A-level

Physics

PHYA5/2A – Astrophysics

Mark scheme

2450

June 2016

Version: 1.0 Final

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

Question	Answers	Additional Comments/Guidance	Mark	ID details
1 (a)	Use of M = fo/fe To give 5 = fo/0.15 ✓ And fo = 0.75m Use of length = fo + fe ✓ To give length = 0.75 + 0.15 = 0.9(0)(m) ✓	The first mark is for substitution into the magnification equation. If M=50 used allow max 2. If fo and fe are reversed, allow max 1. The second mark is for using the sum of the focal lengths. If fo-fe used allow max 1. The third mark is for the final answer. Allow c.e. for the second and third marks.	3	
1 (b) (i)	real	Allow “not virtual” Allow "can be captured on a screen" or similar	1	
1 (b) (ii)	Use of 1/f = 1/u + 1/v To give 1/0.15 = 1/u + 1/0.6✓ And therefore u = 0.2(0) m✓	There is no c.e. for using a negative value of image distance or focal length If fo used for fe allow max 1 If 0.9 m used for fe, give 0/2 If correct answer seen without substitution, give 2/2. Condone use of u for image distance and v for object distance.	2	
1 (b) (iii)	Ray diagram: One construction ray correct, ✓	If telescope seen, only first mark can be awarded.	3	

	Second construction ray correct to give magnified inverted image. ✓ Image, object and focal point labelled. ✓	For fat lens, construction ray must pass through principal axis within the lens. If magnifying glass seen, only 1st and 3rd marks can be awarded. Allow F or labelled focal length. Focal point must be on the side of the lens where the ray cuts the principal axis. Labelled lines for image and object – may be dotted.		
1 (c)	Chromatic aberration		1	
Total			10	

Question	**Answers**	**Additional Comments/Guidance**	**Mark**	**ID details**
2 (a) (i)	Spectral class axis correct: OBAFGKM ✓	Ignore bunching of labels. Do not condone letters beyond O and M	1	
2 (a) (ii)	Main sequence correct ✓ Dwarf and giant stars correct ✓	Bands not lines. Main sequence must have correct curvature LHS must be above -5 and RHS below 10 on abs mag scale. Dwarfs in bottom left quadrant, below abs mag 5, not touch Main sequence.	2	

		Giants in top right quadrant, can extend left, above abs mag 0, not touch Main sequence.		

2 (b) (i)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking. The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear. The candidates answer should be assessed holistically. The answer will be assigned to one of 3 levels according to the following general criteria:			
	Low level (1 or 2 marks)	**Intermediate Level (3 or 4 marks)**	**Higher Level (5 or 6 marks)**	
	The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate. Appearance: The apparent magnitude scale is identified as the one that indicates brightness, but it may be interpreted the wrong way round by the student. Incorrectly, there may be some reference to how big the stars appear based on the radius. References to colour may be missing altogether Spectrum: little or no relevant detail related to the spectrum of each star is given. Position: on the HR diagram: there may be no attempt.	The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate. Appearance: Student gives a coherent description the relative brightness and of the three stars, linked to their apparent magnitude. Spectrum: There may be some less accurate comparison of colour based on temperature **or** description of the spectra of the stars. Position: There is some attempt to discuss the position of the stars on the HR diagram.	The information conveyed by the answer is clearly organised, logical and coherent using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question. Appearance: Student gives a coherent description the relative brightness and of the three stars, linked to their apparent magnitude. For 6 marks, they go on to describe the colour of each star related to the temperature and spectral class Spectrum: The student further describes the spectrum of each of the three stars in terms of the major absorption lines, again related to the spectral class from their temperatures. Position on HR. There is some discussion of the position of the stars. For example it is pointed out that 41	

			Arieti cannot be a dwarf star as it is too large.	
	Summary of relevant information about each star Property / 41 Arieti / Sharatan / Hamal Brightness / Dimmest / Middle / Brightest Colour / Blue / Blue/ white / Orange/ red Spectra / He and H / H and ionised metals A / Neutral metals K class / B type of star / Main sequence Not dwarf. / Main sequence / Main sequence Position on HR / Top left / Middle/ left / Middle/ Right		**extra information** Answers that suggest that the size of the stars can be compared visually are unlikely to be awarded marks in the top half of a band.	

2 (b) (ii)	d = 66 /3.26 = 20 pc ✓ Use of m-M = 5 log (d/10) To give 2 – M = 5 log (20/10) ✓ M = 2 – 1.5 = 0.5 ✓	The first mark is for the conversion of d into parsec Allow ce for two marks. If M and m wrong way round, treat as physics error: only the first mark can be awarded The second mark is the correct substitution	3	

		The third mark is for the final answer; allow 0.46 to 0.5; no sf penalty		
2 (b) (iii)	41 Arietis has the largest radius and temperature, ✓ and therefore the greatest power output/ brightest abs mag/greatest intrinsic brightness (ref to $P = \sigma AT^4$) ✓ But appears dimmest in the sky (as it has the greatest apparent magnitude.) so 41 Arietis must be furthest away. ✓	No mark for an unsupported answer. Allow area for radius The first two marks can be awarded for a correct calculation of the power of 41 Arietis.	3	
Total			15	

Question	Answers	Additional Comments/Guidance	Mark	ID details
3 (a)	A silicon chip ✓ (divided into)picture elements ✓	Condone silicone, but not silicon(e) dioxide etc. Ignore references to wiring or process Allow pixels for picture elements	2	
3 (b)	The image formed on the CCD is created by incident photons. These photons cause <u>electrons</u> to be released. ✓ The electrons are trapped in ("potential wells" in the CCD) ✓ The number of electrons liberated (in each pixel) is proportional to the intensity of the light/number of photons falling (on each pixel). **or** so that the pattern of the charge built up is related to the image. ✓	The first mark is for identifying the role of photons in forming the charge build up. Condone excited/promoted Do not condone ejected/emitted/escaped. References to the photoelectric effect loses the first mark. The second is for describing how the charge /no of electrons is stored/built up The third is for stating the relationship between the number of electrons/charge and the image pattern.	3	
Total			5	

Question	Answers	Additional Comments/Guidance	Mark	ID details
4 (a)	The quasar is a <u>bright</u> radio source.✓	Allow strong/intense/powerful for bright. Ignore reference to pulses Other incorrect properties, eg red shift, loses the mark.	1	
4 (b) (i)	Using $I = I_0/d^2$ with some evidence of substitution ✓ $P_q = 4 \times 10^{11} P_s$ $I_s = 1.4 \times 10^{17} I_q$ at Earth $P_s/1^2 = 1.4 \times 10^{17} (4 \times 10^{11} P_s/d^2)$✓ $d^2 = 4 \times 10^{11} \times 1.4 \times 10^{17}$ $=5.6 \times 10^{28}$ $d = 2.4 \times 10^{14}$ AU✓	The first mark is for some evidence of using the inverse square law. Do not condone equation the wrong way up. The second is for an attempt to compare the two stars using the inverse square law. The third is for the final answer.	3	
4 (b) (ii)	Dark energy	Evidence of hedging bets eg dark energy/dark matter etc. loses the mark	1	
Total			5	