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Paper 3 Physics Extension

Mark scheme

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2 3 6 Y 9 2 0 4 / P E / M S

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from [oxfordaqaexams.org.uk](https://www.oxfordaqaexams.org.uk)

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

- 2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.
- 2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.
- 2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.
- 2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do **not** accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.1	alternating current repeatedly changes direction		1	AO1 3.22.1 a/b	
	direct current is in one direction		1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.2	peak potential difference $= 50 \times 3$		1	AO2 3.22.1 b/c	
	150 (V)		1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.3	$t = 0.25$ hours		1	AO2 3.22.3f	
Mark with 01.4	$E = 14 \times 0.25$	allow a correct substitution using an incorrectly / not converted value of time	1		
	3.5 (kWh)	allow a correct calculation using an incorrectly / not converted value of time	1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.4	cost $= 3.5 \times 0.22$		1	AO2 3.22.3f	
Mark with 01.3	(\$) 0.77	allow ecf from 01.3	1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.5	if the current in the circuit becomes too high		1	AO1 3.22.1e	
	the fuse heats up and melts	allow the fuse blows do not accept the fuse blows up	1		
	which causes the circuit to break	dependent on mp1 or mp2	1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.6	any one from: • works faster than a fuse • can be reset	allow does not need replacing	1	AO1 3.22.1e	
Total			13		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.1	ammeter		1	AO4	
	variable resistor		1	3.21.2 g	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.2	any two from: • number of turns on the coil • thickness of the wire on the coil • length / diameter of the iron nail • mass of the iron block • thickness of each sheet of paper	if no other mark awarded, allow 1 mark for same material of block and / or nail	2	AO4 3.21.2g	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.3	all points plotted correctly	allow 1 mark for 2 or 3 correctly plotted points	2	AO2 3.21.2g	
Mark with 02.4	line of best fit drawn		1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.4	number of pieces of paper is directly proportional to current		1	AO3 3.21.2g	
Mark with 02.3 and Figure 4	because the graph (in Figure 4) is a straight line through the origin	allow because (in Figure 4) when current doubles, the number of sheets of paper doubles allow 1 mark for as the current increases the number of pieces of paper increases	1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.5	increasing the current increases the strength of the magnetic field	allow increasing the current increases the strength of the electromagnet	1	AO1 / AO3 3.21.2 b/e	
	so the force due to the magnetic field acts over a greater distance		1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.6	greater current can cause wires to get hot		1	AO4 3.21.2g	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.7	the number of sheets of paper between the coil and the iron block would be lower (for every current)	allow the iron block would not be attracted	1	AO3 3.21.2g	
	because the magnetic field strength is much weaker (without the iron nail inside the coil)		1		

Total			14		
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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
03.1	$a = \frac{1.2 - 0}{3.0 - 0}$	allow any correct values read from graph	1	AO2 3.17.3e	
	0.4 (m/s ²)	allow 0.40 (m/s ²)	1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
03.2	$d = 1.6 \times 1.2$	allow $\Delta t = 1.5$ to 1.7 (s)	1	AO2 3.17.3f	
	1.92 (m)	this mark may still be awarded if Δt is incorrect and $v = 1.2$ (m/s)	1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
03.3	$0.21 = F \times 2.8$	allow a correct rearrangement using an incorrectly / not converted value of energy	1	AO2 3.18.1a	
	$F = \frac{0.21}{2.8}$		1		
	0.075 (N)	allow a correct calculation using an incorrectly / not converted value of energy	1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
03.4	any two pairs from: • decrease the mass of the car • because a smaller mass will result in a greater acceleration (with the same driving force) or • use a bigger balloon • so there is a greater force from the air or • decrease the surface area of the front of the car • to reduce air resistance	allow blow more air into the balloon allow so the force acts for a greater time	4	AO3 3.17.1b	

Total			11		
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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.1	condensation		1	AO1 3.20.2b	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.2	the water particles near to the ice move closer together	allow the water particles near to the ice lose kinetic energy	1	AO1 3.20.2a	
	so the density of the water increases		1		
	and the cooler water sinks		1		
	water at the bottom of the glass is less dense and rises		1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.3	$4800 = 0.015 \times I$	allow a correct rearrangement using an incorrectly / not converted value of mass	1	AO2 3.20.1d	
	$I = \frac{4800}{0.015}$		1		
	320 000 (J/kg)		1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.4	the temperature difference between the water and the surroundings decreases		1	AO1 / AO3 3.20.2d	
	so the rate of energy transfer to the water decreases		1		
	so the rate of increase in temperature decreases		1		

			11		
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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.1	any one from: • wave power • solar power • hydroelectric power • wind power • biofuel • tidal power		1	AO1 3.18.3 d	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.2	temperature change per kilometre = $\frac{95 - 20}{3 - 0}$ 25 (°C/km)	allow any two correct points read from the graph	1	AO2 3.18.3 d	
			1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.3	any one from; - less drilling to reach rocks of the same temperature increase - the temperature is higher (at all depths) - smaller energy losses as the steam returns to the surface		1	AO3 3.18.3 c	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.4	$12 = \frac{42 \times 10^6}{\text{total energy input}} \times 100$		1	AO2 3.18.2e	
	total energy input = $\frac{42 \times 10^6}{12} \times 100$		1		
	$350 \times 10^6 \text{ J}$		1		
	mass = $\frac{350 \times 10^6}{2.8 \times 10^6}$		1		
	125 (kg)	allow 130 kg	1		

Question	Answers	Mark	AO / Spec. Ref.	ID
05.5	Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	3–4	AO1 3.18.3 c / d	
	Level 1: Relevant features are identified and differences noted.	1–2		
	No relevant content	0		
	Indicative content • both sources are reliable • both sources can supply continuous power • geothermal energy can only be used in certain areas of the world • coal can be used in many locations • geothermal energy releases very little / no carbon dioxide • burning coal releases carbon dioxide • geothermal energy contributes very little to global warming • burning coal contributes to global warming • there is no fuel cost for geothermal energy • there is a fuel cost for coal • there is an environmental impact of mining for coal			
Total		13		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.1	electromagnetic radiation (emitted from the nucleus)		1	AO1 3.23.2e	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.2	gamma radiation is the most penetrating so it can pass out of the body	allow a converse answer for beta and alpha	1	AO1 3.23.2g	
		allow it is weakly ionising allow it can be detected (outside the body)	1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.3	both nuclei have the same number of protons but the nucleus of Iodine-131 has 8 more neutrons than Iodine-123		1	AO1 / AO2 3.23.1f	
			1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.4	131, 0 (top line) 54, -1 (bottom line)	if no other mark is awarded, allow 1 mark for ${}^0_{-1}(\beta)$	1	AO2 3.23.2f	
			1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.5	ultrasound is not ionising and gamma radiation is ionising and ionising radiation can cause genetic mutations / cancer		1	AO1 3.19.1d / 3.19.2b/g	
			1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.6	$1500 = 12 \times 10^6 \times \lambda$		1	AO2 3.19.1h	
	$\lambda = \frac{1500}{12 \times 10^6}$	allow a correct rearrangement using an incorrectly / not converted value of frequency	1		
	0.000125 (m)	allow a correct calculation using an incorrectly / not converted value frequency	1		
			12		

Question	Answers	Mark	AO / Spec. Ref.	ID
07.1	Level 3: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO4 3.20.1b	
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4		
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2		
	No relevant content	0		
	Indicative content • use a balance to measure mass • measure the mass of the beaker • add water and measure the total mass of the water and beaker • determine the mass of the water • record starting temperature of water with the thermometer • ensure that the joulemeter reading is zero • switch on the heater • leave until heater has heated up • switch off the heater • wait until the thermometer reading is at a maximum • record the maximum temperature • determine the temperature change • record the energy transferred using the joulemeter • substitute into the equation $E = mc\Delta\theta$ • $c = \frac{E}{m\Delta\theta}$ To access level 3 students must include a description of the calculations required to determine specific heat capacity			

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
07.2	the temperature increase would be greater (for the same amount of energy)	allow less energy is lost to the surroundings allow less energy is required (for the same change in temperature)	1	AO3 3.20.1b	
	therefore the calculated value of specific heat capacity would be smaller	dependent on MP1	1		

			8
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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
08.1	potential difference across R = 7.2 (V)		1	AO2 3.21.1 g / n	
	$R = \frac{7.2}{0.0045}$		1		
	1600 (Ω)		1		
	allow a maximum of 1 mark if V = 1.8 (V)				

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
08.2	<u>ammeter</u>				
	when light intensity decreases the resistance of the LDR increases		1	AO1 / AO3 3.21.1 f / i / m / n	
	so the total resistance of the circuit increases		1		
	therefore the current in the circuit decreases so the ammeter reading decreases		1		
	<u>voltmeter</u>				
	pd is shared between the components in series		1		
	so LDR has a greater proportion of the total resistance		1		
	therefore the pd across the LDR increases so the voltmeter reading increases		1		
	OR				
	if current decreases pd across R decreases (1)				
and pd across LDR = pd across battery – pd across R (1)	allow total pd (across both components) is constant				
therefore the pd across the LDR increases so the voltmeter reading increases (1)					

		9
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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
09.1	$E_e = \frac{1}{2} \times 48 \times 0.060^2$ $E_e = 0.0864\text{J}$ $(E_e = E_k)$ $0.0864 = \frac{1}{2} \times 0.012 \times v^2$ $v = \sqrt{\frac{0.0864}{(\frac{1}{2} \times 0.012)}}$ 3.79473... (m/s) 3.8 (m/s)		1 1 1 1 1 1	AO2 3.18.1c / e	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
09.2	kinetic energy as the ball leaves the toy is the same therefore (maximum) gravitational potential energy of the ball is the same as mass is greater maximum height is lower OR kinetic energy as the ball leaves the toy is the same (1) so if mass is greater, velocity is lower (1) acceleration is the same so maximum height is lower (1)	allow energy transferred to the ball remains the same allow gravitational potential energy would be greater for the same height dependent on mv^2	1 1 1	AO3 3.18.1d / e 3.18.2a	

			9
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