4	**B is the only correct answer** A is not the correct answer, as acceleration is always towards the equilibrium point C is not the correct answer, as acceleration is always towards the equilibrium point D is not the correct answer, as this would increase the energy of oscillation	**(1)**

4	**B is the correct answer (P is the least stable and Q is the most stable)** A is not correct because Q is more stable than R C is not correct because Q is the most stable and P the least stable D is not correct because P is less stable than Q	**1**

3	**The only correct answer is D (B.E. / nucleon increases in fission and fusion)** A is not correct because B.E. / nucleon increases for both fusion and fission B is not correct because B.E. / nucleon increases for fusion C is not correct because B.E. / nucleon increases for fission	**1**

5	**B is the correct answer,** as $v = H_0 d$	**(1)**

2	**D is the correct answer (these materials deform plastically)** A is not correct because this will not absorb energy from the oscillation B is not correct because this will not absorb energy from the oscillation C is not correct because this will absorb and then return energy to the oscillation	**1**

7	**The only correct answer is C ($0.13\ I_0$)** A is not correct because the absorption calculation assumes a linear absorption B is not correct because this would be the intensity with 5 cm of absorber D is not correct because this would be the intensity with 10 cm of absorber	**1**

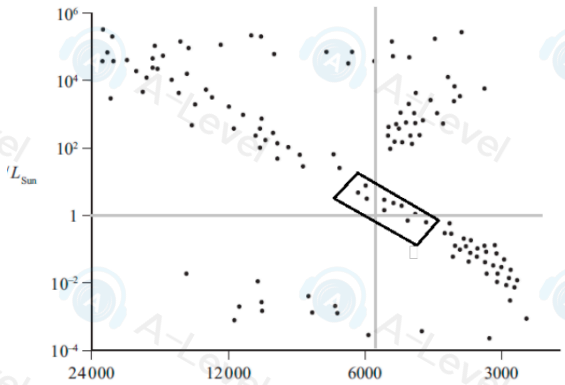
8	**The only correct answer is A (Star X has a higher surface temperature and is closer than star Y.)** B is not correct because star X has a higher surface temperature than star Y C is not correct because star X has a higher intensity than star Y D is not correct because star X has a higher surface temperature **and** a higher intensity than star Y	**1**

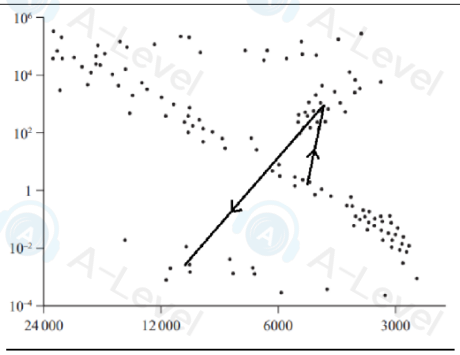
6	**The only correct answer is B ($\left(\frac{54-22}{4}\right)+22$)** A is not correct because inverse square law has not been applied correctly C is not correct because neither inverse square law nor correction for background has not been applied correctly D is not correct because correction for background has not been applied correctly	**1**

8	**B is the only correct answer** A is not the correct answer, as penetration is high C is not the correct answer, as ionising power is low and penetration is high D is not the correct answer, as ionising power is low	**(1)**

2	**D is the only correct answer (trigonometric parallax)** A is not the correct answer, as Doppler shift lets relative motion be determined B is not the correct answer, as an HR-diagram shows luminosity v temperature C is not the correct answer, as Hubble's law applies to galaxies	**1**

Question Number	Answer		Mark
20(a)	Reverse scale	(1)	
	Approximately logarithmic values [With realistic values of temperature. Max temperature range 50000 – 2000 K, with temperature of Sun about 6000 K]	(1)	2
20(b)	(This star cluster is not a young star cluster because)		
	This cluster has red giant stars on the top right of the diagram	(1)	
	And white dwarf stars bottom left of diagram	(1)	
	A young cluster would only have a main sequence **Or** Red giant stars only occur in the later stages of a star's evolution **Or** White dwarf stars only occur in the later stages of a star's evolution	(1)	3
	If no marks can be awarded, award max 1 for: The cluster has red giant stars **and** white dwarf stars		
	[Accept positions of red giant stars and white dwarf stars shown on the diagram]		
20(c)	The luminosity of the standard candle is known	(1)	
	Measure/determine intensity of radiation from V1 [standard candle] [do not accept 'calculate']	(1)	
	Use inverse square law to calculate distance (to cluster) **Or** use $I = \frac{L}{4\pi d^2}$ to determine distance, where I is intensity **and** L is luminosity	(1)	4
	Distance is too large (for V1 to be in a nearby cluster) [Must have the idea of being too far away, rather than just being far away]	(1)	
	Total for question 20		9

Question Number	Acceptable Answer		Additional Guidance	Mark
18(a)(i)	Sun marked where luminosity ≈ 1 and within marked main sequence region	(1)	 Allow any part of S within the approximate area shown	1

18(a)(ii)	Line from S to red giant region **(1)** Line from red giant region to white dwarf region **(1)**		 If S is not marked, then arrows needed to show direction Allow arrow from their position of Sun to red giant region	**2**

***18(b)**	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning. **Indicative content** IC1 Hydrogen is being fused in core of the Sun IC2 When hydrogen (in core) is used up and (rate of) fusion decreases/ceases IC3 The core collapses / contracts (under gravitational forces) IC4 Temperature rises (high enough) and helium fusion starts IC5 The Sun expands into a red giant IC6 When no further fusion takes place, core/star collapses (into a white dwarf)		Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. IC4: Must be temperature rise to start helium fusion not temperature rises after helium fusion starts.	**6**

IC points	IC mark	Max linkage mark	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

Number of indicative points seen in answer	Number of marks awarded for indicative points
6	4
5-4	3
3-2	2
1	1
0	0

	Number of marks awarded for structure and lines of reasoning
Answer shows a coherent and logical structure with linkage and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkage between points and is unstructured	0

18(c)	Massive main sequence stars have (much) higher temperatures (than the Sun) **(1)** Hydrogen is fused at a greater rate than in the Sun (so the time spent on the main sequence is less) **(1)**		Allow the Sun has a (much) lower temperature (than massive main sequence stars), ignore references to density Must have the idea of 'rate of fusion'	**2**