AQA

A-level PHYSICS (7408/3BA)

Paper 3 – Section B (Astrophysics)

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).

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	Concave mirror with parallel incident rays reflecting to different focal points. ✓ Rays further from PA brought to focus nearer the mirror. ✓	PA does not need to be drawn.	1 1
01.2	**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.**	The following statements are likely to be present: Location • light must travel through some of the atmosphere to reach GTC which affects the amount of light arriving and resolution. • IUE In orbit needs its own power source, • and information needs to be sent to ground for analysis. • position of IUE inconvenient as, if something goes wrong, it is difficult to service an orbiting satellite. Collecting power • Collecting power is proportional to D^2. • So ratio is $10.4^2/0.45^2 = 530$ • GTC has 530x collecting power.	6

Mark	Criteria	QoWC
6	All three aspects covered: A full comparison of location in terms of the affect of atmosphere on the GTC, and the difficulties of maintaining, servicing and obtaining data from IUE. A quantitative comparison of the collecting power with conclusion that GTC has 530x collecting power of IUE. A quantitative comparison of minimum angular resolution, with conclusion that GTC is 5x better.	The student presents relevant information coherently, employing structure, style and sp&g to render meaning clear. The text is legible

	5	Two of the three aspects fully covered, with some detail missing from the third.		• GTC better as bigger diameter telescopes make brighter images. Minimum angular resolution • Minimum angular resolution is proportional to 1/D • $\theta = \lambda/D$ so ratio of min angular resolution is $(1 \times 10^{-6}/10.4) / (2 \times 10^{-7} / 0.45) = 0.2$ • GTC is 5x better at resolving • GTC better as bigger diameter telescopes make clearer images.	
	4	One aspect fully covered, with some detail missing from the other two Or Two aspects fully covered, with little or no relevant information about the third.	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.		
	3	All three aspects partially covered, with some detail missing from each Or One aspect fully covered, with little or no relevant information about the other two			
	2	Two aspects partially covered, with little or no relevant information about the third.	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		
	1	One aspect partially covered, with little or no relevant			

		information about the other two.	obstructive.		
	0	Little or no relevant information about any of the three aspects.	The student's presentation, spelling punctuation and grammar seriously obstruct understanding.		

01.3	QE. = $\dfrac{\text{no. of photons arriving at detector and being detected}}{\text{total arriving at detector}}$ For CCD QE> 80%✓ For eye QE = 1%✓	Both needed	1 1

02.1	Spectral class A✓ The temperature range for A class is 7500 K to 11 000 K✓		1 1
02.2	Lowest value of apparent magnitude indicates the brightest star. ✓ Vega has the lowest apparent magnitude (so is brightest) ✓		1 1
02.3	Closest of three stars is Altair✓ Using m – M = 5 log (d/10) To give 0.77 – 2.21 = - 1.44✓ And d = 5.2 pc✓	Allow ce for calculation of wrong star	1 1 1
02.4	Deneb is the largest✓ It has approximately the same temperature, but has a much brighter absolute magnitude and therefore greater power ouput✓ To have a much greater power output for a similar temperature, it must have a greater area✓ As $P = \sigma A T^4$	No mark for unsupported answer Allow alternative: from position on HR diagram, from T and M, Altair and Vega are main sequence stars Deneb is a giant star so Deneb largest.	1 1 1
02.5	Using $\lambda_{max} T = 0.0029$ To give $\lambda_{max} = 0.0029/7700$✓ $= 3.8 \times 10^{-7}$ m✓		1 1

03.1	An object that produces a rapid increase in brightness ✓	Allow lowering in value of absolute magnitude	1
03.2	Extremely dense ✓ Made up of neutrons ✓	Ignore descriptions of Neutron star surface Ignore refs to spinning or producing radio waves	1 1
03.3	Use of $Rs = 2GM/c^2$ To give $Rs = 2 \times 6.67 \times 10^{-11} \times 2 \times 2 \times 10^{30} / (3 \times 10^8)^2$ ✓ $= 5.9 \times 10^3$ m ✓	First mark is for substitution Second mark for answer	1 1
03.4	Collapsing star can produce gamma ray bursts with energy similar to total output of Sun ✓ Highly collimated – if in direction of Earth, could cause mass extinction event ✓	First mark is for gamma ray burst and an idea of the amount of energy Second mark is for consequence.	1 1

04.1	Star much brighter than reflected light from planet ✓ Or Planet very small and distant – subtends very small angle compared to resolution of telescopes		1
04.2	Planet and star orbit around common centre of mass that means the star to moves towards/away from Earth as planet orbits ✓ Causes shift in wavelength of light received from star ✓		1 1
04.3	Light curve showing constant value with dip ✓ When planet passes in front of star (as seen from Earth), some of the light from star is absorbed and therefore the amount of light reaching Earth reduced ✓ Apparent magnitude is a measure of the amount of light reaching Earth from the star ✓		1 1 1

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