Space

Question Paper 2

Level	International A Level
Subject	Physics
Exam Board	Edexcel
Topic	Physics from Creation to Collaps
Sub Topic	Space
Booklet	Question Paper 2

Time Allowed: **72 minutes**

Score: **/60**

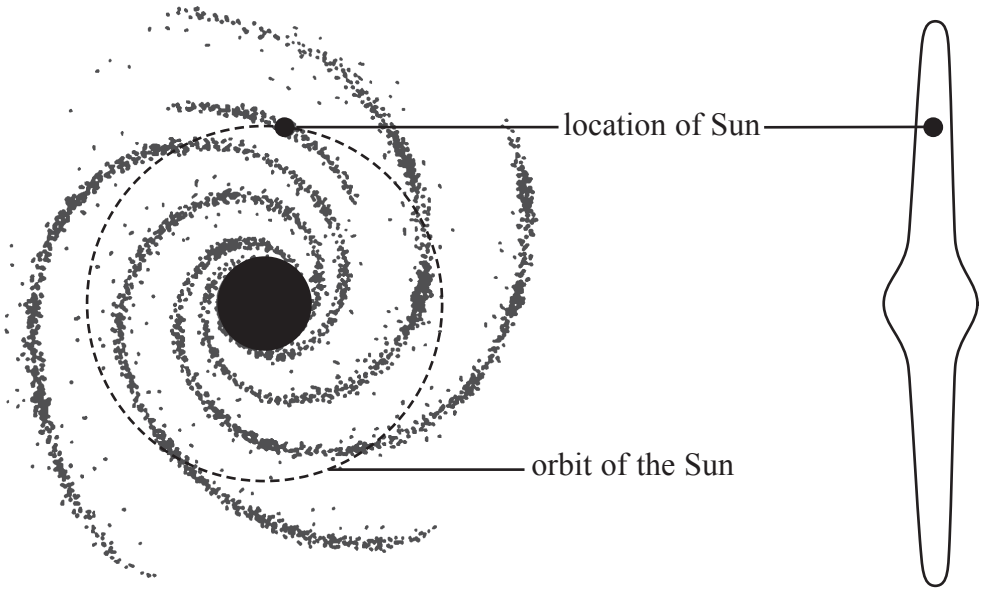
Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 The Sun is a typical star in our galaxy, the Milky Way. It is 2.5×10^{20} m from the centre of the galaxy. The Sun orbits the centre of the galaxy at a speed of 220 km s^{-1}.

The diagrams below represent the Milky Way. The central black area represents a very high density of stars, known as the nucleus of the galaxy. The total mass of stars within the orbit of the Sun may be treated as a point mass at the centre of the galaxy.



Face-on view Side-on view

(a) Calculate the mass of the Milky Way within the orbit of the Sun.

(3)

Mass = ...

(b) (i) The vast majority of stars in the Milky Way are observed to be within the nucleus of the galaxy.

Explain why it might be expected that stars similar to the Sun, but further away from the centre of the galaxy, would orbit at a lower speed than the Sun.

(2)

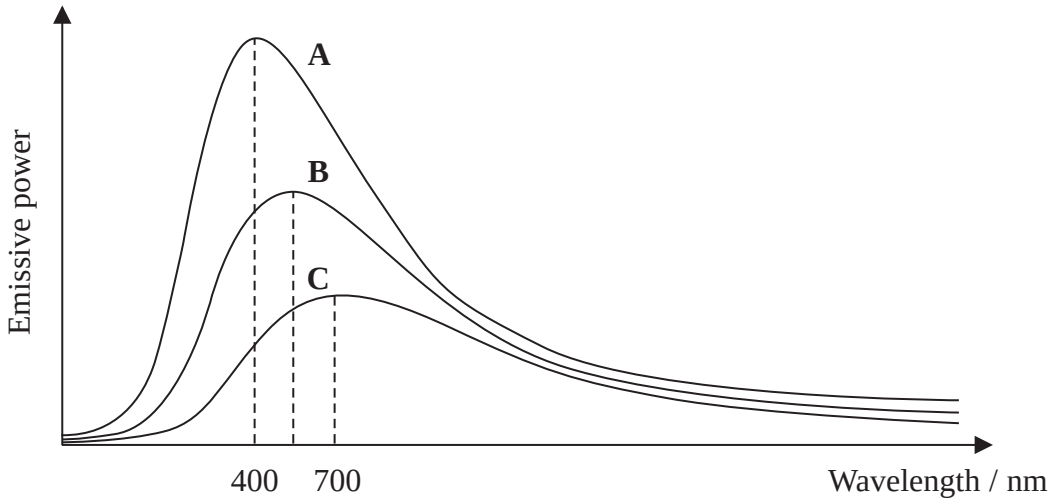
(ii) Stars similar to the Sun, but further away from the centre of the galaxy, are actually observed to have orbital speeds that are all approximately the same as the Sun's.

Explain what astronomers can conclude from these observations.

(2)

(Total for Question 1 = 7 marks)

2 Curves A, B and C show the radiation spectra of stars with three different surface temperatures.



(a) (i) Curve B represents radiation from the Sun. State what evidence from the graphs suggests that this might be so.

(1)

.....

.....

(ii) State with a reason which curve represents a star with a greater surface temperature than the Sun.

(1)

.....

.....

(iii) Use the graphs to explain how the radiation from the star identified in (ii) differs from the radiation from the Sun.

(2)

.....

.....

.....

.....

(b) Stars other than the Sun are too far away from the Earth for us to make a direct measurement of their diameter.
Explain how we can deduce that some are giant stars and some are dwarf stars.

(3)

(c) For stars which are relatively close to the Earth, describe how parallax measurements can be used to determine their distances from the Earth.

(4)

(Total for Question 2 = 11 marks)

3 So far, manned space flight has only taken us to the Moon. There are plans to send a manned mission to Mars, our nearest planetary neighbour, later this century.

(a) Calculate the weight of an astronaut of mass 72.0 kg on the surface of Mars.

mass of Mars = 6.42×10^{23} kg

diameter of Mars = 6.79×10^{6} m.

(2)

Weight of astronaut = ...

(b) (i) It takes Mars 5.94×10^7 s to orbit the Sun.

Show that the radius of the orbit is about 2×10^{11} m. Assume the orbit is circular.

mass of Sun = 1.99×10^{30} kg

(3)

(ii) Mars does **not** have a circular orbit. As Mars completes one orbit of the Sun, the distance from Mars to the Sun varies by ±10% of the average distance to the Sun.

Calculate the ratio of the maximum radiation flux from the Sun at the surface of Mars F_{max} to the minimum radiation flux F_{min} over one orbit.

(3)

F_{max} / F_{min} = ...

(Total for Question 3 = 8 marks)

4 (a) Stars are formed from gas clouds within galaxies. As the gas cloud contracts, an extremely dense core at a very high temperature is formed. Within the core the hydrogen begins to fuse into helium.

(i) Explain why the core must be extremely dense and at a very high temperature for fusion to take place.

(2)

(ii) As the gas cloud contracts the internal energy of the system increases.

Explain how energy conservation applies to the system during this period of contraction.

(2)

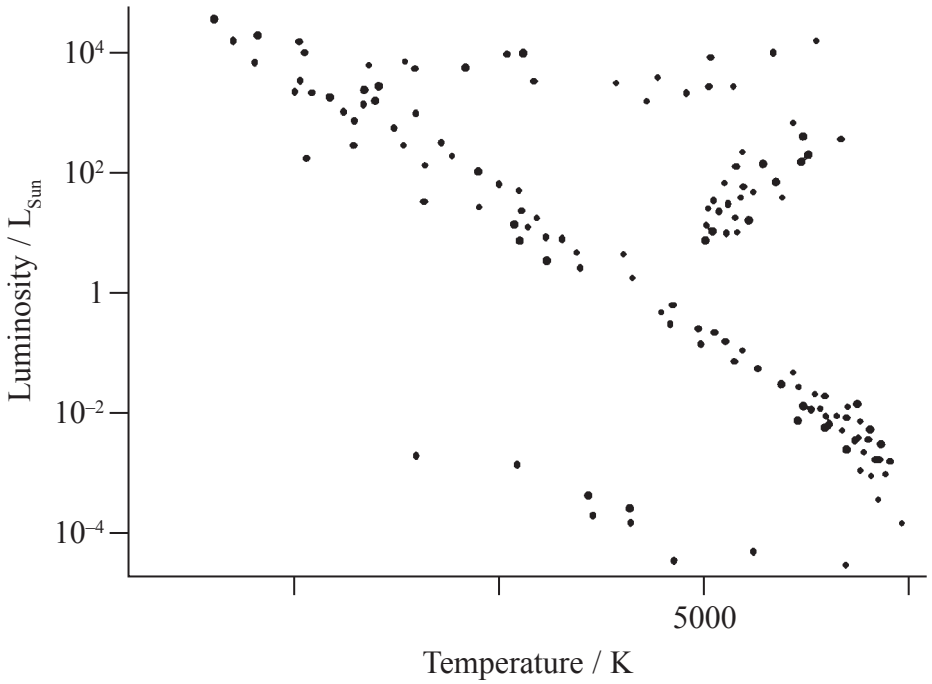
(iii) Explain how the fusion of hydrogen into helium in the core enables large amounts of energy to be released.

(3)

(b) The Hertzsprung-Russell diagram is used by astronomers to show the relationship between luminosity and temperature for stars.

(i) Complete the temperature scale on the Hertzsprung-Russell diagram.

(2)



(ii) The table shows the luminosity and temperature of a range of stars.

Star	Luminosity / L_{Sun}	Temperature / K	Star type
A	0.001	8 000	
B	0.1	4 400	main sequence
C	160	3 600	red giant
D	160	13 600	

Complete the table.

(2)

(iii) On the Hertzsprung-Russell diagram indicate where each of the stars A, B, C, and D is located.

(2)

(c) Polaris is the nearest variable star to the Earth and is an example of a standard candle.

(i) State what astronomers mean by a standard candle.

(1)

.....

.....

*(ii) Recent measurements indicate that Polaris may be significantly closer to the Earth than previously thought.

Explain why this would have a significant impact on our estimation of the age of the universe.

(4)

.....

.....

.....

.....

.....

.....

.....

(Total for Question 4 = 18 marks)

5 Europa is a moon of Jupiter. Europa is thought to contain an abundant supply of water and is therefore seen as a possible place for primitive life.

(a) Calculate the value of g at the surface of Europa.

mass of Europa = 4.8×10^{22} kg
radius of Europa = 1600 km

(2)

g = ...

(b) Explain how Europa is maintained in a circular orbit about Jupiter.

(2)

(c) Calculate the time taken for Europa to make one orbit.

mass of Jupiter = 1.90×10^{27} kg
radius of Europa's orbit = 6.71×10^{5} km

(3)

Time taken = ...

(d) The average distance of Jupiter from the Sun is 5.2 times the average distance of the Earth from the Sun.

Calculate the ratio of the brightness (flux) of the Sun as seen from the Earth to the brightness as seen from Jupiter.

(3)

Ratio = ...

(Total for Question 5 = 10 marks)

6 (a) Explain how the light emitted from a star enables us to determine the temperature of the star and hence its luminosity.

(3)

*(b) An object whose luminosity is known may be referred to as a standard candle.

Explain why standard candles are important to astronomers and outline how standard candles are used to find distances to stars.

(3)

(Total for Question 6 = 6 marks)