Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

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 $\frac{\text{brightness of brighter object}}{\text{brightness of dimmer object}}$.

_____

_____

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ratio = _____

(3)

(d) The black hole at the centre of IC 1101 has a mass of $7.1 \times 10^{11}\ M_S$ where M_S is the mass of the Sun.

Calculate the average density within the event horizon of the black hole.

average density = _____ kg m^{-3}

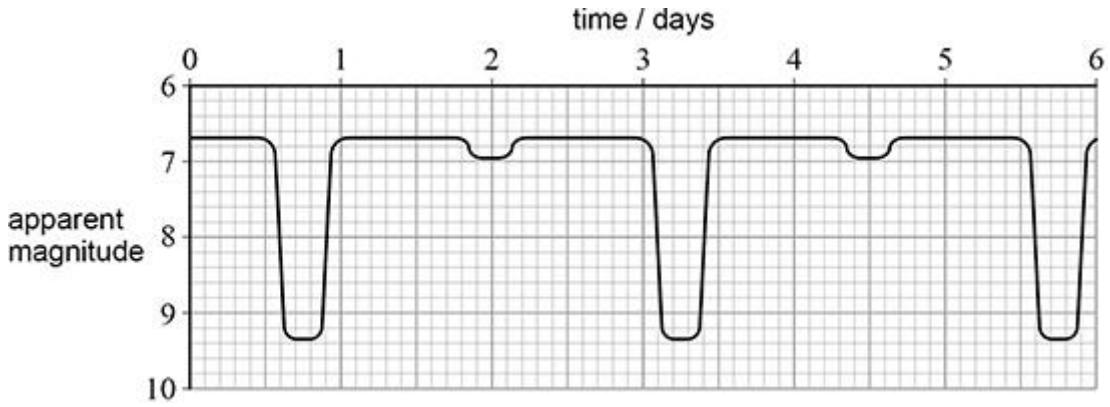
(3)

(Total 9 marks)

Q2.

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.

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_____

(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

(d) 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)

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(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)

(f) A different eclipsing binary star system is thought to consist of a white dwarf star and a neutron star.

Discuss how astronomers could confirm this.

_____

_____

_____

_____

_____

_____

_____

(2)

(Total 11 marks)

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