Mark Scheme (Results)

November 2021

Pearson Edexcel GCE
In Physics (8PH0)
Paper 2: Core Physics II

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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 schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

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	Answer	Mark
1	**D – derived unit**	**1**
	Incorrect Answers: A – not a base quantity B – not a base unit C – not a derived quantity	
2	**B – TIR as angle of incidence is greater than the critical angle**	**1**
	Incorrect Answers: A – light is reflecting at an incorrect angle C – light is not refracted D – light is not refracted	
3	**B** $\frac{1}{\sin 35}$	**1**
	Incorrect Answers: A – incorrect arrangement of equation C – incorrect arrangement of equation D – incorrect arrangement of equation	
4	**A 0.4 + 0.05**	**1**
	Incorrect Answers: B – compound uncertainties by addition C – compound uncertainties by addition D – compound uncertainties by addition	
5	**D – increases non-linearly**	**1**
	Incorrect Answers: A – incorrect as $f \propto \sqrt{T}$ B – incorrect as $f \propto \sqrt{T}$ C – incorrect as $f \propto \sqrt{T}$	
6	**A** $\frac{36000 \times 0.5}{4.5 \times 10^{-4} \times 2.0 \times 10^{-4}}$	**1**
	Incorrect Answers: B – incorrect arrangement of equation C– incorrect arrangement of equation D – incorrect arrangement of equation	

7	**D –** both are moving up	**1**
	Incorrect Answers: A – incorrect answer B – incorrect answer C – incorrect answer	

8	**D** – $\frac{P}{\pi r^2}$	**1**
	Incorrect Answers: A – Incorrect equations B – Incorrect equation for area of a circle C – Incorrect equation	

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
9(a)	• Use of $f = \frac{1}{T}$ with T = 125 μs • 8000 Hz	(1) (1)	Example of calculation $f = \frac{1}{1.25\times10^{-8}\ \text{s}}$ = 8000 Hz	**2**
9(b)	• Fewer waves/cycles on screen	(1)	Accept wavelength increases	**1**

(Total for question 9 = 3 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
10(a)	• Use of $v = \frac{s}{t}$ with a factor of 2	(1)	Example of calculation $s = \frac{3200\ \text{m s}^{-1} \times 1.25\times10^{-4}\ \text{s}}{2} = 0.2\ \text{m}$ $t = \frac{2 \times 0.2\ \text{m}}{3200\ \text{m s}^{-1}} = 250\ \mu\text{s}$ 125 μs < 160 μs so detected	**3**
	Either • t = 125 μs • Comparison of their calculated value with 160 μs to reach a conclusion consistent with their answer	(1) (1)		
	Or • s = 0.256 m • Comparison of their calculated value with 0.2 m to reach a conclusion consistent with their answer	(1) (1)		
10(b)	• Use of $\Delta E_{el} = \frac{1}{2}F\Delta x$ • 0.026 J	(1) (1)	Example of calculation $\Delta E_{el} = \frac{1}{2} \times 130\ \text{N} \times 4.0 \times 10^{-4}\ \text{m} = 0.026\ \text{J}$	**2**

(Total for Question 10 = 5 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
11(a)	Use of $E = hf$ **and** $v = f\lambda$	(1)	Example of calculation	**3**
	Conversion eV to J	(1)	$\lambda = \frac{6.63\times10^{-34}\text{J s} \times 3.0\times10^{8}\text{m s}^{-1}}{4.3\text{ eV}\times 1.6\times10^{-19}\text{ C}} = 289$ nm	
	$\lambda = 2.9 \times 10^{-7}$ m	(1)		
11(b)	electron falls back down energy levels emitting a photon	(1)		**3**
	wavelength (of photon) is inversely proportional to the energy change	(1)		
	refers to energy transition n=3 to n=2 **or** n=2 to n=1	(1)		

(Total for Question 11 = 6 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
12(a)	• Longitudinal wave **Or** Oscillations of air molecules are parallel to the direction of the energy transfer (1) • Creating compressions **and** rarefactions **Or** Creating regions where the molecules are close together **and** regions where they are further apart (1) • Molecules close together create higher pressure **Or** molecules further apart create lower pressure **Or** compressions are areas of high pressure **Or** rarefactions are areas of low pressure (1)		**3**
12(b)	• use of $v = f\lambda$ (1) • Path difference needs to be = $\left(n + \frac{1}{2}\right)\lambda$ **Or** Path difference needs to be $\frac{\lambda}{2}$ **Or** Length of chamber needs to be $\frac{\lambda}{4}$ **Or** See $\frac{2.4\text{ m}}{4}$ (1) • (so) waves meet in antiphase (1) • destructive interference (1)	<u>Example of calculation</u> $\lambda = \frac{340\text{ m s}^{-1}}{140\text{ s}^{-1}} = 2.43\text{ m}$ path difference = $2l = \frac{2.43\text{ m}}{2}$ $l = \frac{2.43\text{ m}}{4} = 0.61\text{ m}$	**4**

(Total for Question 12 = 7 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Additional guidance</th><th>Mark</th></tr>
<tr>
<td>*Q13</td>
<td>This question assesses a student's ability to show a coherent and logical structured answer with linkage 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.
<table>
<tr><td>Number of indicative points seen in answer</td><td>Number of marks awarded for indicative points</td></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
Indicative content

At 180° the screen is normal/bright
When oscillations/vibrations are parallel to the filter all the light is transmitted
or
When oscillations/vibrations are parallel to the filter no light is absorbed
At 270° the screen is dark/darkest/black
When oscillations/vibrations are perpendicular to the filter all the light is absorbed
or
When oscillations/vibrations are perpendicular to the filter no light is transmitted
The idea of a gradual change as the filter is rotated
(as) Light from the screen is (partially) polarised

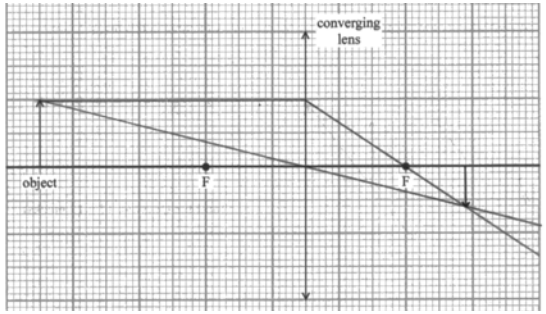
</td>
<td>The following table shows how the marks should be awarded for structure and lines of reasoning
<table>
<tr><td></td><td>Number of marks awarded for structure and lines of reasoning</td></tr>
<tr><td>Answer shows a coherent and logical structure with linkage and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkage between points and is unstructured</td><td>0</td></tr>
</table>
</td>
<td>6</td>
</tr>
</table>

(Total for question 13 = 6 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
14(a)	• Recognises $\lambda = 2L$ (1) • Equates $v = f\lambda$ **and** $v = \sqrt{gh}$ (1) • $T = 5.9 \times 10^4$ s (1)	Example of calculation $T = \frac{L}{\sqrt{gh}} = \frac{2 \times 4.0 \times 10^5 \text{ m}}{\sqrt{9.81 \text{ m s}^{-1} \times 19 \text{ m}}} = 5.9 \times 10^4$ s = 16.4 h	**3**
14(b)	• Use of $F = 6\pi\eta r v$ (1) • Use of $U = mg$ **and** $\rho = \frac{m}{V}$ **and** $V = \frac{4}{3}\pi r^3$ (1) • Recognises $W = F + U$ (1) • Use of $v = \frac{s}{t}$ (1) **Either** (1) • $t = 1.7 \times 10^7$ s • comparison with 6 months and conclusion consistent with their answer (1) **Or** • $s = 3.3$ - 3.6 m • comparison with 4 m and conclusion consistent with their answer	Example of calculation $F = 6\pi \times 1.0 \times 10^{-3}$ kg m^{-1} s^{-1} $\times$ 2.5×10^{-7} m $\times$ v $V = \frac{4}{3}\pi(2.5 \times 10^{-7} \text{ m})^3 = 6.5 \times 10^{-20}$ m^3 $U = \rho_w V g$ = 1000 kg m^{-3} $\times$ 6.5×10^{-20} m^3 $\times$ 9.81 m s^{-1} $U = 6.4 \times 10^{-16}$ N W = 2650 kg m^{-3} $\times$ 6.5×10^{-20} m^3 $\times$ 9.81 m s^{-1} $W = 1.7 \times 10^{-15}$ N $F = 1.7 \times 10^{-15}$ N - 6.4×10^{-16} N $F = 1.1 \times 10^{-15}$ N $v = \frac{1.1 \times 10^{-15} \text{ N}}{6\pi \times 1.0 \times 10^{-3} \text{kg m}^{-1}\text{s}^{-1} \times 2.5 \times 10^{-7} \text{ m}}$ $v = 2.3 \times 10^{-7}$ m s^{-1} $t = \frac{4 \text{ m}}{2.3 \times 10^{-7} \text{ m s}^{-1}} = 1.7 \times 10^7$ s t =197 days which is 6.6 months accept 1 month = 28 to 31 days giving t = 6.3 to 7.0 months	**6**

14(c)	• Viscosity increases with decreasing temperature (1) **Or** Viscosity **or** viscous drag increases with depth • (so) rate at which the particle falls decreases with depth (1)	MP2 dependent on MP1	**2**
14(d)	• The idea that human reaction time is large (compared to the short time to be measured) • Giving a greater %U in measurements of time so not suitable		**2**

(Total for Question 14 = 13 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
15(a)	• two rays correctly drawn (1) • image drawn in correct position ±half square (1) • use of $m = \frac{v}{u}$ **or** $m = \frac{image\ height}{object\ height}$ (1) • m = 0.6 (1)	 Example of calculation $m = \frac{4.8\ \text{cm}}{8.0\ \text{cm}} = 0.6$	**4**
15(b)	• Use of $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ **and** $P = \frac{1}{f}$ • Use of $P = P_1 + P_2$ • (−) 0.6 D • Diverging	MP4 dependent on MP3 Example of calculation Power of eye $P = \frac{1}{1.5\ (\text{m})} + \frac{1}{0.024(\text{m})}$ = 42.3 D P of spectacles = 41.7 (D) – 42.3 (D) = -0.6 D diverging	**4**

(Total for Question 15 = 8 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
16 (a)	• Experimental evidence became available (eg speed of light in water) **or** wave model could be used to explain other properties of light **or** Huygens' construction could be used to explain interference/diffraction (1) • further support for wave theory by other scientists (eg Thomas Young) **or** (younger) scientists were willing to accept new ideas (1)	MP1 the idea of evidence MP2 the idea of further support	**2**
16 (b)	• use of $n_1 sin\theta_1 = n_2 sin\theta_2$ **and** $n = \frac{c}{v}$ (1) • $v = 2.3 \times 10^8$ m s^{-1} (1) • conclusion comparing their answer to 3.0×10^8 m s^{-1} (1)	Accept use of $n_1 sin\theta_1 = n_2 sin\theta_2$ to establish that $n(water) > 1$ with conclusion referring to $n = \frac{c}{v}$ Example of calculation $n(water) = \frac{\sin 35}{\sin 26} = 1.3$ $v(water) = \frac{3.0 \times 10^8 \text{ms}^{-1}}{1.3} = 2.3 \times 10^8$ m s^{-1}	**3**
16(c)	• calculates $\theta = 24°$ **and** $d = 3.3 \times 10^{-6}$ m • use of $n\lambda = dsin\theta$ • $6.7 - 6.8 \times 10^{-7}$ m	Example of calculation $\tan\theta = \frac{0.89 \text{ m}}{2.0 \text{ m}}$ $\theta = 24°$ $d = \frac{1 \times 10^{-3}}{300} = 3.3 \times 10^{-6}$ m $\lambda = \frac{3.3 \times 10^{-6} \text{ m} \times \sin 24}{2} = 678$ nm	**3**

16(d)	• one photon interacts with one electron (1) • when the energy of the photon is equal to or greater than the work function (of the metal) an electron is released (1) • energy of photon = hf so there is a minimum/threshold frequency (1)		**3**
16(e)	• Use of $\lambda = \frac{h}{p}$ **Either** • $h = 6.7 \times 10^{-34}$ (J s) • compares answer to 6.63×10^{-34} (J s) **Or** • $\lambda = 1.38 \times 10^{-10}$ (m) • compares answer to 1.40×10^{-10} (m)	<u>Example of calculation</u> $h = 1.4 \times 10^{-10}$ m $\times 4.8 \times 10^{-24}$ kg m s^{-1} $h = 6.7 \times 10^{-34}$ J s $\approx 6.63 \times 10^{-34}$ J s	**3**

(Total for Question 16 = 14 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
17 (a)(i)	• Use of $v^2 = u^2 + 2as$ • Use of $a = \frac{\Delta v}{\Delta t}$ • Use of $F = R - mg = ma$ • R = 360 N [accept total force = 721 N]	(1) (1) (1) (1)	Example of calculation $v^2 = 2 \times 9.81$ m s^{-1} $\times$ 1.6 m [v = 5.60 m s^{-1}] $a = \frac{5.60 \text{ m s}^{-1}}{0.9} = 6.23$m s^{-2} F = 45 kg $\times$ 6.23 m s^{-2} = 280 N R = 45 kg $\times$ 9.81 m s^{-2} + 280 N = 721 N	**4**
17(a)(ii)	• bending knees increases the time to come to rest • decreasing rate of change of momentum **or** reducing the deceleration • and (hence) force	(1) (1) (1)	Accept converse argument	**3**
17(b)	**Max three** Elderly bone: • lower gradient showing the bone is under more strain for a given stress • graph ends at a lower stress showing it has a lower breaking stress • Area under graph is smaller as less energy is absorbed before fracture • Graph is shorter showing less plasticity	(1) (1) (1) (1)	Accept answer with respect to healthy bone Accept more brittle	**3**

(Total for Question 17 = 10 marks)

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