AQA

# AS
# PHYSICS

7407/1 Paper 1

Mark scheme

7407

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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.

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# 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 <u>not</u> 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 kg m$^2$ s$^{-2}$ 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 | Answer | Comments/ Guidance | Mark |
|---|---|---|---|
| **01.1** | (momentum of air) increases✓ | words implying increase | 1 |
| **01.2** | (rate of change of momentum so) force acting on the air (Newton 2) ✓<br>it/air exerts force (on engine) of the same/equal magnitude/size✓<br>but opposite in direction (Newton 3) ✓ | <br><br><br>allow backwards and forwards to indicate opposite | 1<br>1<br><br>1 |
| **01.3** | (*use of F = ⊿mv/t*)<br>F = 210 × 570 = 120 000 (N) (119 700) ✓ | | 1 |
| **01.4** | momentum/velocity is a vector OR momentum/velocity has direction✓<br>there is a change( in the air's)direction✓ | | 1<br>1 |
| **01.5** | *(use of F = ma*)<br>a = (-) 190 000/7.0 × $10^4$ = 2.7 (2.71) (m $s^{-2}$) ✓ | | 1 |
| **01.6** | (use of $v^2 = u^2 + 2as$)<br>0 = $68^2$ – 2 × 2.7 × *s*✓<br>*s* = $68^2$/(2 × 2.7)= 860 (m) (856) | CE from 01.5<br>accept range 850 – 860<br>if forget to square *u* or double *a* score 1 mark<br>accept alternatives using $s = ut + 1/2at^2$ OR average speed – first mark for time calculation AND correct substitution | 1<br><br>1 |

| | | | |
|---|---|---|---|
| **01.7** | rate of intake of air decreases (as plane slows) OR volume/mass/amount of air (passing through engine) per second decreases✓<br>(as) smaller rate of change of momentum OR momentum change ✓ | allow argument in terms of (air) resistance<br>(air) resistance decreases as speed of aircraft decreases for 1 mark<br>NOT FRICTION | 1<br>1 |

| Question | Answer | Comments/ Guidance | Mark |
|---|---|---|---|
| **02.1** | waves are <u>reflected</u> (from the oven wall)✓<br>and superpose/interfere with wave travelling in opposite direction/incident waves/transmitted wave✓ | NOT superimpose | 1<br>1 |
| **02.2** | energy/amplitude is maximum✓<br>(chocolate melts at) antinode✓ | if refer to node can still be awarded first mark | 1<br>1 |
| **02.3** | clear evidence that used first and third antinode✓<br>distance from first to third antinodes = 0.118±0.001 (m) OR distance between two adjacent antinodes= 0.059±0.001(m) ✓<br>wavelength = 0.118 (m) ✓<br>frequency = $3.0 \times 10^8$ /0.118✓<br>frequency = $2.5 \times 10^9$ (Hz) ✓ | Can be from diagram<br>mark for either value<br>carry their value forward for subsequent marks even if outside tolerance<br>mark for using their wavelength (range 0.112 to 0.124)<br>mark for use of $v=f\lambda$ allow this mark if use 0.059<br>**must** be in range $2.40 \times 10^9$ - $2.60 \times 10^9$<br>if use 330 for speed lose last 2 marks | 1<br><br>1<br>1<br>1<br>1 |
| **02.4** | position of antinode/maximum energy/maximum amplitude/nodes (in food) continually changes✓ | must be clear antinode maximum energy/maximum amplitude changes location | 1 |

| Question | Answer | Comments/ Guidance | Mark |
|---|---|---|---|
| **03.1** | tensile stress is the force exerted per/over cross-sectional area✓<br>tensile strain is the extension per/over original length✓ | Can use equation but must define terms<br>NOT compared to | 1<br>1 |
| **03.2** | material is brittle✓<br>shown on graph by little or no of plastic behaviour OR by linear behaviour/straight line to breaking stress ✓<br>OR<br>material has high Young modulus OR material is stiff ✓<br>shown on graph by large gradient/steep line (compared to other materials)✓ | 2nd mark dependent on first | 1<br>1 |
| **03.3** | area = $\pi \times (1.5 \times 10^{-4})^2/4 = 1.77 \times 10^{-8}$✓<br>tensile force = $1.77 \times 10^{-8}$ ✓<br>= 23 (N)✓ | If use diameter as radius -1<br>If use incorrect formula ($d^2$ $2\pi r$ etc. -2)<br>range 22.5 – 24<br>power of ten error -1<br>if calculated area incorrectly get following answers<br>diameter as radius = 92 (2 marks)<br>$d^2$ = 7.3 (1 mark)<br>$2\pi r$ = 610 000 (1 mark)<br>if use d for area then zero | 1<br>1<br>1 |
| **03.4** | **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 marking this question.** | The following statements may be present for cable supporting a lift<br><br>material B/C is used for the lift because it has a high breaking stress and a high Young modulus<br>material A not chosen because lower breaking stress | 1<br><br>1<br>1<br><br>1 |

| Mark | Criteria | QoWC |
|---|---|---|
| 6 | Correct materials selected for **each** application (B/C for lift and D for bungee). One reason for choices given for **each** application and explanation why at least one other material would be rejected for **each** application. | The student presents relevant information coherently, employing structure, style and sp&g to render meaning clear. The text is legible. |
| 5 | Correct materials selected for **each** application (B/C for lift and D for bungee). One reason for choices given for **each** application and explanation why at least one other material would be rejected for **one** application. | |
| 4 | Correct material selected for **one** application (B/C for | The student presents relevant information and in a way which |

| | |
|---|---|
| material A not chosen because fails without warning | 1 |
| material C not chosen because has a lower breaking stress | 1 |
| material D not chosen as larger increase in strain for a given increase in stress | |
| material D not chosen as low breaking stress. | |
| material D a given stress produces a large strain meaning large extension | |
| | |
| The following statements may be present. for rope or cable used for bungee jump | |
| | |
| material D chosen as due large strain for given stress time taken to come to rest lengthens | |
| material D is chosen because D can store a large amount of energy before failure | |
| not A ,B or C because high Young Modulus so sudden stop resulting in large forces | |
| not A as brittle and therefore limited strain and sudden failure | |
| not C because requires a large strain before plastic behaviour | |
| not C because if behaves plastically will not return to original length | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | lift and D for bungee). **One** reason for choice given for one application and explanation why at least one other material would be rejected for **one** application. | assists the communication of meaning. The text is legible. Sp&g are sufficiently accurate not to obscure meaning. | | |
| | | 3 | Correct material selected for **one** application (B/C for lift and D for bungee). **One** reason for choices given application.<br>OR<br>Correct materials selected for **each** application (B/C for lift and D for bungee). One reason for choices given for **each** application | | | |
| | | 2 | No correct material selected but at least **two** properties necessary for an | The student presents some relevant information in a simple form. The text | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | application given. | is usually legible. Sp&g allow meaning to be derived although errors are sometimes obstructive. | | |
| | | 1 | No correct material selected but at least **one** property necessary for an application given. | | | |
| | | 0 | No correct material selected and no properties necessary for an application given | The student's presentation, spelling and grammar seriously obstruct understanding. | | |

| Question | Answer | Comments/ Guidance | Mark |
|---|---|---|---|
| **04.1** | (*use of R* = $\rho l/A$ )<br>*A*= 9.7 × $10^{-8}$× 0.50/0.070✓<br>A= 6.929 × $10^{-7}$ ($m^2$)✓<br>diameter = √(6.929 × $10^{-7}$ × 4/π) = 9.4 × $10^{-4}$ (m)✓ | <br><br><br>CE for third mark if incorrect area | <br>1<br>1<br>1 |
| **04.2** | *R* = 1.5/0.66 = 2.3(Ω) (2.27)✓ | | 1 |
| **04.3** | *use of V=IR*)<br>I = 1.5/(22+1.2)= 0.065✓(A) (0.0647) | | <br>1 |
| **04.4** | current in $R_1$ = 0.66 – 0.0647 = 0.595 (A)✓<br>resistance of $R_1$ and probe = 1.5/0.595 = 2.52 (Ω) ✓<br>resistance of probe = 2.52 – 2.4 = 0.12 (Ω)✓ | CE from 4.2/4.3<br>alternative method: 1/2.3 = 1/23.2 + 1/($R_{probe}$ + 2.4) ✓<br>correct rearrangement✓<br>range 0.1 – 0.15✓ accept 1 sig. fig. for final answer | 1<br>1<br>1<br> |
| **04.5** | cross-sectional area must decrease OR R ∝ 1/A✓<br>area decreases by 1.6% hence diameter must decrease by 0.8%✓ | indicated by downward arrow or negative sign which can b e seen on answer line<br>accept 1% | 1<br><br>1 |
| **04.6** | ANY TWO FROM<br><br>correct reference to lost volts OR terminal pd OR reduced current✓<br>reference to resistors not changing OR resistors constant ratio✓<br>reference to voltmeter having high/infinite resistance (so not affecting circuit) ✓ | | 1<br><br>1 |

| | | | |
|---|---|---|---|
| | reference to pd between AB being (very) small (due to closeness of resistance ratios in each arm) ✓<br>voltmeter (may not be) sensitive enough✓ | | |

| Question | Answer | Comments/ Guidance | Mark |
|---|---|---|---|
| **05.1** | energy of <u>photon</u> ✓<br>is greater than the work function✓<br>so electrons are emitted✓ | If correct reference to threshold frequency and no mention of work function then only score one of first two marks and can be awarded third mark | 1<br>1<br>1 |
| **05.2** | increased intensity means more photons incident per second✓<br>current greater OR more electrons emitted per second✓ | only need to see per second once<br>rate of photons incident OK (or rate of electrons emitted) | <br>1<br>1 |
| **05.3** | (*use of* $hf = \phi + E_k$)<br>$\phi = 2.1 \times 1.6 \times 10^{-19} = 3.36 \times 10^{-19}$ ✓(J)<br>$E_k = 6.63 \times 10^{-34} \times 7.23 \times 10^{14} - 3.36 \times 10^{-19}$✓<br>$E_k = 1.4(3) \times 10^{-19}$ ✓(J) | If incorrect or no conversion to J then CE for next two marks | <br>1<br>1<br>1 |
| **05.4** | (*use of* $eV = E_k$)<br>$V_s = 1.43 \times 10^{-19} / 1.6 \times 10^{-19} = 0.89$ (V)✓ | CE from 05.3<br>RANGE 0.70 – 0.90 | <br>1 |
| **05.5** | stopping potential would be greater✓<br>because the <u>energy</u> of the <u>photons</u> (of the electromagnetic radiation) would be greater✓<br>(hence) <u>maximum</u> kinetic energy of (photo)electrons would be greater✓ | | 1<br>1<br>1 |

| Question | Answer | Comments/ Guidance | Mark |
|---|---|---|---|
| **06.1** | atoms/nuclei with same number of protons/atomic number✓<br>but different numbers of neutrons/mass number✓ | atom/nuclei seen at least once | 1<br>1 |
| **06.2** | momentum must be conserved✓<br>so need two photons travelling in different directions✓ | | 1<br>1 |
| **06.3** | rest energy = 2 × 3728 = 7456✓ (MeV)<br>rest energy = $1.193 \times 10^{-9}$ ✓ (J)<br>use of energy of each photon = *hf*✓<br>*f* = $(1.193 \times 10^{-9}/2)/6.63 \times 10^{-34} = 8.997 \times 10^{23}$✓(Hz) | must show doubling OR explain that is halved<br>because two photons OR implied because$1.193 \times 10^{-9}$<br>no working but correct answer scores last three marks<br>RANGE: $8.90 \times 10^{23}$ - $9.00 \times 10^{23}$ | 1<br>1<br><br>1<br><br>1 |
| **06.4** | ${}^{1}_{0}\overline{\mathrm{n}} \rightarrow {}^{1}_{-1}\overline{\mathrm{p}} + {}^{0}_{1}\overline{e} + \nu_{(e)}$ ✓✓ | Can use $e^+$ OR $\beta$ in place of e<br>Allow slight loop in bottom of neutrino but must not look like gamma | 1<br>1 |
| **06.5** | electromagnetic: <br>gravitational: <br>strong nuclear: <br>weak nuclear: ✓ | | 1 |