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Mark Scheme (Results)

Summer 2016

Pearson Edexcel AS
in Physics (8PH0 / 02)
Paper 02 – 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 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. '<u>resonance</u>'
   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].

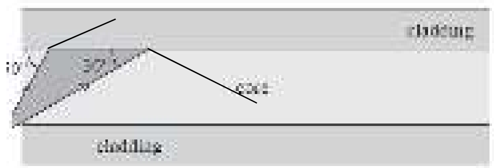
2. **Unit error penalties**
   2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.
   2.2 This does not apply in 'show that' questions or in any other question where the units to be used have been 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 $g = 10\ \text{m s}^{-2}$ or $10\ \text{N kg}^{-1}$ instead of $9.81\ \text{m s}^{-2}$ or $9.81\ \text{N kg}^{-1}$ will mean that one mark will not be awarded. (but not more than once per clip). Accept $9.8\ \text{m s}^{-2}$ or $9.8\ \text{N kg}^{-1}$
   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 answers		Additional guidance	Mark
1	A	Sound can travel through a solid.		**1**
2	C	W m^{-2}		**1**
3	B			**1**
4	B	The bubble has a constant velocity because upthrust is equal to viscous drag.		**1**
5	C	The uncertainty is 0.1 s.		**1**
6	D	90 degrees		**1**
7	D	oscillates in one direction, no light		**1**
8	D	transverse, longitudinal		**1**

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable answers	Additional guidance	Mark
9(a)	• Use of $n_1 \sin \theta_1 = n_2 \sin \theta_2$ **(1)** • Angle in cladding $\theta = 90(^{\circ})$ **(1)** • Critical angle = 50.3(°) **(1)**	Accept alternative method using $\sin c = \frac{1}{n}$ **and** $n = \frac{c}{v}$ to give $n = \frac{v_{cladding}}{v_{core}}$ **Or** $n = \frac{n_{core}}{n_{cladding}}$ Use of $\sin c = \frac{1}{n}$ with n=1.2 or 1.56 gains 1 mark <u>Example of calculation</u> e.g. $1.56 \sin \theta_1 = 1.20 \sin \theta_2$ $1.56 \sin c = 1.20 (\sin 90^{\circ})$ $\sin c = \frac{1.20}{1.56}$ $c = 50.3(^{\circ})$	3
9(b)	• Left hand side of beam refracts away from normal **(1)** • Right hand side of beam totally internally reflected **(1)** • State Student C is correct **(1)**	Ignore any line continued beyond cladding Ignore any reflection Reflection correct by eye Do not award if any line shown in cladding **(MP3 dependent on MP1 and MP2)**  Arrows on rays not needed	3

(Total for Question 9 = 6 marks)

Question Number	Acceptable answers		Additional guidance	Mark
10(a)(i)	• σ = 54-56 (MPa) • Use of $\sigma = \frac{F}{A}$ with their value of σ • F = 64.5 N – 67.5 N	**(1)** **(1)** **(1)**	do not penalise powers of 10 Example of calculation $F = 56 \times 10^6 \text{ Nm}^{-2} \times 1.2 \times 10^{-6} \text{ m}^2$ F = 67 N	**3**
10(a)(ii)	• Use of $\varepsilon = \frac{\Delta x}{x}$ • Extension = 1.0 cm	**(1)** **(1)**	Example of calculation 0.04 = Δx / 25 cm Δx = 0.04 × 25 cm = 1.0 cm Allow 1 cm, 0.01 m, 10 mm	**2**
10(b)	An answer that makes reference to the following: • Shrilk has less strain for same stress **Or** Shrilk is stiffer • Shrilk breaks at a higher stress (compared to polythene) **Or** Shrilk can withstand a greater stress/force/load/weight **Or** Shrilk is stronger • Shrilk doesn't stretch as much (for a given force)	 **(1)** **(1)** **(1)**	It should be clear from the student's answer that shrilk is the better material Ignore references to Young modulus, renewable, biodegradable, cost Accept converse arguments for polythene	**3**

(Total for Question 10 = 8 marks)

Question Number	Acceptable answers	Additional guidance	Mark
11(a)	An explanation that makes reference to the following: • The light is diffracted **(1)** • (because) each point on wavefront acts as a source of secondary waves **Or** wavelets emitted (from points on the wavefront) **(1)**	Marks may be shown on a clearly labelled diagram	**2**
11(b)	An explanation that makes reference to the following: • Path lengths (to centre of shadow from edge of ball) are equal **Or** path difference (at spot) is zero **(1)** • Will arrive in phase **Or** phase difference is zero **(1)** • (Bright spot is position of) <u>constructive</u> interference/superposition **(1)**		**3**
11(c)	• Wave model **(1)** **Any two** • (Demonstration) provided experimental evidence (in support of wave model) **(1)** • (Demonstration) supported previous evidence **(1)** • (This demonstration was) reproducible **Or** (This demonstration) could be repeated by others **(1)**		**3**
11(d)	• (Vernier) callipers **Or** travelling microscope **Or** micrometer **(1)** • Measure diameter in different places **and** calculate mean **(1)**		**2**

(Total for Question 11 = 10 marks)

Question Number	Acceptable answers	Additional guidance	Mark
12(a)	• Use a pulley and set of masses/weights hung on string **(1)** • Tension = weight (of set of masses) **Or** $T=mg$ **(1)**		**2**
12(b)	• Calculate missing $f^2 = 9025$ **(1)** • Plot missing point **(1)** • Draw line of best fit **(1)**	Plot (35, 9025) or their calculated value of f^2	**3**
12(c)	• Determines the gradient **(1)** • Equates $v = f\lambda$ and $v = \sqrt{\dfrac{T}{\mu}}$ **(1)** • Uses $\lambda = 0.8$ (m) **(1)** • Mass per unit length $\mu = (6.0 \text{ to } 6.2) \times 10^{-3}$ (kg m^{-1}) **(1)** • Conclusion consistent with their value **(1)**	e.g. gradient= $\frac{(10200-0)}{(40-0)}$ =255 accept $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ $\mu = \frac{1}{255\text{Hz}^2\text{N}^{-1} \times 0.8^2\text{m}^2}$ $=6.1 \times 10^{-3}$ (kg m^{-1})	**5**

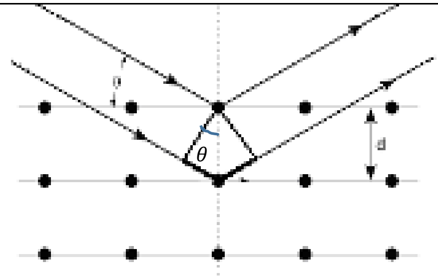
(Total for Question 12 = 10 marks)

Question Number	Acceptable answers	Additional guidance	Mark
*13(a)	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	

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

	Indicative content • This is a diffraction/interference pattern • Electrons behave as waves • As speed/momentum increases the circles get smaller • $n\lambda = d\sin\theta$ used to justify that as θ decreases λ decreases • Refers de Broglie equation ($\lambda = h/p$) to confirm that as speed/momentum increases, wavelength decreases. • Crystal has a regular/layered structure	**PP2** Do not credit 'electrons behave as waves or particles' on its own **PP3** accept circles get condensed for circles get smaller **PP4** do **not** credit use of equation to justify λ same size as gaps in crystal or to measure the gaps in the graphite **PP6** small gaps at uniform distances/lengths **Or** accept that graphite is made up of more than a single crystal	**6**

13(b)(i)	• Identification of θ between a wavefront and a vertical line **(1)** • Clear evidence of extra distance before **and** after reflection **(1)**		**2**
13(b)(ii)	• There is more than one order (of diffraction) **(1)**	Accept: path difference of one λ for 1st ring and 2 λ for 2nd ring rings occur for any whole number of wavelengths each ring corresponds to a different layer of atoms from which the electrons reflect.	**1**

(Total for Question 13 = 9 marks)

Question Number	Acceptable answers	Additional guidance	Mark
14(a)	• Use of $P = \frac{1}{f}$ **(1)** • 1220 (mm) **(1)**	<u>Example of calculation</u> 0.82 D = 1/f f = 1 / 0.82 D = 1.22 m Accept 122 (cm)	**2**
14(b)(i)	**Either** • Rays from (a point) on the moon are <u>parallel</u> **(1)** • So the rays converge to the principal focus **Or** so the image is formed at the principal focus **(1)** **Or** • Use of $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ with u=∞ or very large **(1)** • $f = v$ **(1)**	Description of focal length as: the distance between the lens and point at which parallel rays will converge (after passing through lens), scores 2 Accept focal point for principal focus **(MP2 dependent on MP1)** **(MP2 dependent on MP1)**	**2**
14(b)(ii)	Real Diminished **(2)** Inverted	One/Two properties scores 1 mark Three properties score 2 marks Accept smaller Accept upside down	**2**

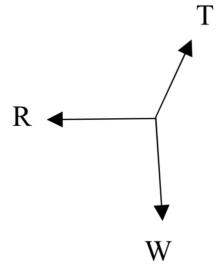
14(c)	• Use of $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ with u = 100 and v = (−)300 • $f = 150$ (mm) • converging lens with focal length 150 mm	**(1)** **(1)** **(1)**	**(MP3 dependent on MP2)** <u>Example of calculation</u> $\frac{1}{f} = \frac{1}{100\text{ mm}} - \frac{1}{300\text{ mm}}$ $\frac{1}{f} = \frac{3-1}{300\text{ mm}}$ $f = 150\text{ mm}$ MP3 accept if annotated in question Accept convex for converging	**3**

(Total for Question 14 = 9 marks)

Question Number	Acceptable answers	Additional guidance	Mark
15(a)	• (UV radiation consists of) photons **(1)** • One photon interacts with one electron **Or** energy of photon depends on frequency **(1)** • Electrons released if energy (of photon) greater than work function **Or** frequency is greater than threshold frequency **Or** energy supplied is sufficient to remove electron **(1)**	Accept quanta/packets of energy	**3**
15(b)(i)	• when slider at the bottom - reading on voltmeter is zero **Or** minimum resistance - reading on voltmeter is zero **(1)** • When slider at the top – reading on voltmeter is 1.5 V **Or** maximum resistance - reading on voltmeter is 1.5 V **(1)** • Potential difference split between top and bottom part of resistor (either side of slider) **Or** reading on voltmeter depends on the ratio of resistances (either side of slider) **Or** moving the slider changes the resistance that the voltmeter is across **(1)**		**3**
15(b)(ii)	Maximum Kinetic Energy of electron = 0.6 (eV) **(1)**		**1**

15(c)	**Max 4** Valid because: • Moon and photocell both have vacuum **(1)** • Both demonstration and theory use photoelectric effect **(1)** Not valid because: • Different wavelengths in each case **(1)** • On the moon there is dust not metal **(1)** • Dust is free to move but the metal plate is fixed **(1)** • On the moon UV removes electrons from (individual) <u>atoms</u> **and** in the demo light removes electrons from metal <u>surface</u> **(1)** • Demonstration is based on photoelectric effect but effect on moon could be ionisation **(1)**	Full marks can only be scored if a correct link is made between at least one physics point and the demonstration being valid or not valid Accept the same concept for photoelectric effect Accept one uses light the other UV Accept different materials for MP4	**4**

(Total for Question 15 = 11 marks)

Question Number	Acceptable answers		Additional guidance	Mark
16(a)	• Arrow upwards and to the right at approximately 20° to the vertical labelled Tension/T • Arrow to left and horizontal labelled Reaction/R • Arrow vertically down labelled Weight/W/mg/540 N	**(1)** **(1)** **(1)**	Accept Push (from rock) /Contact  Max 2 if any additional arrows drawn	**3**
16(b)(i)	• Resolve tension vertically: $T\cos 20$ **Or** $T\sin 70$ • Equate mg and their vertical component of T • Tension = 570 (N)	**(1)** **(1)** **(1)**	<u>Example of calculation</u> $55 \times 9.81 = T\cos 20$ $T = 574$ N	**3**
16(b)(ii)	• Use of $\Delta E = \frac{1}{2} F \Delta x$ • Energy stored = 7.1 – 7.2 J	**(1)** **(1)**	(ecf from (b)(i)) show that value gives 7.5 J <u>Example of calculation</u> $\Delta E = \frac{1}{2} \times 570\text{ N} \times 2.5 \times 10^{-2}\text{ m}$ $\Delta E = 7.1$ J	**2**
16(b)(iii)	• Rope has extended linearly **Or** Hooke's law applies **Or** extension $\propto$ force **Or** has not exceeded limit of proportionality	**(1)**	Do not accept elastic limit	**1**

(Total for Question 16 = 9 marks)

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