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Paper 1

Mark scheme

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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 Assessment Writer.

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

Level of response marking instructions

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 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. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in 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 and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 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.

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

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 errors/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 <u>not</u> 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.

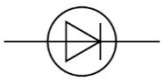
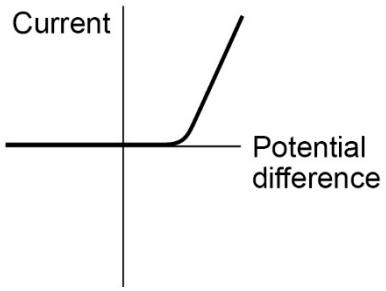
- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

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.

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.1	independent		1	AO4 3.1.1	
01.2	the initial charge stored in the battery the mass of the drone		1 1	AO4 3.1.1	
01.3	185		1	AO2 3.1.1	
01.4	3 points from the table plotted correctly	within ½ square allow **1** mark for 2 points plotted correctly	2	AO2 3.1.1	
01.5	correct line of best fit drawn	a straight line passing within 1 mm of all points	1	AO2 3.1.1	
01.6	125	allow 122–128 allow an answer using their line of best fit	1	AO2 3.1.1	
01.7	$5.0 = \frac{s}{266}$ $s = 266 \times 5.0$ 1330 (m)	an answer of 1330 (m) scores **2** marks	1 1 1	AO2 3.1.2 c	
01.8	(work is done against) air resistance		1	AO2 3.1.1 a	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.9	any **one** from: • invasion of privacy • drone falling out of sky and landing on someone • noise pollution • threat to national security	allow spying allow colliding with plane allow banned from flying near military bases **or** airports **or** water ways allow other sensible suggestion	1	AO3 3.1.1	
Total			**13**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.1	two neutrons and two protons		1	AO1 3.7.2 e	
02.2	has a long half-life so source does not need changing **or** has a long half-life so provides a constant power supply	allow so source remains active for a long time allow (can provide power for) the length of time as a person will live for	1	AO2 3.7.2 j	
02.3	an electron emitted from the nucleus		1	AO1 3.7.2 e	
02.4	beta will pass through plastic ionize cells	allow beta is not stopped by plastic allow mutates cells/causes cancer	1 1	1xAO3 1xAO2 3.7.2 g 3.7.2 j	
02.5	people concerned about nuclear radiation **Or** radioactive source difficult to dispose of needs changing more often	allow cheaper	1 1	AO3 3.7.2 j	
Total			**7**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
03.1			1	AO1 3.5.1 g	
03.2			1	AO1 3.5.1 n	
03.3	low resistance (once the potential difference reached a certain value)		1	AO1 3.5.1 n	
03.4	LED uses lower current any **one** from • for the same brightness • LED more efficient • battery lasts longer • less energy wasted	 do **not** allow cheaper unless quantified with an explanation of payback time	1 1	AO3 3.5.1 o	
03.5	it has the greatest potential difference		1	AO3 3.5.1 e	
03.6	 20 mA = 0.020 A 3.4 = 0.020 × R $R = \frac{3.4}{0.020}$ R = 170 (Ω)	an answer of 170 (Ω) scores **4** marks allow a correct substitution using an incorrectly/not converted value of I allow a correct rearrangement using an incorrectly/not converted value of I allow a correct calculation using an incorrectly/not converted value of I	 1 1 1 1	AO2 2.5.1 h	

Total			**10**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.1	speed		1	AO1 3.3.5 a	
04.2	0°		1	AO1 3.3.5.a	

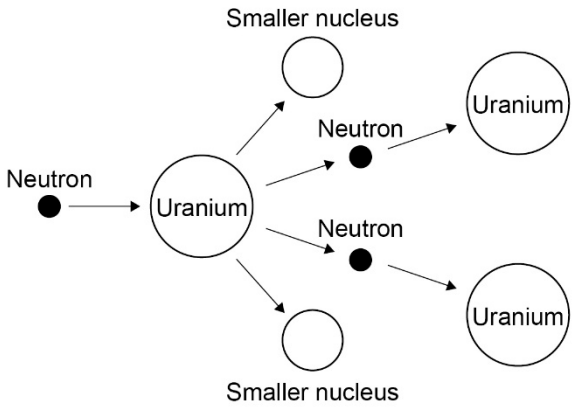
04.3	**Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 3.3.5 b AO1 3.3.5 e	E
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically 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 • place the single slit in front of the ray box • turn on the lamp to get a ray of light • place the Perspex block on a piece of paper and draw around it • draw a normal line at 90° to the edge of the Perspex block using a protractor • shine the ray of light through the block at an angle • draw the ray of light entering the block • draw the ray of light emerging from the block • remove Perspex block and draw a line connecting the rays • draw a normal line at the point the ray emerges from block • measure the angle of incidence between the ray and the normal line using a protractor • measure the angle of refraction between the ray and the normal line using a protractor • use the equation $n = \frac{\sin i}{\sin r}$ to calculate refractive index • repeat the investigation 3 times and find the mean result • repeat the investigation using different angles • plot a graph of $\sin i$ against $\sin r$ and the gradient is the			

	refractive index to access level 3 there must be a description of how angles are measured			

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.4	$1.49 = \frac{1}{\sin c}$ $c = 42^{o}$	an answer of 42° scores **2** marks allow a correct answer given to more than 2 s.f.	1 1	AO2 3.3.5 f	
04.5	higher refractive index so thinner glasses low density so lighter glasses does not transmit UV so eyes are not damaged	allow more powerful lens allow does not transmit harmful UV	1 1 1	AO3 3.3.5 e	
Total			**13**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.1	gravity		1	AO1 3.8.1 a	
05.2	energy is released by the fusion of hydrogen nuclei to make helium nuclei the temperature and density of a star are greatest at the core of the star		1 1	AO1 3.8.1 b 3.8.1 c	
05.3	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.		4-6	AO1 3.8.1 f g h j	E
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.		1-3		
	No relevant content		0		
	Indicative content **Similarities** • both stars are formed from dust and gas brought together by gravitational forces • both stars form a protostar • both stars then become main sequence stars • in both stars hydrogen fuses to form helium • both stars run out of hydrogen • both stars cool and expand **Differences** • Betelgeuse becomes a red supergiant • Sun becomes a red giant • Betelgeuse explodes / supernova • Sun does not undergo a supernova • Betelgeuse forms a neutron star • Sun becomes a white dwarf • if Betelgeuse is massive enough • Betelgeuse forms a black hole • Sun becomes a black dwarf				

Total			**9**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.1	plutonium		1	AO1 3.7.3 b	
06.2	a large nucleus splits (into 2 smaller nuclei)	do **not** accept atom for nucleus	1	AO1 3.7.3 a	
06.3		uranium splitting into 2 smaller nuclei 2/3 neutrons being emitted at least one neutron going on to interact with another uranium nuclei	1 1 1	AO1 3.7.3 c	
06.4	control rods absorb neutrons there are fewer neutrons (per second) fewer fusion events (per second)	 allow chain reaction slows down allow doesn't overheat allow to ensure an average of one neutron per fission goes on to produce further fission	1 1 1	AO1 3.7.3 d	

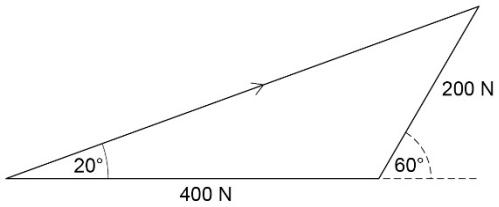
Question	Answers	Mark	AO / Spec. Ref.	ID
06.5	**Level 2:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4	2xAO2 2xAO3 3.2.3 a 3.7.3 e	E
	Level 1: Some logically linked reasons are given. There may also be a simple judgement.	1–2		
	No relevant content	0		
	Indicative content **Advantages** • doesn't need to keep refuelling as less volume of fuel is needed • can stay under water for a very long time as does not need to resurface to generate electricity • diesel submarines cannot stay under water for a long time as they need to resurface for air to be used in combustion engine **Disadvantages** • reactor produces radioactive waste which needs to be disposed of • radioactive waste contaminating the ocean if the submarine is damaged			

Total			12		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
07.1	the sides of the coil experience a force in opposite directions	allow the current creates a magnetic field	1	2xAO1 2xAO2 3.6.4 a 3.6.4 d	
	the forces cause moments that act in the same direction	allow the magnetic fields interact to create a pair of forces allow the magnetic fields interact causing the coil to rotate	1		
	the two halves of the commutator swap from one brush to the other		1		
	the commutator reverses the current in the coil	allow keeps the current in the same direction relative to the permanent magnet	1		
07.2	allow any **two** from: • increase the current • increase the size of the magnetic field • increase the number of turns on the coil • reduce the mass		2	AO1 3.6.4 b	
07.3	reverse the direction of current		1	AO1 3.6.4 c	
	reverse the poles of the magnet		1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
07.4	any **two** from: • operated remotely so no danger for the operator • smaller and lighter so can fit into smaller spaces • one operator could deploy many robots and find people quicker • robot does not need to be trained	do **not** allow cheaper unless linked to training/other costs associated with the dog	2	AO3 3.6.4	
Total			**10**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
08.1	35 (seconds)	allow 33 - 37	1	AO2 3.1.3 e	
08.2	steepest gradient		1	AO2 3.1.3 e	
08.3	$a = \frac{(14.2 - 5.8)}{(90 - 63)}$ 0.31 (m/s^2)	an answer of 0.31 (m/s^2) scores **2** marks allow $a = \frac{8.4}{27}$ allow correct answer given to more than 2 s.f. allow an answer 0.30 – 0.32	1 1	AO2 3.1.3 d 3.1.3 e	
08.4	distance during first acceleration = $\frac{1}{2} \times 5.8 \times 28$ distance during second acceleration = $\left(\frac{1}{2} \times 8.4 \times 27\right) + (27 \times 5.8)$ total distance = $\left(\frac{1}{2} \times 8.4 \times 27\right) + (27 \times 5.8) + \left(\frac{1}{2} \times 5.8 \times 28\right)$ 351.2 m	an answer of 351.2 (m) scores **4** marks allow values read to ± ½ small square allow values read to ± ½ small square allow values read to ± ½ small square allow correct calculation using their values of distance	1 1 1 1	AO2 3.1.3 f	
08.5	$m = \frac{6370}{9.8}$	an answer of 11 000 (J) scores **5** marks allow correct substitution using incorrect/not converted value of weight allow correct calculation using	1 1	AO2 3.1.1 e 3.2.1 e	

	m = 650 kg $E_k = 0.5 \times 650 \times 5.8^2$ E_k = 10 933 E_k = 11 000 (J)	incorrect/not converted value of weight this mark and subsequent marks maybe awarded for using their value of mass calculated using W=mg allow an answer to 2 s.f. using their value of E_k calculated using the correct equations	1 1 1		
Question	**Answers**	**Extra information**	**Mark**	**AO / Spec. Ref.**	**ID**
08.6	diagram drawn to scale angle of 60° resultant force 530 N  	 allow range of 525 N to 535 N	1 1 1	AO2 3.1.3 b	
Total			**16**		