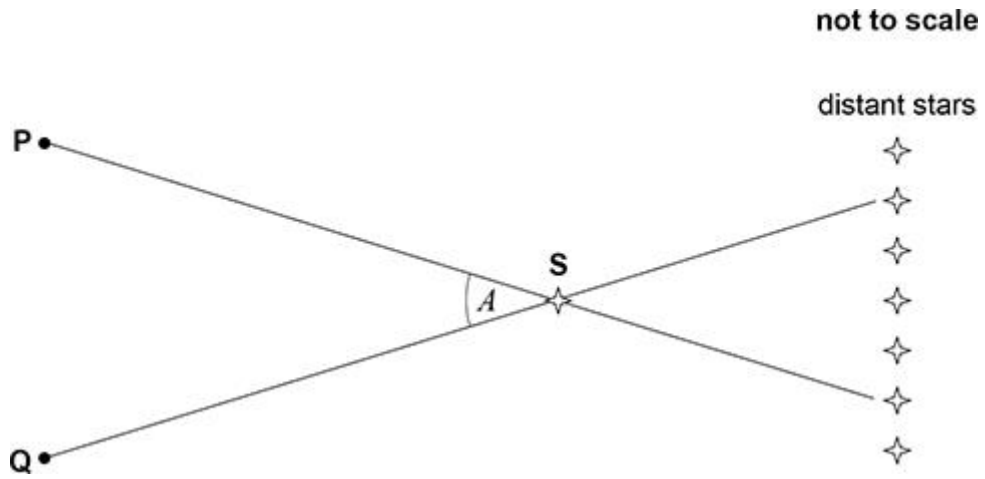
Q1.

The apparent change in position of a nearby star relative to distant stars is due to an effect known as parallax.

The figure below shows how parallax arises. As the Earth moves from point **P** to point **Q**, an observer on the Earth sees the position of a nearby star **S** change in relation to distant stars.



Angle A is the parallax angle. This angle can be used to determine the distance to a nearby star, provided that the relative motion between the star and the Sun is negligible between observations.

(a) The distance from the Sun to **S** is 79 ly.
The Earth takes 6 months to move from point **P** to point **Q**.

Calculate, in degrees, angle A.

A = _____ °

(2)

(b) Parallax is used to determine the distance to a different star. Observations of the star produce the following data:

distance determined using parallax = 0.40 pc
apparent magnitude = 13.5
absolute magnitude = 16.7

An astronomer suggests that the star moved significantly relative to the Sun between the two parallax observations.

Discuss whether this suggestion is valid.

_____

_____

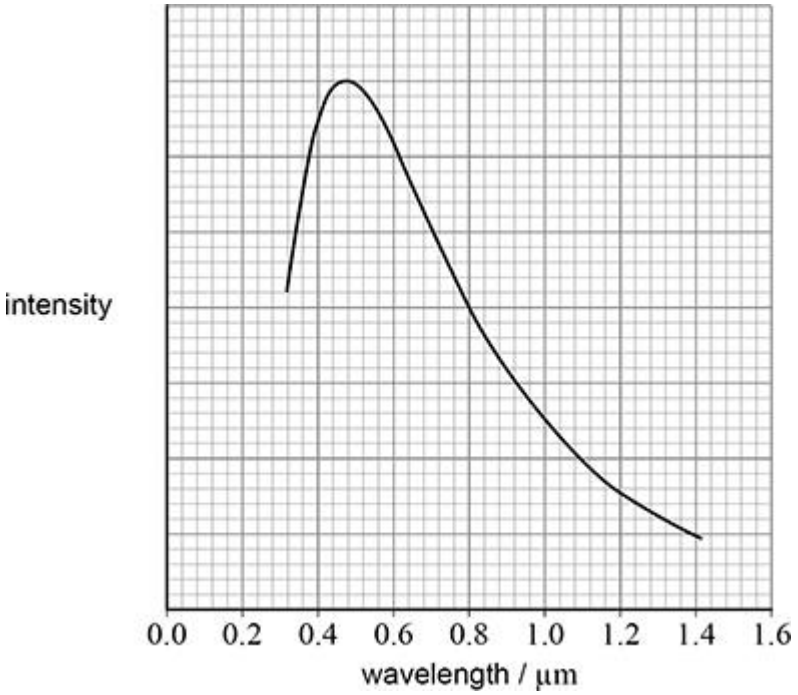
_____

(4)

(Total 6 marks)

Q2.

(a) The figure below shows the variation of intensity with wavelength for a star.



Show that above figure is consistent with a black-body temperature of about 6.0×10^3 K.

(2)

(b) The radius of the star is 9.6×10^6 m.

Calculate the power output of the star.

power output = _____ W

(2)

(c) Which row gives the type and spectral class of the star?

Tick (✓) **one** box.

Type of star	Spectral class	
white dwarf	F	
main sequence	G	
red giant	K	
main sequence	F	
red giant	G	
white dwarf	K	

(1)

(d) The light from the star passes through an interstellar dust cloud before reaching Earth. The reduction in intensity when light passes through a dust cloud is assumed to be inversely proportional to the wavelength of the light.

An astronomer on the Earth estimates the black-body temperature of the star.

Discuss the effect that the dust cloud has on this estimate.

(2)

(Total 7 marks)

Q3.

(a) Draw a labelled diagram to define the parsec (pc).

(1)

The table below shows data for two stars: Rigel and the Sun.

Star	**Surface temperature / K**	**Absolute magnitude**	**Mass / kg**
Rigel	12 000	−7.84	3.6×10^{31}
Sun	5700	4.83	2.0×10^{30}

(b) State the spectral class of Rigel.

_____

(1)

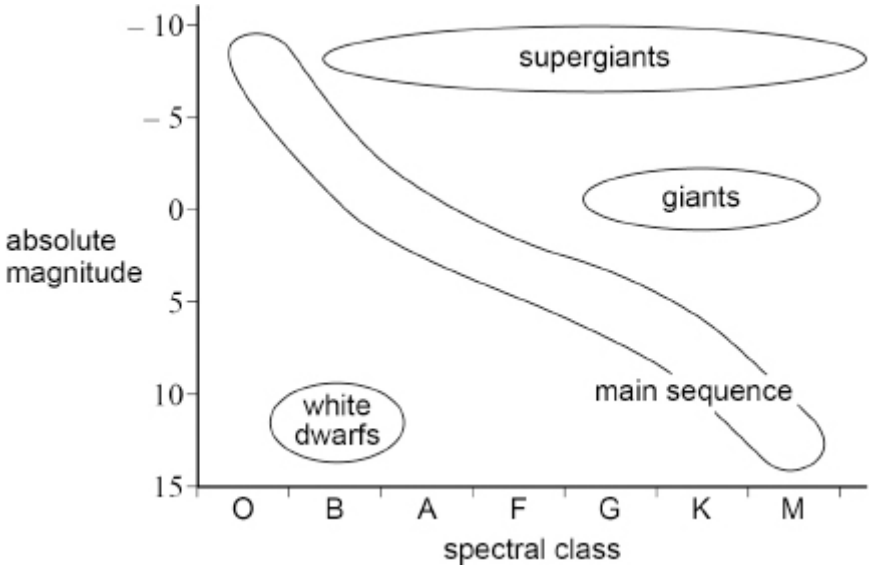
(c) The apparent magnitude of Rigel is 0.11

Calculate, in pc, the distance from Rigel to the Earth.

distance = _____ pc

(2)

(d) The figure below shows a Hertzsprung–Russell (HR) diagram.



Draw a line on the figure above to show the evolution of the Sun from formation to white dwarf.

(1)

(Total 5 marks)

Q4.

V1031 and WASP-82 are two stars in the constellation Orion.
V1031 appears 40 times brighter than WASP-82 when viewed from Earth.
The apparent magnitude of V1031 is 6.0

(a) Calculate the apparent magnitude of WASP-82.

apparent magnitude = _____

(2)

(b) V1031 is just visible to the naked eye of an astronomer when her pupil diameter is 7 mm.

Suggest whether she can observe WASP-82 using a telescope with an objective diameter of 60 mm.
Support your answer with a calculation.

_____

_____

_____

_____

(2)

(c) CCDs are often connected to telescopes.

Explain **two** reasons why this improves the ability of astronomers to observe dim stars.

1 _____

_____

_____

_____

2 _____

_____

_____

_____

(3)

(Total 7 marks)

Q5.

M40 A and M40 B are two stars that appear very close to each other when viewed from Earth.
There are two possible reasons for this:

- they are an orbiting binary system
- they are distant from each other and only appear in the same line of sight.

In an orbiting binary system, the difference between the apparent magnitude and the absolute magnitude for each star is similar.

The table below shows data about these two stars.

	Temperature / K	**Radius of star / m**	**Apparent magnitude**
M40 A	6000	6.3×10^{9}	9.7
M40 B	4700	1.1×10^{10}	10.1

Discuss the appearance of the two stars to an astronomer on the Earth. In your answer you should:

- compare the colour of the stars
- compare the brightness of the stars
- deduce, with a calculation, whether the stars form an orbiting binary system.

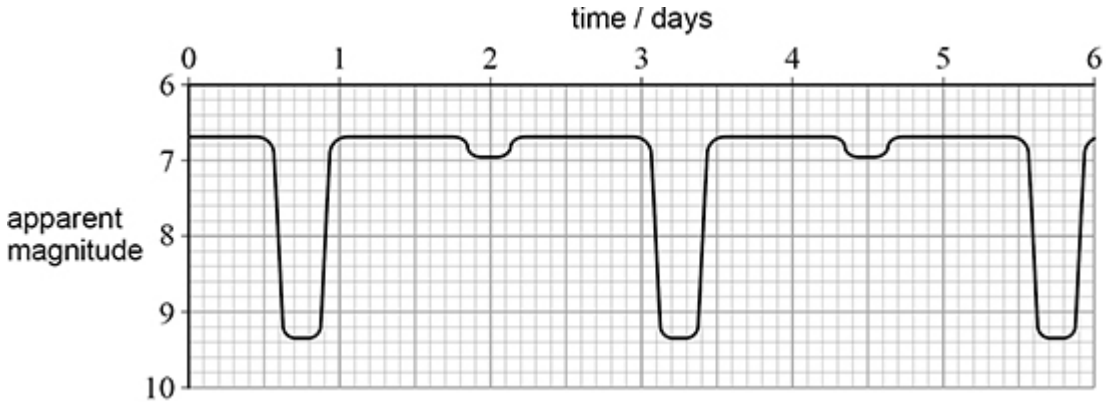
(6)

(Total 6 marks)

Q6.

U Cephei is an eclipsing binary system consisting of two stars that orbit their common centre of mass.
The primary star is class B; the secondary star is class G.

The figure below shows the variation of apparent magnitude of U Cephei with time as observed from Earth.



(a) Explain the shape of the graph in the figure above.

_____

_____

_____

_____

_____

_____

(2)

A particular spectral line has a wavelength of $486.136\ \text{nm}$ when measured from a source in the laboratory.
This line is also present in the absorption spectrum of the primary star of U Cephei. When observed from Earth, the wavelength of the primary star's absorption line varies as shown in the table below.

	Wavelength / nm
maximum value	486.498
minimum value	485.672

(b) State why the average of the values in above table is different from the laboratory value.

_____

_____

(1)

(c) Show that the orbital speed of the primary star is about $250\ \text{km s}^{-1}$.

(3)

(d) Calculate the orbital radius of the primary star.

orbital radius = _____ m

(2)

(e) Which absorption lines would be most prominent in the spectrum of the primary star?
Tick (✓) **one** box.

- hydrogen ☐
- hydrogen and helium ☐
- ionised metals ☐
- neutral metals ☐

(1)

(Total 9 marks)

Q7.

3C 273 was the first quasar to be discovered.
IC 1101 is one of the largest galaxies known.
The table below shows some information about these objects.

	Absolute magnitude	Apparent magnitude	Distance / Mpc
quasar 3C 273	**X**	12.8	760
galaxy IC 1101	−22.8	14.7	320

(a) State the property of the quasar that led to its discovery.

_____

(1)

(b) Show that the absolute magnitude **X** of quasar 3C 273 is about −27

(2)

(c) Assume that the quasar and the galaxy are both viewed from the same distance.
Explain which would be the brighter object.

Go on to calculate the ratio $\frac{\text{brightness of brighter object}}{\text{brightness of dimmer object}}$.

_____

_____

_____

ratio = _____

(3)

(Total 6 marks)