

Name of the Student: \_\_\_\_\_

Max. Marks : 24 Marks

Time : 24 Minutes

**Q1.**

- (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	$3.6 \times 10^{31}$
Sun	5700	4.83	$2.0 \times 10^{30}$

- (b) State the spectral class of Rigel.

\_\_\_\_\_

(1)

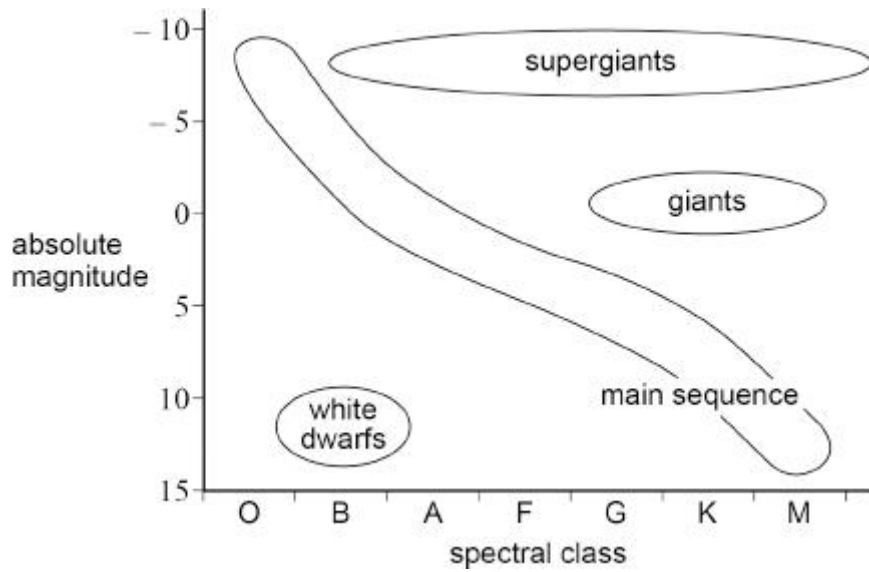
- (c) The apparent magnitude of Rigel is 0.11

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)

(e) One stage in the evolution of Rigel includes the emission of a gamma ray burst.

Outline the circumstances during which a gamma ray burst will be emitted by Rigel.

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(2)

(Total 7 marks)

## Q2.

(a) State what is meant by normal adjustment when applied to an astronomical refracting telescope.

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(1)

(b) Which combination of lenses gives the largest angular magnification when used as an astronomical telescope in normal adjustment?

Tick ✓ one box.

Objective lens		Eyepiece lens		
Focal length / cm	Type	Focal length / cm	Type	
5	diverging	100	converging	<input type="checkbox"/>
5	converging	100	converging	<input type="checkbox"/>
100	diverging	5	converging	<input type="checkbox"/>
100	converging	5	converging	<input type="checkbox"/>

(1)

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

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

apparent magnitude = \_\_\_\_\_

(2)

(d) 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.

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(2)

- (e) CCDs are often connected to telescopes.

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

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2 \_\_\_\_\_

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(3)

(Total 9 marks)

**Q3.**

- (a) State the defining property of a black hole.

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\_\_\_\_\_

(1)

- (b) In 2019, astronomers linked several radio telescopes to produce a single telescope called the EHT. The resolution of the EHT is the same as the resolution that a telescope with an aperture equal to the diameter of the Earth could achieve.

The table below shows data about the EHT and the Hubble telescope.

	Aperture	Operating wavelength
EHT	$1.3 \times 10^7$ m	1.3 mm
Hubble	2.4 m	410 nm

Galaxy M87 is  $5.3 \times 10^7$  light years from Earth. The supermassive black hole at the centre of M87 has a mass  $6.5 \times 10^9$  times the mass of the Sun.

The radius of the event horizon is  $R$ .

The astronomers propose to use either the EHT or the Hubble telescope to observe stars whose distance from the centre of the black hole is less than  $1000R$ .

Discuss, with calculations, which telescope is more suitable for this observation.

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(4)

- (c) A star is orbiting the black hole in M87. The star is observed in the plane of its orbit. The wavelength of a spectral line observed in the light emitted from the star varies between a maximum and a minimum value.

maximum value observed = 374.96 nm

minimum value observed = 373.53 nm

Calculate the orbital speed of the star.

orbital speed = \_\_\_\_\_ m s<sup>-1</sup>

(3)

(Total 8 marks)