AS
PHYSICS
(7407/1)

Paper 1

Mark scheme

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 aqa.org.uk

Physics - Mark scheme instructions 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 and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

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

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.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates 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 (often prefaced by 'Ignore' in the mark scheme) are not penalised.

3.2 Marking procedure for calculations

Full marks can usually be given for a correct numerical answer without working shown unless the question states 'Show your working'. However, if a correct numerical answer can be evaluated from incorrect physics then working will be required. The mark scheme will indicate both this and the credit (if any) that can be allowed for the incorrect approach.

However, if the answer is incorrect, mark(s) can usually be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

A calculation must be followed through to answer in decimal form. An answer in surd form is never acceptable for the final (evaluation) mark in a calculation and will therefore generally be denied one mark.

3.3 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.

3.4 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are likely to be restricted to calculation questions and should be shown by the abbreviation ECF or *conseq* in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.5 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited (eg fizix) **unless** there is a possible confusion (eg defraction/refraction) with another technical term.

3.6 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.

3.7 Ignore / Insufficient / Do not allow

'Ignore' or 'insufficient' 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.

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

3.8 Significant figure penalties

An A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the **final** answer in a calculation to a specified number of significant figures (sf). This will generally be assessed to be the number of sf of the datum with the least number of sf from which the answer is determined. The mark scheme will give the range of sf that are acceptable but this will normally be the sf of the datum (or this sf -1). The need for a consideration will be indicated in the question by the use of 'Give your answer to an appropriate number of significant figures'. An answer in surd form cannot gain the sf mark. An incorrect calculation **following some working** can gain the sf mark.

3.9 Unit penalties

An A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the correct unit for the answer to a calculation. The need for a unit to be quoted will be indicated in the question by the use of 'State an appropriate SI unit for your answer '. Unit answers will be expected to appear in the most commonly agreed form for the calculation concerned; strings of fundamental (base) units would not. For example, 1 tesla and 1 weber/metre^2 would both be acceptable units for magnetic flux density but 1 $\text{kg m}^2\ \text{s}^{-2}\ \text{A}^{-1}$ would not.

3.10 Level of response marking instructions.

Level of response mark schemes are broken down into three 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.

Determining 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. i.e. if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2.

The exemplar materials used during standardisation will help you to determine the appropriate level. 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.

Question	Answers	Additional Comments/Guidance	Mark
01.1	1✓ 0✓ 1✓ $u\bar{d}$✓ uud✓	1 mark each	5
01.2	Strong nuclear circled✓		1
01.3	Charge *1 +1 = 1 + X* *X = 1*✓ Baryon number *0 + 1 = 0 + X* *X = 1*✓ Strangeness *0 + 0 = 1 + X* *X = -1*✓	Any order	1 1 1
01.4	Weak nuclear circled✓		1
01.5	Strangeness of X is -1, The strangeness of the pion and neutron are both zero The strangeness changes from -1 to 0✓ This can only occur in weak interactions. ✓	First mark is for showing that strangeness changes Second is for stating that this can only happen if the interaction is weak.	1 1
01.6	$n \rightarrow p$ ✓$+ \beta^- + \bar{\nu}_e$ ✓	First mark is for the proton Second is for the beta minus and antineutrino.	1 1

01.7	The only particles remaining are electrons/positrons and neutrinos/antineutrinos which are stable ✓ And a proton which is the only stable baryon ✓	1 1	1 1
02.1	The process involves the ejection of electrons which are negatively charged. ✓ Any electrons ejected will only make the positive charge greater. ✓		1 1

<table>
<tr>
<td>02.2</td>
<td>
The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2 mark (L1), 3 or 4 mark (L2) and 5 or 6 mark (L3) answer. Guidance provided in section 3.10 of the ‘Mark Scheme Instructions’ document should be used to assist in marking this question.
<table>
<tr><th>Mark</th><th>Criteria</th><th>QoWC</th></tr>
<tr><td>6</td><td>Both ideas fully analysed, with full discussion of alternatives.</td><td rowspan="2">The student presents relevant information coherently, employing structure, style and sp&g to render meaning clear. The text is legible.</td></tr>
<tr><td>5</td><td>Both ideas analysed with supporting discussion but without alternatives</td></tr>
<tr><td>4</td><td>Both ideas analysed, with one dealt with satisfactorily and the other with some supporting discussion</td><td rowspan="2">The student presents relevant information and in a way which assists the communication of meaning. The text is legible. Sp&g are sufficiently accurate not to obscure meaning.</td></tr>
<tr><td>3</td><td>Both ideas analysed, with only one dealt with satisfactorily</td></tr>
<tr><td>2</td><td>One idea analysed with some supporting discussion</td><td rowspan="2">The student presents some relevant information in a simple form. The text is usually legible. Sp&g allow meaning to be derived although errors are sometimes obstructive.</td></tr>
<tr><td>1</td><td>One idea analysed, with little supporting discussion</td></tr>
<tr><td>0</td><td>Unsupported combination or no</td><td>The student’s presentation, spelling,</td></tr>
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</td>
<td>
The following statements are likely to be present
To demonstrate threshold frequency:
The metal should be kept the same, and the light source varied.
Using any metal, and light sources 1 and 3,
no charge will be lost with light source 1
but charge will be lost with light source 3
because light source three has a greater photon energy
and therefore frequency (from E=hf)
and is above the threshold frequency
as the photon energy is greater than the work function of the metal
but light source 1 has a photon energy less than the work function of the metal
so its frequency is below the threshold frequency.
To demonstrate work function
The light source should be kept the same, and the metal varied
Use light source 2 as the other two will either cause all three metals to lose their charge, or none of the metals to lose their charge.
Use each metal in turn, so that zinc loses its charge, due to its low work function, but copper and iron do not lose their charge.
</td>
<td>6</td>
</tr>
</table>

	relevant analysis	punctuation and grammar seriously obstruct understanding	

02.3	Work function in joules = 1.6 x 10^{-19} x 4.3 = 6.9 x 10^{-19} J ✓ Use of hf = work function + KE $_{max}$ KE_{max} = hf – work function = (6.63 x 10^{-34}) x (1.2 x 10^{15}) – 6.9 x 10^{-19} ✓ = 7.9 x 10^{-19} – 6.9 x 10^{-19} = 1.0 x 10^{-19} J ✓	The first mark is for converting the work function into J The second mark is for substituting into the photoelectric equation The third mark is for the final answer Allow 1.1	1 1 1
02.4	The work function is the minimum amount of energy needed to remove the electron from the zinc surface ✓	Alternative Reference to max ke corresponding to emission of surface electrons whilst electrons from deeper in the metal will be emitted with smaller ke	1

03.1	Initially the path difference is zero/the two waves are in phase when they meet/the (resultant) displacement is a maximum ✓ As the movable tube is pulled out, the path difference increases and the two waves are no longer in phase, so the displacement and loudness decrease ✓ When the path difference is one half wavelength, the two are in antiphase and sound is at its quietest. ✓ As the path difference continues to increase, the two waves become more in phase and the sound gets louder again. ✓	Alternative: Constructive interference occurs when the path difference is a whole number of wavelengths and the waves are in phase Destructive interference occurs when the path difference is an odd number of half wavelengths and the waves are in antiphase Initially the path difference is zero and the sound is loud As the pipe is pulled out the path difference gradually increases, changing the phase relationship and hence the loudness of the sound	1 1 1 1

03.2	Use of *wavelength = speed/ frequency* To give: 340/800 = 0.425 m✓ Path difference = one half wavelength = 0.21 m✓ Path difference = 2 $(d_2 - d_1)$ = 2 (distance moved by movable tube) Distance moved by movable tube = 0.10 m. ✓	The first mark is for calculating the wavelength The second mark is for relating the wavelength to the path difference The final mark is for relating this to the distance moved by the tube and working out the final answer.	1 1 1

03.3	Start with d1 = d2 Measure distance moved by movable tube for each successive minima and maxima✓ Each change in distance is equal to one quarter wavelength. ✓ Continue until tube is at greatest distance or repeat readings for decreasing distance back to starting point. ✓ Use speed = frequency x wavelength ✓	(Alternative mark scheme involving changing frequency and measuring to first min for each one can gain equal credit) Start with d1 = d2 Measure distance moved by movable tube for first minimum. Distance is equal to one quarter wavelength Repeat for different measured frequencies. Use speed = frequency x wavelength)	1 1 1 1

04.1	m = 16 g = 0.016 kg r = 0.008 m Use of $V = 4/3\ \pi\ r^3$ to give $V = 4/3\ \pi\ (0.008)^3$ $= 2.1 \times 10^{-6}\ m^3$✓ Use of density = m/V to give density = $0.016/2.1 \times 10^{-6}$✓ Density = $7.4 \times 10^3\ kg\ m^{-3}$ ✓	 The first mark is for calculating the volume The second mark is for substituting into the density equation using the correct units The final mark is for the answer.	 1 1 1

04.2	Use of $v^2 = u^2 + 2as$ to give $v^2 = 2\ (9.81)\ (1.27)$ ✓ $v^2 = 25\ (24.9)$ $v = 5.0\ (\mathrm{m\ s^{-1}})$ ✓	*(allow use of $mg\Delta h = ½\ mv^2$)* The first mark is for using the equation The second for the final answer	 1 1
04.3	Use of v2 = u2 + 2as to give $0 = u^2 + 2\ (-9.81)\ (0.85)$ ✓ $u^2 = 17\ (16.7)$ $u = 4.1\ \mathrm{m\ s^{-1}}$ ✓	The first mark is for using the equation The second for the final answer	1 1
04.4	Change in momentum = mv + mu = 0.016 x 5 + 0.016 x 4.1✓ = 0.15 (0.146) $\mathrm{kg\ m\ s^{-1}}$ ✓	The first mark is for using the equation The second for the final answer	1 1
04.5	Use of Force = change in momentum / time taken = 0.15 / 40 $\times 10^{-3}$✓ = 3.6 N ✓	The first mark is for using the equation The second for the final answer	1 1

04.6	Impact time can be increased if the plinth material is not stiff✓ Increased impact time would reduce the force of the impact. ✓	Alternative A softer plinth would decrease the change in momentum of the ball (or reduce the height of rebound) ✓ Smaller change in momentum would reduce the force of impact ✓	1 1
05.1	A combination of resistors in series connected across a voltage source (to produce a required pd) ✓	Reference to splitting (not dividing) pd	1
05.2	When R increases, pd across R increases ✓ Pd across R + pd across T = supply pd ✓ So pd across T/voltmeter reading decreases ✓	Alternative: Use of $V = \frac{R_1 \times V_{tot}}{R_1 + R_2}$ ✓ V_{tot} and R_2 remain constant ✓ So V increases when R_1 increases ✓	3
05.3	At higher temp, resistance of T is lower ✓ So circuit resistance is lower, so current/ammeter reading increases ✓		1 1

05.4	Resistance of T = 2500 Ω Current through T = V/R = 3/2500 = 1.2×10^{-3} A ✓ pd across R = 12 -3 = 9 V Resistance of R = V/I = 9/ 1.2×10^{-3} = 7500 Ω✓	*(Allow alternative using $V_1/R_1 = V_2/R_2$)* The first mark is working out the current The second mark is for the final answer	 1 1
05.5	Connect the alarm across R instead of across T ✓	allow: use a thermistor with a ptc instead of ntc.	1
06.1	Use of Young Modulus = $\frac{\text{tensile stress}}{\text{tensile strain}}$ ✓ To give tensile stress = $2 \times 10^{11} \times 3.0 \times 10^{-4} = 6.0 \times 10^{7}$ ✓ Use of tensile stress = $\frac{\text{tensile force}}{\text{cross sectional area}}$ To give tensile force = $6.0 \times 10^{7} \times 7.5 \times 10^{-3} = 4.5 \times 10^{5}$ N ✓	The first mark is for calculating the tensile stress The second mark is substituting into the tensile force equation The third mark is for the correct answer	1 1 1

06.2	Use of strain = extension / original length To give extension = $3.0 \times 10^{-4} \times 45 = 1.4 \times 10^{-2}$ m (1.35×10^{-2}) ✓ Use of energy stored = ½ F e To give Energy stored = $½ \times 4.5 \times 10^{5} \times 1.4 \times 10^{-2}$ = 3.2×10^{3} J ✓ (3.04×10^{3})	The first mark is for calculating the extension The second mark is for the final answer	1 1
06.3	Temperature change = pre-strain/pre-strain per K = $3.0 \times 10^{-4} / 2.5 \times 10^{-5} = 12$ K✓ Temperature = 8 ^{o}C + 12 = 20 ^{o}C ✓	The first mark is for the temperature change The second mark is for the final answer	1 1
06.4	So that the rail is not always under stress✓ as the rail spends little time at the highest temperature✓ Or To reduce the average stress the rail is under ✓ as zero stress will occur closer to average temperature/the rail will be under compressive/tensile stress at different times✓		1 1

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