13 The Summer Triangle consists of three stars, Altair, Deneb and Vega.
Some of the properties of the three stars are summarised in the table below.

5,12 182·2

	Altair	Deneb	Vega
surface temperature / K	7700	8500	9600
apparent magnitude	0.77	1.25	0.03
absolute magnitude	2.21	–8.38	0.60

m
M

-1·44 -9·36 -0·57

(a) The three stars belong to the same spectral class.

State and explain which spectral class they belong to.

Temp range for A 7500-11,000K and all three stars are within this range

(2)

(b) Deduce which of the three stars appears brightest.

lowest apparent magnitude is brightest - so Vega

(2)

(c) Calculate the distance from Earth to the closest of the three stars.

$m - M = 5 \log\left(\frac{d}{10}\right)$

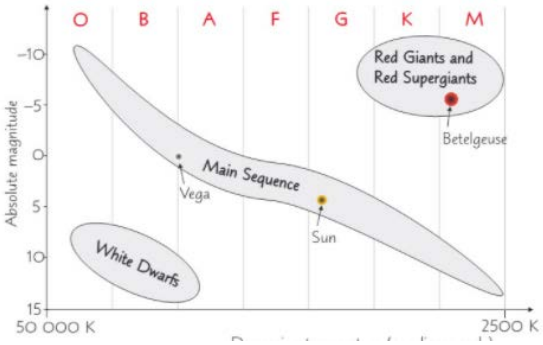
$10 \times 10^{\left(\frac{m-M}{5}\right)} = d$

		A	D	V
	m	0.77	1.25	0.03
	M	2.21	-8.38	0.60
b=	(m-M)/5	-0.29	1.93	-0.11
dist(pc)	10*10^b	5.15	843.33	7.69

distance = Altair at 5.2 pc pc

(3)

(d) Deduce which of the three stars is the largest.



T M

A : 7700, 2.11 → M.S.

D : 8500, -8 → Red Giant

V : 9600, 0.6 → M.S.

Deneb is biggest

Plot each approx on the H-Z diagram

or: all approx same temp. Greatest M has greatest power output.
Then Stefan's law to say that Power is proportional to surface Area.

$P = \sigma A T^4$

(3)

(e) Calculate the wavelength of the peak in the black body radiation curve of Altair.

$\lambda_{max} T = \text{constant} = 2.9 \times 10^{-3}$

wavelength = 3.8×10^{-7} m

(2)

(Total 12 marks)

14 (a) State which property of the first identified quasar led to its discovery.

Brightness - very bright radio source

(1)

(b) 3C48 is a quasar in the constellation Triangulum. It is believed to have a power output 4×10^{11} times greater than that of the Sun. At the Earth, the Sun's intensity is 1.4×10^{17} times greater than that of the quasar.

(i) Calculate, using the inverse square law, the distance from Earth to this quasar in AU.

$P_q = 4x10^{11}P_s$ *and* $I_s = 1.4x10^{17}I_q$ *and* $d_s = 1AU$

$I_s = \frac{P_s}{4\Pi d_s^2}$ *and smilarly for* I_q *NOw divide* I_s/I_q

$\frac{I_s}{I_q} = \frac{P_s d_q^2}{P_q d_s^2} \Rightarrow \frac{1.4x10^{17}I_q}{Iq} \Rightarrow 1.4x10^{17} = \frac{P_s d_q^2}{1^2 x4x10^{11}P_s}$

$\Rightarrow 1.4x10^{17}x4x10^{11} = d_q^2$

$\Rightarrow d_q = 2.4x10^{14}AU$

ance = _____ AU

(3)

(ii) Measurements of the red shift of the quasar suggest the expansion of the Universe has accelerated since the detected light left the quasar.
State the cause of this acceleration.

_____ dark energy _____

(1)

(Total 5 marks)

15 (a) The graph shows the axes of a Hertzsprung–Russell (H–R) diagram.

(i) Label the spectral class axis with a suitable scale.

(1)

(ii) Complete the H–R diagram by marking the positions of the main sequence, dwarf star and giant star regions.

(2)

(b) The table summarises some of the properties of three stars in the constellation Aries.

Star	Apparent magnitude	Temperature / K	Radius / m
Hamal	2.0	4500	1.0×10^{10}
Sharatan	2.7	9000	1.8×10^{9}
41 Arietis	3.6	12000	9.6×10^{10}

(i) With reference to the data in the table, compare the three stars.
Your answer should include a discussion of:

- the appearance to the naked eye of the three stars as seen from Earth
- the spectrum of the three stars
- the region of the Hertzsprung–Russell diagram to which each star belongs.

The quality of your written communication will be assessed in your answer.

Naked eye: A is dimmest, H is brightest
Spectral class and colour: Arietis is B from H and He, Blue. Sharatan is A from H and metal ions, and is blue white, Hamal is K from neutral metals and is orange. (Colours are hard to see in the city with naked eye)

All three are main sequence
H is right, just below the middle - too small to be giant and too dim
S is left-middle, middle
A is left, above middle - it is too large to be a dwarf

(6)

(ii) Hamal is 66 light years from the Earth.
Calculate the absolute magnitude of Hamal.

1pc = 3.26ly s0 Hamal is 66/3.26 = 20pc (2sf)

$$m - M = 5\log\left(\frac{d}{10}\right) \Rightarrow 2.0 - M = 5\log\left(\frac{20}{10}\right) = 1.5 \; so \; -M = 1.5 \; - 2.0$$

$$\rightarrow M = 0.5$$

(3)

(iii) Identify which star is the greatest distance from Earth.
Explain your answer.

Arieti. has largest R & T therefore has highest power via Stefan's law

$P = \sigma A T^4$

which would maKe it the brightest if all at same d (or highest M)
However it has highest value m, so is dimmest & so furthest away

(3)

(Total 15 marks)