Mark Scheme (Results)

Summer 2022

Pearson Edexcel GCE
In Physics (8PH0)
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 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. '<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 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.

Section A

Question Number	Answer	Mark
1	**D visible line spectra**	**1**
	Incorrect Answers: **A –** wave model **B –** wave model **C –** wave model	
2	**B stress v strain**	**1**
	Incorrect Answers: **A –** gradient ≠ Young modulus **C –** gradient ≠ Young modulus **D –** gradient ≠ Young modulus	
3	**C kg m^2 s^{-1}**	**1**
	Incorrect Answers: **A** – N is not an SI base unit and incorrect arrangement **B** – N is not an SI base unit **D** – incorrect arrangement	
4	**A 2.5 cm converging**	**1**
	Incorrect Answers: **B –** incorrect type of lens **C –** incorrect focal length **D –** incorrect focal length and type of lens	
5	**B (1.8 + 1.8) % additional of two uncertainties as A $\propto r^2$**	**1**
	Incorrect Answers: **A –** incorrect, using only one value for uncertainty **C –** incorrect, addition of three uncertainties **D –** incorrect, multiplication of two uncertainties	
6	**C** $\frac{\pi}{3}$	**1**
	Incorrect Answers: **A –** incorrect **B –** incorrect **D –** incorrect	
7	**D shortest arrow pointing to ground state**	**1**
	Incorrect Answers: **A –** shortest wavelength absorbed	

	B – longest wavelength absorbed **C –** shortest wavelength emitted	

8	**D wavelength**	**1**
	Incorrect Answers: **A –** determined from the maximum displacement on y-axis **B –** determined from 1/time for one cycle **C –** determined from the time for one cycle on x-axis	

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
9(a)	• Use of $\tan\theta = \frac{x}{D}$ • Use of d = 1/300 • Use of $n\lambda = d\sin\theta$ • λ = 530 (nm) with conclusion green	(1) (1) (1) (1)	<u>Example of Calculation</u> d = $1/(300 \times 10^3 \text{m}^{-1})$ = 3.33×10^{-6} m $\theta = \tan^{-1}\frac{1.35}{4.0}$ = 18.65° $\lambda = \frac{3.33 \times 10^{-6}\text{ m} \times \sin 18.65°}{2}$ = 5.32×10^{-7}m = 532 nm Green	**4**
9(b)	• The resolution would be the same but the distance measured is greater **Or** The uncertainty would be the same but is divided by a greater length	(1)		**1**

(Total for Question 9 = 5 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
*10	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 structure and lines of reasoning	6

IC points	IC mark	Max linkage mark	Max final mark
6	**4**	**2**	**6**
5	**3**	**2**	**5**
4	**3**	**1**	**4**
3	**2**	**1**	**3**
2	**2**	**0**	**2**
1	**1**	**0**	**1**
0	**0**	**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

IC1 Pulses of light are emitted from laser/Earth **or** Pulses of light sent to the Moon/mirror
IC2 Light reflects from the mirrors
IC3 Measure the time taken for the reflected light to return
IC4 Calculate distance = speed x time
IC5 Use speed of light c
IC6 Measured time must be divided by 2
Or calculated distance must be divided by 2

(Total for Question 10 = 6 marks)

Question Number	Answers	Additional guidance	Mark
11(a)	• Use a micrometer **Or** vernier callipers **Or** digital callipers (1) • Measure diameter/width of ball at more than one orientation/position (1) • Calculate the mean of the diameter **and** divide by 2 (1)		3
(b)i	• Use of $V = \frac{4}{3}\pi r^3$ (1) • Use of $\rho = \frac{m}{V}$ **and** $W = mg$ (1) • $W = 4.1 \times 10^{-2}$ (N) (1)	Example of Calculation $W = 8.0 \times 10^3 \text{ kg m}^{-3} \times \frac{4}{3}\pi(0.005 \text{ m})^3 \times 9.81 \text{ m s}^{-2}$ $W = 4.11 \times 10^{-2}$ N	3
(b)ii	• Use of $F = 6\pi r\eta v$ (1) • $v = 0.24 \text{ m s}^{-1}$ (1)	Example of Calculation $4.1 \times 10^{-2} \text{ N} = 6\pi \times 0.005 \text{ m} \times 1.78 \text{ N s m}^{-2} \times v$ $v = \frac{4.1 \times 10^{-2} \text{ N}}{6\pi \times 0.005 \text{ m} \times 1.78 \text{ N s m}^{-2}}$ $v = 0.24 \text{ m s}^{-1}$	2
(c)	• Ensure the velocity is low **Or** use small (radius) spheres **Or** use a wide cylinder (1) • To prevent turbulence **Or** to ensure laminar flow (1)		2

(Total for Question 11 = 10 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
12(ai)	For the 30-year-old • greater stress for a given strain **Or** greater Young Modulus **Or** stiffer **Or** max deformation of the 23-year-old lens is greater **Or** breaking stress of 30-year-old lens is greater (1)	Accept answers for the 23-year-old	**1**
12(aii)	• Reference to the graph consistent with their answer to **(ai)** (1)		**1**
12(b)	• Use of $m = \frac{v}{u}$ (1) • Use of $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ (1) • Use of $P = \frac{1}{f}$ (1) • Use of $P = P_1 + P_2$ = 5D therefore use one lens with power of 2 (D) and one with power of 3 (D) (1)	<u>Example of Calculation</u> v = 0.5 x 0.6 m = 0.3 m $\frac{1}{f} = \frac{1}{0.6\text{ m}} + \frac{1}{0.3\text{ m}}$ f = 0.2 m P = 1/0.2 m = 5D	**4**

(Total for Question 12 = 6 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
spring 13(a)	• Draws a line of best fit • Calculates a gradient using at least half the graph • 19.4 – 20.6 N m^{-1}	(1) (1) (1)	<u>Example of calculation</u> Gradient = $\frac{5\text{ N}}{0.25\text{ m}}$ = 20 N m^{-1}	3
(b)	• Comment that a straight line graph through the origin (up to 5 N) is consistent with Hookes law / $F \propto x$ • Comment that indicates that the max extended length 400 mm is not covered by the student's results • Use of $\Delta E_{el} = \frac{1}{2}F\Delta x$ **and** $F = k\Delta x$ with $\Delta x = 0.4$ m **Or** Use of $\Delta E_{el} = \frac{1}{2}F\Delta x$ using extrapolated readings from graph • Candidate's calculated energy value compared with 1.6 J and valid conclusion given **Either** • Use of %U to determine the range in *k* (manufacturer's) • Comparison of values for *k* with conclusion consistent with candidates calculated value in (a) **Or** • Calculates % difference between candidate's calculated value for *k* and 21 N m^{-1} • Comparison of calculated % difference with 5% and conclusion made	(1) (1) (1) (1) (1) (1) (1) (1)	<u>Example of calculation</u> $k = 21 \pm 1.05$ = 19.95 – 22.05 N m^{-1} $F = k\Delta x$ = 20 N m^{-1} × 0.4 m = 8.0 N $\Delta E_{el}(\text{max}) = \frac{1}{2}$ × 8.0 N × 0.4 m = 1.6 J	6

(Total for Question 13 = 9 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
14(a)	• Use of $n = \frac{c}{v}$ (1) • Use of $n_1 sin\theta_1 = n_2 sin\theta_2$ (1) • Uses $\sin C = \frac{1}{n}$ (1) • Comparison of C = 50° with 30° and conclusion (1)	Example of Calculation $n_{\text{(air-water)}} = \frac{3.0 \times 10^8}{2.25 \times 10^8} = 1.33$ $\sin 40 = 1.33 \sin\theta_2$ $\theta_2 = 29°$ At X: $\sin C = \frac{1}{1.33}$ C = 49° > 29° so refracted	4
(b)(i)	• Use of node to node distance = $\frac{\lambda}{2}$ (1) • Use of $v = f\lambda$ (1) • v = 340 m s^{-1} (1)	Example of Calculation λ = 2 x 0.86 m = 1.72 m v = 200 s^{-1} x 1.72 m = 344 m s^{-1}	3
(b)(ii)	• Wavelength is 1.7 m which is the same order of magnitude as 2 m (1) • Diffraction will take place so sound will be heard at Y (1)	Example of Calculation λ = 2 x 0.86 (m) = 1.7 m	2

(Total for Question 14 = 9 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
15(a)	• Use of $hf = \emptyset + \frac{1}{2}mv^2$ • $v = 6.3 \times 10^6$ m s^{-1}	(1) (1)	<u>Example of Calculation</u> $E_k = (6.63\times 10^{-34}$ J s $\times 2.8 \times 10^{16}$ s^{-1}) - 6.9×10^{-19} (J) = 1.78712×10^{-17} J $v = \sqrt{\frac{2 \times 1.78712\times10^{-17}\text{J}}{9.11\times10^{-31}\text{ kg}}} = 6.26 \times 10^6$ m s^{-1}	2
(b)(i)	• Use of $\lambda = \frac{h}{p}$ • recognise $\lambda = 2 \times$ diameter of atom • 1.7×10^{-24} kg m s^{-1}	(1) (1) (1)	<u>Example of calculation</u> $p = \frac{6.63 \times10^{-34}\text{ (J s)}}{2\times 2.0\times10^{-10}\text{ (m)}} = 1.67\times 10^{-24}$ kg m s^{-1}	3
(b)(ii)	• A discrete number of half wavelengths fit into the diameter of an atom • Reference to $E = \frac{hc}{\lambda}$ to link wavelength to discrete energy levels	(1) (1)		2

(Total for Question 15 = 7 marks)

(Total for Section A = 60 marks)

Section B

Question Number	Acceptable Answers		Additional guidance	Mark
16(a)	• Use of $\Delta E_{grav} = mg\Delta h$ **and** $P = \frac{E}{t}$ • Use of Efficiency $= \frac{\text{useful energy/power output}}{\text{total energy/power input}}$ • 0.76 m s^{-1}	(1) (1) (1)	<u>Example of calculation</u> Useful energy output in 1 s = 15 MJ Total energy in 1 s $= \frac{1.5 \times 10^7}{0.8} = 1.875 \times 10^7$ J $mg\Delta h$ per second = 1.875×10^7 J Δh per second = $v = \frac{1.875 \times 10^7 \text{ J}}{2500000 \text{ kg} \times 9.81 \text{ N kg}^{-1}}$ $v = 0.76 \text{ m s}^{-1}$	3
(b)	**Either** • A high power requires the mass to be lowered at a high speed • But the length of time is limited by the depth of the mineshaft **Or** • Total output energy is determined by the depth of the shaft • *E*=*Pt* so for a high power time must be small (since *E* is constant)	 (1) (1) (1) (1)		2
(c)	• Use of $E = \frac{stress}{strain}$ **and** $stress = \frac{F}{A}$ • $5.5 \times 10^{-2} \text{ m}^2$	(1) (1)	<u>Example of calculation</u> Stress $= 1.8 \times 10^{11} \times 0.005 = 9.0 \times 10^8 \text{ N m}^{-2}$ $A = \frac{5.0 \times 10^6 \text{kg} \times 9.81 \text{N kg}^{-1}}{9.0 \times 10^8 \text{ N m}^{-2}} = 5.45 \times 10^{-2} \text{ m}^2$	2
(d)	• load needs to be accelerated upwards • so greater force/stress/tension in cables • a greater area decreases the stress	(1) (1) (1)		3

(Total for Question 16 = 10 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
17a	• Increasing light intensity increases rate of photons/energy arriving at LDR (1) • More electrons gain enough energy to be released/free to conduct (1) • Greater number of conduction electrons per unit volume (1) • $I = nAvq$ so current increases and resistance decreases (1)		**4**
17b	• Use of $I = \frac{P}{A}$ **and** $P = \frac{E}{t}$ (1) • $E =$ 2.6 J (1)	<u>Example of calculation</u> P = 1100 W m^{-2} × 4.0 × 10^{-5} m^2 = 4.4 × 10^{-2} W E = 4.4 × 10^{-2} W × 60 s = 2.64 J	**2**
17c	• Unpolarised light oscillates in many planes (1) • The light perpendicular to the plane of polarisation of the filter is absorbed **Or** only light parallel to the plane of polarisation of the filter is transmitted (1) • So polarised light oscillates in only one plane (1) • So light intensity is reduced (1)	dependent upon MP2 or MP3	**4**

(Total for Question 17 = 10 marks)

(Total for Section B = 20 marks)
(Total for Paper = 80 marks)

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