GCSE Questions on Circular Motion, Satellites and Stellar Evolution

Q1. A student collects data from the Internet about planets in the solar system:

Name of the planet	Distance from the Sun in millions of kilometres	Time taken for one orbit of the Sun in years	Time taken to spin on its axis in hours	Average temperature on the side facing the Sun in °C
Mercury	60	0.24	1400	+430
Venus	110	0.60	5800	+470
Earth	150	1	24	+20
Mars	230	2	25	−20
Jupiter	780	12	10	−150
Saturn	1400	30	10	−180
Uranus	2900	84	17	−220
Neptune	4500	160	16	−230

(a) Name the two variables in the student's table which always have the relationship: 'As one increases, so does the other'

(1 mark)

(b) (i) Give an example of two variables in the student's table which generally have the relationship: 'As one increases, the other decreases.'

(1 mark)

(ii) Which piece of data does not seem to fit the relationship in (b)(i)?

(1 mark)

(c) Scientists plan to launch a satellite which will orbit Mars above its equator. It will be a geostationary satellite. How many hours will it take to orbit Mars?

(1 mark)

(d) Mars has two moons. Neither of them is in a geostationary orbit and they both take different times to orbit the planet. Which one of these statements is correct.

(1 mark)

A: The two moons will always be above the same point on the surface of Mars.
B: The two moons will be in different positions at different times.
C: You can never see both moons at the same time.

(e) Choose words from the box to complete the passage below.

circular	direction	friction	gravitational	speed	universal

The moons of the planet Neptune move in circular paths around the planet. They continuously accelerate towards the centre of Neptune. The acceleration changes the ...**(X)**...of each moon but does not change its ...**(Y)**.... The force causing the acceleration is a ....**(Z)**.... force.

(2 marks)
(7 marks TOTAL)

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Q2.   (a)   Our star, the Sun, is stable. Explain what the conditions need to be for a star to remain stable.

(2 marks)

          (b)   Shortly after the 'big bang', hydrogen was the only element in the Universe. Explain how the other elements came to be formed.

(3 marks)

(5 marks TOTAL)

Q3.   This page is from a science magazine:

The Red Planet
The two natural satellites, or moons, of Mars are Phobos (fear) and Deimos (terror). They are named after the horses which pulled the chariot of Mars, the god of war in the mythology of Ancient Greece.
Phobos takes less than eight hours to orbit Mars and gets slightly closer every time it does so. Scientists predict that in about 100 million years time it will either be ripped apart by the gravitational force or will crash onto the surface of Mars.

◉ Deimos

◉ Phobos
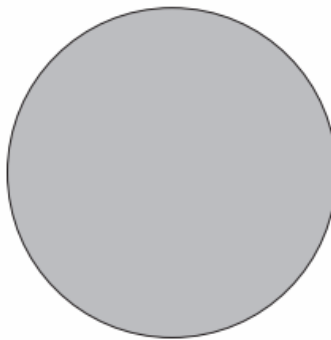
(Not to scale)

    (a) Suggest how scientists have arrived at their prediction of about 100 million years.

(2 marks)

    (b) The centripetal force on Phobos is gradually changing as it orbits Mars. Is the force increasing or decreasing? Explain your answer.

(2 marks)

    (c) Scientists expect that the mass of Mars and the mass of Phobos will not increase. Explain what will happen to the gravitational force on Phobos as it orbits Mars.

(2 marks)

(6 marks TOTAL)

Q4.   Immediately after the 'big bang', at the start of the Universe, there were only atoms of the element hydrogen (H). Now the Universe contains atoms of over one hundred elements.

    (a) Explain how atoms of the element helium (He) are formed in a star.

(2 marks)

    (b) Explain how atoms of very heavy elements, such as gold (Au), were formed.

(2 marks)

    (c) Explain how, and when, atoms of different elements may be distributed throughout the Universe.

(2 marks)

(6 marks TOTAL)

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Q5. The table gives data on the Solar System

Name of planet	Average distance from the Sun in millions of kilometres	Average orbital speed in kilometres per second
Mercury	60	48
Venus	108	35
Earth	150	30
Mars	228	24
Jupiter	778	13
Saturn	1430	9.6
Uranus	2860	6.8

(a)   A student studies this data and comes to the following conclusion:
"For the planets in the table, the average orbital speed is very nearly inversely proportional to the planet's average distance from the Sun."

(i) This conclusion is *not* correct. Use the data for Saturn and Uranus to explain how the student's conclusion is *not* correct.

(2 marks)

(ii) For all the listed planets, write a correct conclusion for the connection between the average distance from the Sun and the orbital speed.

(2 marks)

(b)   The student knows the following:
The planets all move in ellipses (slightly squashed circles). What is the connection between this statement and the headings in the table?

(2 marks)
(6 marks TOTAL)

Q6. The diagram on the next page shows part of the life cycle of a star which is much bigger than the Sun.

(a)   (i) What is the relationship between the masses of the dust and gas in the cloud in Stage 2 and the force of gravity between them?

(1 mark)

(ii) What is the relationship between the distance apart of the dust and gas in the cloud in Stage 2 and the force of gravity between them?
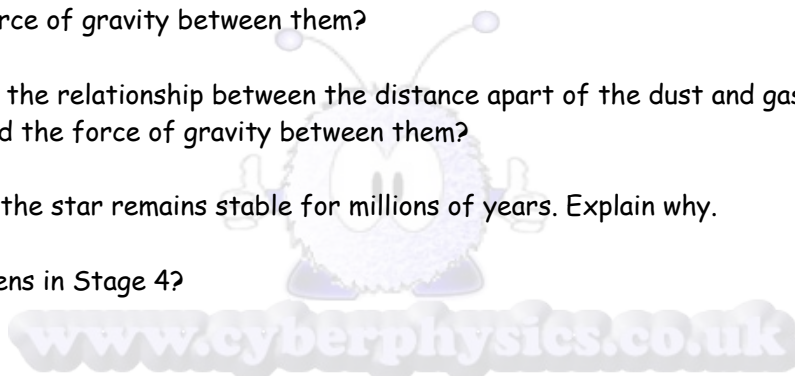
(1 mark)

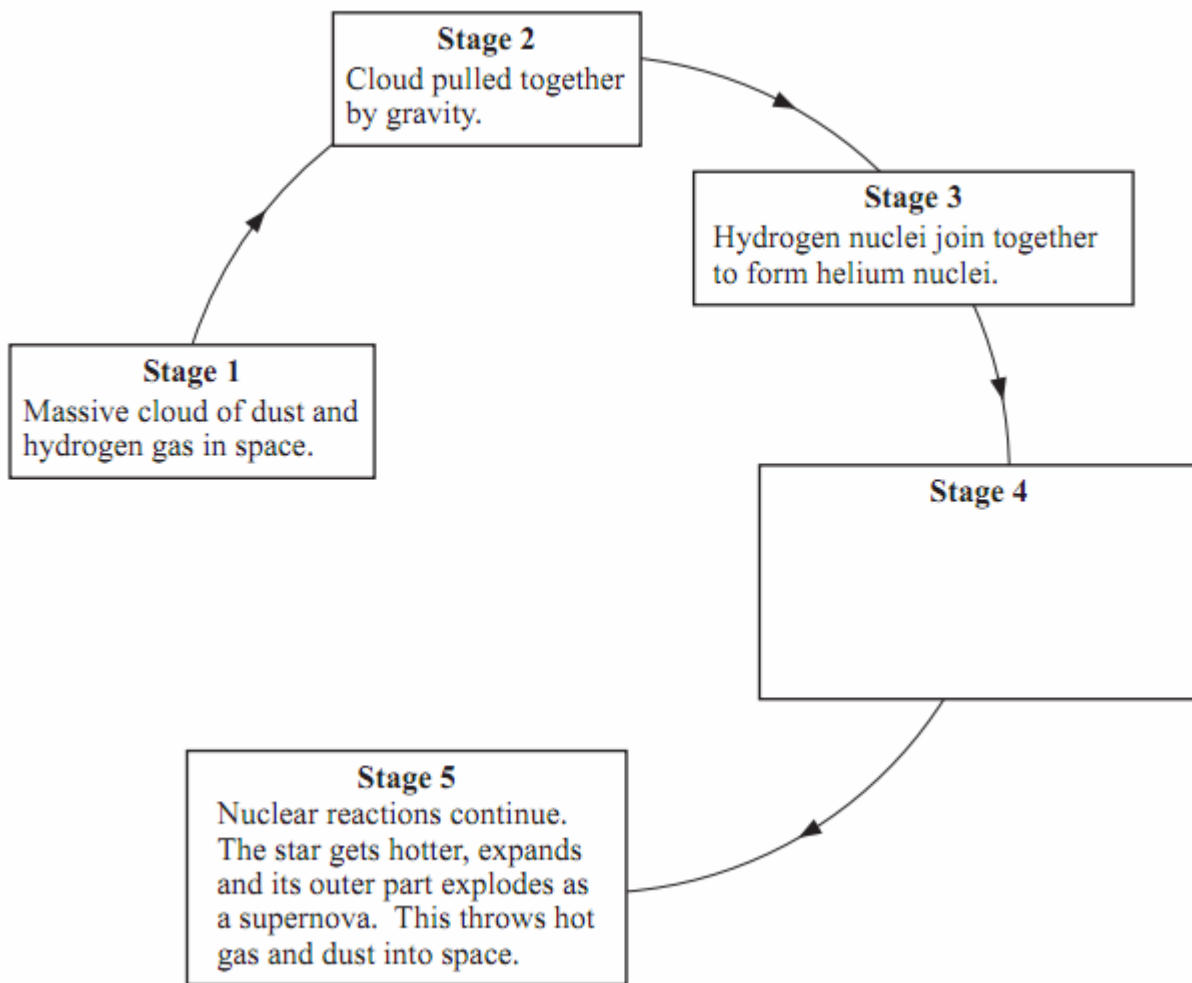(b)   In Stage 3 the star remains stable for millions of years. Explain why.

(2 marks)

(c)   What happens in Stage 4?

(2 marks)
(6 marks TOTAL)

Stage 2
Cloud pulled together by gravity.

Stage 3
Hydrogen nuclei join together to form helium nuclei.

Stage 1
Massive cloud of dust and hydrogen gas in space.

Stage 4

Stage 5
Nuclear reactions continue. The star gets hotter, expands and its outer part explodes as a supernova. This throws hot gas and dust into space.

Q7. The London Eye is the largest observation wheel in the world. The passengers ride in capsules. Each capsule moves in a circular path and accelerates.

(a) Explain how the wheel can move at a steady speed and the capsules accelerate at the same time.

(2 marks)

(b) In which direction does each capsule accelerate?

(1 mark)

(c) What is the name of the resultant force that causes the capsules to accelerate?

(1 mark)

(d) The designers of the London Eye had to consider three factors which affect the resultant force described in part (c). Two factors that increase the resultant force are

- an increase in the speed of rotation
- an increase in the total mass of the wheel, the capsules and the passengers.

Name the other factor that affects the resultant force and state what effect it has on the resultant force.

(1 mark)
(5 marks TOTAL)

Q8. (a) Suggest a word to replace the space in the sentence:

Stars form when enough dust and gas are pulled together by the force of ....

(1 mark)

(b) How are stars able to give out energy for millions of years?
- **A:** By atoms joining together
- **B:** By atoms splitting apart
- **C:** By burning gases

(1 mark)

(c) There are many billions of stars in our galaxy. Our Sun is one of these stars. What is the name of our galaxy?

(1 mark)

(d) *'Why was the Universe created?'* We cannot expect scientists to answer this question. What is the reason for this?
- **A:** It will take too long to collect the scientific evidence.
- **B:** The answer depends on beliefs and opinions, not scientific evidence.
- **C:** There is not enough scientific evidence.

(1 mark)

(4 marks TOTAL)

Grand Total : 45 marks - time allocation 45 minutes