Mark Scheme (Results)

Pearson Edexcel GCE
In Physics (8PH0)
Paper 02 Core Physics II

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

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 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	**C** The stress beyond which the steel becomes permanently deformed.	1
	Incorrect Answers: A – The stress at which the steel undergoes an increase in strain with no increase in stress. B – The stress beyond which the stress and strain are no longer proportional. D – The stress at which the steel breaks.	
2	**C** $\dfrac{3.0 \times 10^8 \times t}{2}$	1
	Incorrect Answers: A – incorrect factor of 2 B – incorrect factor of 2 and speed D – incorrect speed	
3	**D**	1
	Incorrect Answers: A – absorption of the longest wavelength B – emission with the longest wavelength C – absorption of the shortest wavelength	
4	**A** kg s^{-2}	1
	Incorrect Answers: B – base units for N C – incorrect units and not base units D – correct units but not base units	
5	**B** $\boxed{\begin{array}{c\|c} v_1 < v_2 & n_1 > n_2 \end{array}}$	1
	Incorrect Answers: A – incorrect equality for speed C – incorrect equality for speed and refractive index D – incorrect equality for refractive index	
6	**B** $2\pi t f$	1
	Incorrect Answers: A – incorrect expression C– incorrect expression D – incorrect expression	
7	**B** fd	1
	Incorrect Answers: A – incorrect expression C – incorrect expression D – incorrect expression	

8	**D** Transverse waves are always plane polarised.	**1**
	Incorrect Answers: A – An unpolarised wave may be polarised on reflection from a surface. B – Longitudinal waves cannot be plane polarised. C – The vibrations in an unpolarised wave are in many directions.	

(Total for Multiple Choice Questions = 8 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
9(a)	• Use of $\sigma = \frac{F}{A}$ and $A = \frac{\pi d^2}{4}$ (1) • Use of $E = \frac{\text{stress}}{\text{strain}}$ with strain = 0.2 % (1) • $E = 1.4 \times 10^9$ Pa (1)	Example of Calculation Stress = $\dfrac{14\text{ N}}{\pi \times \left(\frac{2.5 \times 10^{-3}\text{m}}{2}\right)^2} = 2.85 \times 10^6$ N m^{-2} $E = \dfrac{2.85 \times 10^6\text{ N m}^{-2}}{0.2/100} = 1.4 \times 10^9$ N m^{-2}	3

9(b)	• Use of $\Delta E_{el} = \frac{1}{2}F\Delta x$
	  Or
	  Use of $F = kx$ **and** $\Delta E_{el} = \frac{1}{2}k\Delta x^2$ (1)
	• 0.028 J (1)
		Example of Calculation
		$\Delta E_{el} = \frac{1}{2} \times 14\text{ N} \times (0.002 \times 2.0\text{ m}) = 0.028$ J
			2

9(c)	• (The longer the wire) the larger the extension (for a given force) (1) • (So) smaller <u>percentage uncertainty</u> (in measurement of extension) (1)		2
	Total for Question 9		7

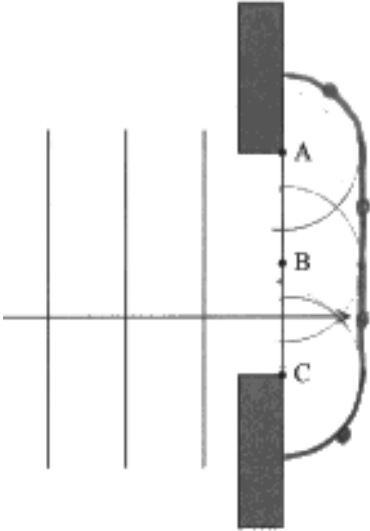| Question Number	Acceptable Answers	Additional guidance	Mark
10(a)	• Use of $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ (1) • $f = 8.0 \times 10^{-2}$ m (1)	Example of calculation $\frac{1}{f} = \frac{1}{0.09 \text{ m}} + \frac{1}{0.75 \text{ m}}$ $f = 8.00 \times 10^{-2}$m	2
(b)	• Light rays pass through the image **Or** Light rays converge to a point where the image is formed (1)		1
(c)	• Use of $m = \frac{v}{u}$ (to calculate m) (1) • Use of $m = \frac{\text{image height}}{\text{object height}}$ to calculate distance between dots on screen (1) • Uses tan/sin **or** small angle approximation to calculate the angle (1) • Answer consistent with their calculation (1) • Comparison with 0.0003 radians **or** 0.017° and conclusion consistent with their value for θ (1)	Example of calculation $m = \frac{0.75 \text{ m}}{0.09 \text{ m}} = 8.3$ Image height = 8.3 x 0.005 m = 0.042 (m) $\tan(\frac{\theta}{2}) = \frac{0.042/2 \text{ m}}{4.5 \text{ m}}$ $\theta = 0.5° = \frac{0.5\pi}{180}$ rads $= 0.0092$radians 0.009 radians $>$ 0.0003 radians so student can distinguish between the dots	5

(Total for Question 10 = 8 marks)

Question Number	Acceptable Answers	Additional guidance	Mark

*11(a)	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
	  • Two waves travelling in opposite directions (1)
	  • Superpose / interfere (1)
	  • Constructive (interference) if waves in phase
	    Or Constructive (interference) if path difference = $n\lambda$ (1)
	  • Destructive (interference) if waves in antiphase
	    Or destructive (interference) if path difference = $(n + \frac{1}{2})\lambda$ (1)
	  • Nodes are formed from points of destructive (interference) **or** antinodes are formed from points of constructive (interference) (1)
	  • Nodes are points with min amplitude **and** antinodes are points with max amplitude (1)
			6

11(b)	• the thicker string has a greater mass per unit length	(1)		
	• wavelength is the same in each string	(1)		
	• Valid assumption stated	(1)	A thicker string has a greater mass **Or** length of strings is the same	
	Either			
	• Equate $v = \sqrt{\frac{T}{\mu}}$ and $v=f\lambda$	(1)		
	• Leading to $f \propto \frac{1}{\sqrt{\mu}}$ **or** $f = \frac{1}{\lambda}\sqrt{\frac{T}{\mu}}$ so f is lower	(1)		
	Or			
	• $v = \sqrt{\frac{T}{\mu}}$ so v is lower (as T constant)	(1)		5
	• $v=f\lambda$ so f is lower	(1)		

(Total for Question 11 = 11 marks)

Question Number	Acceptable Answers		Additional guidance	Mark
12(a)	• experiment shows the liquid flows faster at higher temperature	(1)	MP1 Must be an indication of speed.	
	• (if lava behaves similarly) lava will flow a long way (covering a large area) in a given time **Or** (since) at a higher temperature the liquid has a lower viscosity	(1)	MP2 Accept solidifying as an indication of in a given time	2
12(b)(i)	• Use of $v = \frac{s}{t}$	(1)	Example of Calculation	
	• Use of $V = \frac{4}{3}\pi r^3$	(1)	$\eta = \dfrac{\frac{4}{3}\pi\left(\frac{7.0\times10^{-3}\text{ m}}{2}\right)^3 \times 9.81 \text{ m s}^{-2}\times(7800-1430)\text{kg m}^{-3}}{6\pi \times \frac{7.0\times10^{-3}\text{m}}{2} \times \frac{0.8 \text{ m}}{5.3 \text{ s}}}$	
	• Use of $v = \frac{Vg(\rho_s - \rho_l)}{6\pi r\eta}$	(1)	$\eta = 1.13$ Pa s	
	• $\eta = 1.1$ (Pa s)	(1)		4
12(b)(ii)	• With the large sphere the speed will be greater so Stokes' law won't apply	(1)		
	• The flow is turbulent **or** not laminar	(1)		2
12(b)(iii)	**Any one** • Can eliminate human reaction time • Can playback to measure <u>time</u> more accurately • Can check that terminal velocity is reached	(1)		1

(Total for Question 12 = 9 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
13(a)(i)	• A line/surface/plane along which all the points are in phase (1)		1
13(a)(ii)	• A wavelet drawn centred on any point on the line AC (1) • Minimum of three wavelets drawn (extending to right hand side) with radii equal (by eye) to distance between incoming wavefronts (1) • New wavefront drawn with correct shape and position along leading edge of wavelets (1)	Accept curved line, arc, circle or semicircle for wavelets 	3

13b(i)	Any one			1
	- Monochromatic **or** small range of wavelength / frequencies - Coherent - Little divergence of wave over a distance - Produces plane wavefronts			
13b(ii)	$d = 0.005$ mm **or** use of $d = \frac{1}{200 \text{ mm}^{-1}}$ - Use of tan to find θ - Use of $n\lambda = d\sin\theta$ with $n = 3$ $\lambda = 5.4 \times 10^{-7}$ (m) - Concludes that the laser light is green **Or** conclusion consistent with their value of λ	(1) (1) (1) (1) (1)	Example of Calculation $d = \frac{1}{200 \text{ mm}^{-1}} = 0.005$ mm $\theta = \tan^{-1}\left(\frac{1.02 \text{ m}}{3.0 \text{ m}}\right) = 18.8°$ $\lambda = \frac{(5 \times 10^{-6} \text{m}) \times \sin 18.8°}{3} = 5.37 \times 10^{-7}$m so light is green	5

(Total for Question 13 = 10 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
14(a)	• Use of $p = mv$ with m= 9.11×10^{-31} **and** $v = 0.02 \times 3.0 \times 10^8$ (1) • Use of $\lambda = \frac{h}{p}$ (1) • $\lambda = 1.2 \times 10^{-10}$ m (1)	Example of calculation $$\lambda = \frac{6.63 \times 10^{-34} \text{ J s}}{9.11 \times 10^{-31} \text{ kg} \times 0.02 \times 3.0 \times 10^8 \text{ m s}^{-1}}$$ $\lambda = 1.2 \times 10^{-10}$ m	3
14(b)	**Either** • The wavelength of the electron is less than the wavelength of light (1) • (So) less diffraction (with the electron beam) (1) **Or** • The wavelength of the light is greater than the wavelength of the electrons (1) • (So) more diffraction (with light beam) (1)		2
14(c)	• Use of magnification $= \frac{\text{image height}}{\text{object height}}$ (1) • 3.0×10^{-5} m (1)	Example of calculation mean $= \frac{(0.024+0.025+0.022)\text{m}}{3} = 0.024$ m Size of cell $= \frac{0.024 \text{ m}}{800} = 3.0 \times 10^{-5}$ m	2

(Total for Question 14 = 7 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
15(a)	• Energy absorbed in the impact is equal to the change in GPE (between start and end) (1) • $\Delta E = mg\Delta h$ and mg constant (so $E \propto \Delta h$) (1)		**2**
15(b)	• Equate $E = mg\Delta h$ and $E=\frac{1}{2}mv^2$ (1) • Use of $p=mv$ (1) • p = 50 kg m s^{-1} (1)	Do not accept $v^2 = u^2 + 2as$ (because the hammer does not move in a straight line with constant acceleration) Example of calculation $mg\Delta h = \frac{1}{2}mv^2$ $31 \text{ kg} \times 9.81 \text{ ms}^{-2} \times 0.13 \text{ m} = \frac{1}{2} \times 31 \text{ kg} \times v^2$ $v = \sqrt{(2 \times 9.81 \text{ ms}^{-1} \times 0.13 \text{ m})} = 1.6 \text{ m s}^{-1}$ p = 31 kg $\times$ 1.6 m s^{-1} = 49.6 kg m s^{-1}	**3**
15(c)	• Steel had a lower fracture toughness due to the low temperature (1) • at low temperatures less energy is absorbed before fracture (1) • the (absorbed) energy was sufficient to cause fracture (1)		**3**

(Total for Question 15 = 8 marks)

Question Number	Acceptable Answers	Additional guidance	Mark
16 (a)	• Use of $I = \frac{P}{A}$ (1) • Use of 2.4sin 50 **or** 2.4cos40 (1) • $P = 400$ W (1)	Example of Calculation $P = 1100$ W m^{-2} × 2.4 sin 50 m^2 × 0.2 = 404 W	**3**
16(b)	• Uses ratio of resistances to pd's **Or** uses $I = \frac{V}{R_{total}}$ **and** $V = IR$ (1) • Output pd =13.7 (V) (1) • Compares their answer to 13 (V) with conclusion consistent with their answer (1)	R_{total}=1750 Ω Example of Calculation $V_o = V_s \left(\frac{R_1}{R_1 + R_2} \right)$ $V_{LDR} = 24$ V $\left(\frac{1000\ \Omega}{750\ \Omega\ +\ 1000\ \Omega} \right) = 13.7$ V 13.7 > 13 so motor is on	**3**

16(c)	**Max 6**			
	Similarities			
	• An electron absorbs a photon **Or** electrons gain energy from a photon	(1)		
	• photons need a minimum amount of energy	(1)		
	• So light must be above a certain frequency	(1)		
	• increasing the light intensity increases the number of electrons (released per sec)	(1)		
	• Evidence for the particle model of light	(1)		
	Differences			
	• In the photoelectric effect electrons are released from the surface	(1)		
	• But electrons remain within the LDR	(1)		
	• Photoelectric effect occurs in metals **Or** LDR is a semiconductor	(1)		**6**

(Total for Question 16 = 12 marks)