + c$ so $v = \left(\frac{g(\rho_b - \rho_f)}{18\eta}\right) \times d^2\ (+ 0)$	**3**

<table>
<tr><td>15(b)</td><td>Axes labelled with quantities and units (1)
Suitable scale (1)
Correct plotting (1)
Line of best fit (judged by eye) (1)</td><td>MP1: v / 10^{-3} m s^{-1} on y-axis
and d^2 / 10^{-6} m^2 on x-axis
<table><tr><th>d^2 / 10^{-6} m^2</th><th>v / 10^{-3} m s^{-1}</th></tr><tr><td>1.0</td><td>2.3</td></tr><tr><td>4.0</td><td>11</td></tr><tr><td>9.0</td><td>23</td></tr><tr><td>16.0</td><td>39</td></tr><tr><td>25.0</td><td>64</td></tr></table></td><td>4</td></tr>
<tr><td>15(c)</td><td>Attempt to find gradient, at least half drawn line used (1)
Use of $\eta = \frac{g(\rho_s - \rho_f)}{18} \times \frac{1}{\text{gradient}}$ (1)
$\eta =$ 1.4 − 1.5 (Pa s) (1)
Corn syrup identified as the fluid (1)</td><td>MP4 to be consistent with calculated value for η

<u>Example of calculation</u>
$\eta = \frac{9.81 \text{ N kg}^{-1} \times (8000 \text{ kg m}^{-3} - 1260 \text{ kg m}^{-3})}{18 \times 2.52 \times 10^3 \text{ m}^{-1} \text{ s}^{-1}}$
η = 1.46 Pa s</td><td>4</td></tr>
</table>

(Total for Question 15 = 11 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
16(a)	• As graphene is only 1 atom thick so the CSA/thickness is far smaller than for a sample of steel **Or** most applications need a thickness greater than one atom **Or** if more than one layer of graphene is used it will be weaker or the bonds between the layers will not be strong **Or** Graphene is difficult to manufacture because it has only one atomic layer **(1)** • Although graphene has a greater breaking stress it will break at a lower force **(1)**	MP1: accept graphene can only be 1 atom thick but steel can be any thickness (MP1, treat references to cost/energy as neutral)	**2**
16(b)	• Use of depth of graphite = 100 × diameter of 1 carbon atom **(1)** • Use of cross-sectional area = depth × (0.5×10^{-3} m) **(1)** • Use of $\rho = \frac{RA}{l}$ **(1)** • $\rho = 3.6 \times 10^{-5}$ Ω m **Or** 36 μΩ m **(1)**	<u>Example of calculation</u> Depth of graphite = $100 \times 1.4 \times 10^{-10}$ m = 1.4×10^{-8} m CSA = 1.4×10^{-8} m × 0.50×10^{-3} m = 7.0×10^{-12} m^2 $\rho = \frac{1.029 \times 10^6 \Omega \times 7.0 \times 10^{-12} \text{m}^2}{0.200 \text{ m}} = 3.6 \times 10^{-5}$ Ω m	**4**

16(c)	**Max 3** • Silicon will only release a (photo) electron for a limited range of frequencies/wavelengths • Silicon releases only one (photo) <u>electron</u> per incident photon • Greater current (for the same illumination) in graphene • Graphene (cells are) more efficient **Or** graphene cells could be smaller / cheaper / thinner	**(1)** **(1)** **(1)** **(1)**	MP1: accept single frequency for limited range	**3**

(Total for Question 16 = 9 marks)

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