# 8.1 Star life cycles and orbits

Name: _____ Class: _____ Date: _____ **Total: 21 marks**

**KEY WORDS** main sequence • supernova

## Objective

Build the skills to answer exam questions on **stars and the solar system** : how stars form, the main sequence, the life cycle of stars, how elements are made, planets, moons, comets and orbits.

**You must be able to:**

- describe how a star forms and why it is stable on the main sequence
- describe the life cycle of a star like the Sun and of a much bigger star
- explain how elements are made by fusion and in supernovae
- explain how gravity keeps planets, moons, comets and satellites in orbit

## 1 Key knowledge and worked examples

### ■ Stars and orbits

| idea | equation or rule |
|---|---|
| birth | gravity pulls a cloud of dust and gas (a nebula) together into a protostar; it heats up until hydrogen fuses |
| main sequence | the outward pressure from fusion energy balances the inward pull of gravity, so the star is stable for billions of years |
| a star like the Sun | main sequence → red giant → white dwarf → black dwarf |
| a much bigger star | main sequence → red supergiant → supernova → neutron star or black hole |
| elements | fusion in stars makes elements up to iron; heavier elements are made in supernovae and spread into space |
| orbits | gravity gives the centripetal force: the direction changes but the speed in a circular orbit stays the same; a closer orbit needs a higher speed |



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**Worked example 1: orbital speed.** A satellite moves in a circle of radius 7000 km. One orbit takes 6000 s. Find its speed.

1. Known: $r = 7000$ km, $T = 6000$ s.
2. Rule: speed $= \frac{\text{distance}}{\text{time}} = \frac{2\pi r}{T}$.
3. Numbers: $\frac{2\pi \times 7000}{6000}$.
4. Result: 7.3 **km/s**.

**Worked example 2: an ending.** A star is 20 times the mass of the Sun. Name the stage after the red supergiant and what is left.

1. Known: the star is much bigger than the Sun.
2. Rule: big stars explode at the end.
3. Apply: a supernova; the core collapses.
4. Result: **supernova, then a neutron star or a black hole**.

**Answer shapes:** name the two forces and say they balance; in an orbit the velocity changes because its direction changes.

## 2 Practice

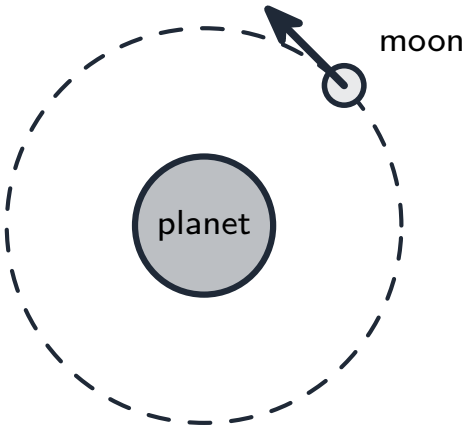
**2.1** The cards show the stages in the life of a star like the Sun. Write them in the right order. [2]

red giant | nebula | white dwarf | main sequence | protostar



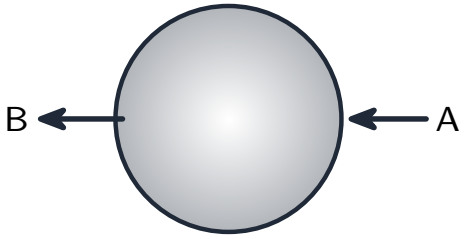
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**2.2** A moon moves in a circular orbit around a planet. Name the force that keeps it in orbit and give its direction. [2]




## 3 Exam-style questions

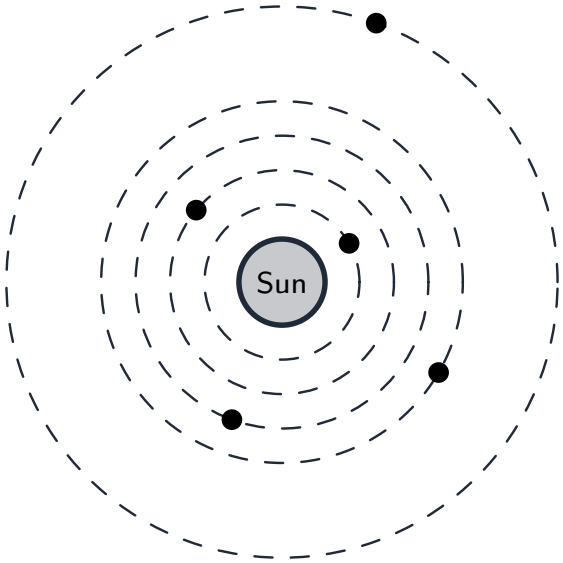
**3.1** The diagram shows two forces on a main-sequence star. Name forces A and B. Explain why the star stays the same size for billions of years. [3]






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**3.2** The table gives data for five planets. All the orbits are almost circles around the Sun.




| planet | distance from Sun / million km | orbital speed / km/s | time for one orbit / years |
|---|---|---|---|
| Mercury | 58 | 47.9 | 0.24 |
| Venus | 108 | 35.0 | 0.62 |
| Earth | 150 | 29.8 | 1.00 |
| Mars | 228 | 24.1 | 1.88 |
| Jupiter | 778 | 13.1 | 11.9 |

(a) Describe how the orbital speed changes with distance from the Sun. Explain why. [3]

(b) Calculate the distance the Earth travels in one orbit. [2]



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(c) A comet moves in a long, thin elliptical orbit. Describe and explain how its speed changes during one orbit. [3]

(d) Describe the life cycle of a star much bigger than the Sun. Explain how the elements in the planets were made. [6]



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