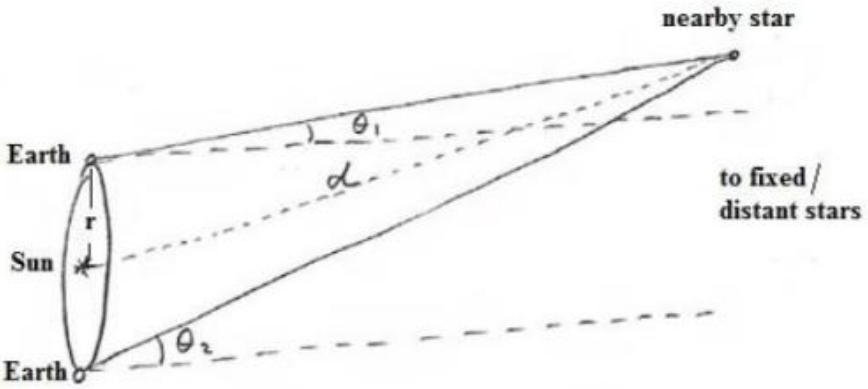
Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Mark Schemes

Q1.

Question Number	Answer	Mark
	QWC – Work must be clear and organised in a logical manner using technical wording where appropriate **Parallax:** The star is viewed from two positions at 6 month intervals **Or** the star is viewed from opposite ends of its orbit diameter about the Sun (1) The (change in) angular position of the star relative to fixed/distant stars is measured (1) The diameter/radius of the Earth's orbit about the Sun must be known and trigonometry is used (to calculate the distance to the star) [Do not accept Pythagoras] (1) [the marks above may be obtained with the aid of a suitably annotated diagram] e.g  [Accept the symmetrical diagram seen in many text books] **Standard candle:** Flux/brightness/intensity of standard candle is measured (1) (1) Luminosity of standard candle is known [accept reference to absolute magnitude **Or** total power output of star] (1) Inverse square law is used (to calculate distance to standard candle)	6
	Total for question	**6**

Q2.

Question Number	Answer		Mark
(a)	(B2 =) 2.9×10^{-3}/A2 **Or** (B2 =) $2.9 \times 10^{-3}/\lambda_{max}$ **Or** (B2=) $2.9 \times 10^{-3}/6.85 \times 10^{-7}$ [Ignore incorrect powers of 10]	**(1)**	**1**
(b)	Use of $L = \sigma T^4 A$ $A = 0.21(48) \times 10^{19}$ (m^2) For max 1 Use of $A = 4\pi R^2$ to give $A = 2.1(1) \times 10^{18}$ (m^2) Example of calculation: $A = \frac{0.392 \times 10^{26}\ \text{W m}^{-2}}{5.67 \times 10^{-8}\ \text{W m}^{-4}\ \text{K}^{-4} \times (4230\ \text{K})^4} = 2.148 \times 10^{18}\ \text{m}^2$	**(1)** **(1)**	**2**
(c)	Flux/brightness/intensity measured and distance to star determined (Luminosity calculated using) $L = 4\pi d^2 F$ **Alternative mark scheme:** Temperature and type of star identified [e.g. main sequence]	**(1)** **(1)** **(1)**	
	Hertzsprung-Russell diagram used to find luminosity	**(1)**	**2**
	Total for question		**5**

Q3.

Question Number	Answer		Mark
(a)(i)	Redshift is the (fractional) increase in wavelength received (by an observer)	(1)	
	Due to source and observer receding (from each other)	(1)	2
6(a)(ii)	**QWC – Work must be clear and organised in a logical manner using technical wording where appropriate**		
	Measure frequency/wavelength of light (from the galaxy)	(1)	
	Compare (measured) frequency/wavelength to the frequency/wavelength for a source on the Earth	(1)	
	States appropriate Doppler formula (consistent with mp1/mp2) and how it is used to calculate velocity	(1)	3
(b)	(Standard candles are stellar) objects of known luminosity	(1)	1
(c)	See $v = H_0 d$ and $v = d/t$	(1)	
	Therefore $t = 1/H_0$ (dependent mark)	(1)	2
(d)(i)	If density less than critical value, expansion would continue for ever	(1)	
	If density greater than critical, expansion would stop and universe would contract again	(1)	
	If density equals critical value, expansion rate would decrease to zero but universe would not contract again	(1)	3
(d)(ii)	The mass of the universe is uncertain because of the amount of dark matter is uncertain	(1)	
	The value of the Hubble constant is uncertain	(1)	
	Or		
	The amount of dark matter (in the universe) is uncertain	(1)	
	Since dark matter doesn't interact via the electromagnetic interaction	(1)	
	Or		
	The value of the Hubble constant is uncertain		
	Since measurements of distances to distant galaxies are uncertain	(1)	
		(1)	2
	Total for question		13