A-LEVEL
PHYSICS A

PHYA5/2A: Astrophysics
Mark scheme

2450
June 2014

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.

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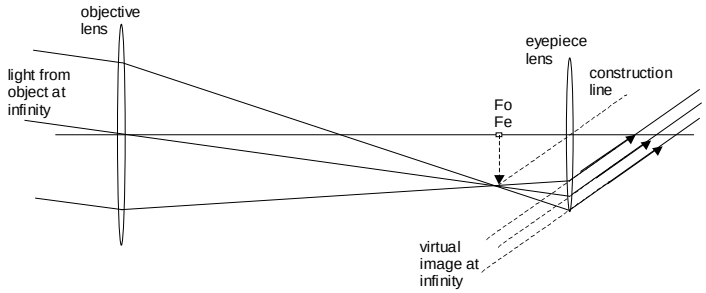
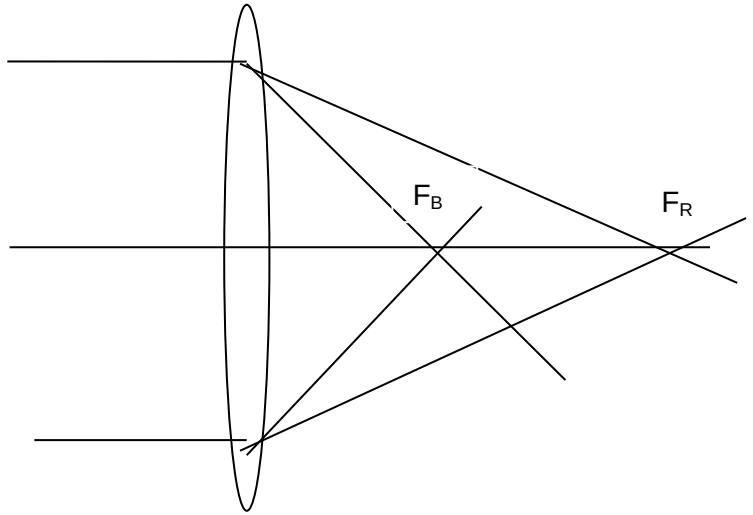
Question	Answers	Additional Comments/Guidance	Mark	ID details
1(a)	Both focal points labelled, on the principal axis, and coincide , with fo>fe ✓ Three <u>off-axis</u> rays through objective lens correct ✓ Three rays through eyepiece correct, parallel to a construction line. ✓	Accept point or length labelled. Allow single point F. Ignore labels outside the space between the two lenses. Rays must be off-axis to get the second mark. Construction line does not need to be drawn. If only 2 rays drawn, or there is no principal axis, max 2.  	3	
1(b)(i)	Using $f_o + f_e = 21$	Evidence of both equations needed for the mark.		

	$f_o/f_e = 210$✓ Gives 211 f_e = 21 fe = 21/211 = 0.10 m and f_o = 21 m (20.9) ✓	Alternative: fo = 4410/211 = 0.10 m If 210 used rather than 211 in substitution, max 1. If the correct answer is obtained by inspection, max 1.	2	

1(b)(ii)	Large diameter allows fainter objects to be viewed, (as the collecting power is proportional to d^2) ✓ Larger diameter allows better resolution(as smallest resolvable angle is proportional to 1/d)✓	Allow: more light, better collecting power, brighter image, able to see more distant objects (not just further) Allow references to more detail or clearer images for this mark. Ignore references to magnification or field of vision.	2	

1(c)	Diagram showing two focal points with blue focal point closer to lens than red focal p$^{oint.}$	Colours must be labelled. Allow wavelengths or frequencies if correct way round Rays need to be focused Allow 1 ray for each colour if principal axis drawn and foci labelled. If other colours included, they must be correct. Allow violet for blue Incident rays do not need to be parallel to the principal axis.	1	

2 (a)			6	

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 also refer to the information on page 4 and 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 criteria.

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
	Lower level (Poor to limited): 1 or 2 marks The information conveyed by	Intermediate level (Modest to adequate): 3 or 4 marks The information conveyed by the answer may be	High level (good to excellent): 5 or 6 marks The information conveyed by the answer is clearly organised, logical and coherent using appropriate

	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. The candidate may not explain what the Big Bang theory is. They may only refer to one piece of evidence that supports the theory.	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. The candidate may only refer to two pieces of supporting evidence poorly or one in detail and the description of the big bang theory may be less complete.	specialist vocabulary correctly. The form and style of writing is appropriate to answer the question. The candidate describes the big bang theory as the Universe expanding from an extremely dense and hot point over the past 13.6 billion years. The candidate also describes the evidence from, the relative abundances of H and He and the measurement of the microwave background radiation and states they support the big bang theory. Hubble's Law may also be used to support the idea that the Universe is expanding.

examples of the points made in the response	**extra information**
The explanations expected in a good answer should include most of the following physics ideas 1 The universe has expanded from a single hot dense point 1 This expansion started approximately 13 billion years ago. 1 Evidence comes from the Hubble relationship and observations of the red shift of distant galaxies. 2 This shows that the galaxies are moving outwards from a single common point. 2 (Conclusive) evidence comes from the cosmological microwave background radiation (which disproved the steady state	The number next to each statement suggests the minimum level of answer the statement may be seen in.

theory) 3 This follows a black body radiation curve which corresponds to a temperature of 2.7 K 3 This can be interpreted as the left over "heat" of the big bang, Hydrogen and helium is present in the Universe in the ratio 3:1 3 This supports the idea that a very brief period of fusion occurred when the Universe was very young, which is consistent with the Big Bang theory.	

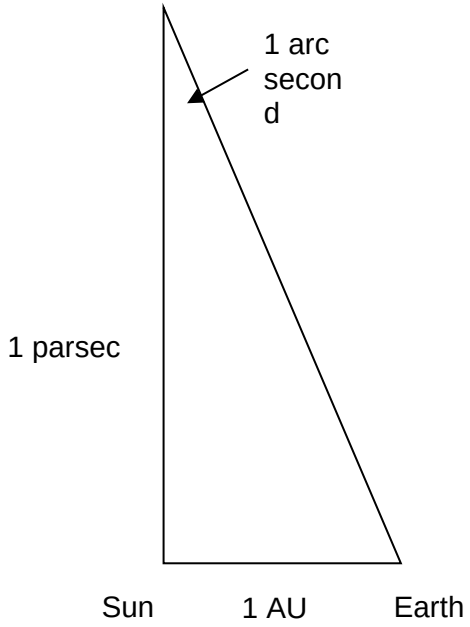
2 (b)(i)	A standard candle is an object whose absolute magnitude <u>is known</u>. ✓	Do not allow "brightness" for absolute magnitude but allow "intrinsic brightness". Do not allow "constant" for "known"	1	

2 (b) (ii)	All type 1a supernovae have same <u>peak</u> absolute magnitude Apparent magnitude can be measured (at this peak). ref to m-M = 5 log (d/10) or inverse square law	The measurement of the apparent magnitude may only be implied and still get credit Alternative using the inverse square law: All type 1a supernova have some peak intensity, I_o Intensity at Earth can be measured, I Distance, d, can be calculatd using $I = I_o/d^2$ If there is no reference to the peak,	3	

		max 2.		

3 (a)	Apparent magnitude at a distance of 10pc	Allow “brightness” Do not allow luminosity or magnitude.	1	
3 (b)	Absolute magnitude from 15 to -10 Temperature from 50 000K to 2500K	Allow 15 to -15 Allow 50 000 to 3500 K	2	
3 (c) (i)	S at 5700 K and abs mag 5	The position of S should be consistent with the scales on the axes. Allow ce on scale Allow 6000 for T If labels not present, or if only correct extreme values on scale, S should be to the right of and below the centre.	1	
3 (c)(ii)	W at same abs mag as S, but further to left	Judgements on 3cii – 3civ should be based on the position of S. If S is not labelled, it should be based on where S should be.	1	
3 (c)(iii)	X at same temperature as S but greater absolute magnitude		1	
3 (c)(iv)	Y at same abs mag or above S, on the right hand side of the diagram,		1	
3 (d)	similar power output✓, but is hotter✓ Ref to $P = \sigma AT^4$ hence W must have smaller diameter than the Sun ✓	Allow luminosity for Power Answer must be supported to get the	3	

		mark.		

4(a)	Diagram showing Earth, Sun and star, with 1AU clearly marked, and 1 arc second angle at the star, with distance between Sun and star as one parsec.  1 pc is the distance at which 1AU subtends an angle of 1 arc second.	A diagram with fewer labels can be supported by a correct statement If either the angle or base are incorrect, 1 max. Right angle does not need to be at the Sun. Triangle does not need to be a right angle Parsec could be the hypotenuse. Ignore writing if the diagram is correct. Base can be either Sun Earth, or 1AU. No diagram, 1 max.	2	

4 (b)	d = 1/p			

	= 1/0.002 parsec = 500 pc✓ = 500 x 3.1 x 10^{16} m = 2 x 10^{19} m✓ 1sf✓	Allow ce for d in pc. If tan(0.002/3600) = 1AU/d used, allow ce for wrong value of 1AU. Allow use of tan or sin.	3	

4 (c)(i)	Two components are 178 pc apart or Distance apart too great (for gravity to have any significant effect between them)	Penalise attempts to hedge bets by references to apparent magnitude or class.	1	

4 (c)(ii)	More distant star will not appear to move as much as nearest star (against the fixed background)	Allow discussions involving parallax. Give credit to correct diagram.	1	