8.1 Orbits and stellar evolution

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

Objective

Build the skills to answer exam questions on **the Universe and stars** : the Solar System, gravity and orbits, orbital speed, the life cycle of stars, and star colour and brightness.

You must be able to:

- describe the Solar System and the role of gravity in orbits
- use orbital speed $v = 2\pi r/T$
- describe the life cycle of stars of different masses
- link the colour of a star to its surface temperature

1 Key knowledge and worked examples

Space

idea	equation or rule
orbits	gravity keeps planets around the Sun and moons around planets; comets have very elliptical orbits
gravitational field strength	g changes from planet to planet; weight $= m \times g$
orbital speed	$v = 2 \times \pi \times r \div T$
star like the Sun	nebula, protostar, main sequence, red giant, white dwarf
massive star	nebula, protostar, main sequence, red supergiant, supernova, neutron star or black hole
colour	hotter stars look blue-white; cooler stars look red

Worked example 1: orbital speed. The Moon orbits Earth with radius 3.8×10^8 m in 2.4×10^6 s. Find its speed.

1. Known: $r = 3.8 \times 10^8$ m; $T = 2.4 \times 10^6$ s.
2. Rule: $v = 2\pi r \div T$.
3. Numbers: $2 \times 3.14 \times 3.8 \times 10^8 \div 2.4 \times 10^6$.

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4. Result: **about** 990 **m/s**.

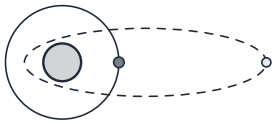
Worked example 2: weight on Mars. On Mars $g = 3.7$ N/kg. Find the weight of a 20 kg rover.

1. Known: $m = 20$ kg; $g = 3.7$ N/kg.
2. Rule: $W = mg$.
3. Numbers: 20×3.7.
4. Result: 74 **N**.

Answer shapes: the mass of an object stays the same everywhere; its weight changes with g.

2 Practice

2.1 Name the force that keeps the planets in orbit around the Sun, and state the shape of a comet's orbit. [2]



2.2 Star A is red and star B is blue-white. Which star is hotter? Explain. [2]

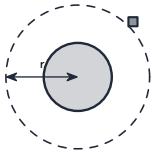


2.3 Name the stage of a star's life when it is stable for billions of years, and explain why it is stable. [2]



3 Exam-style questions

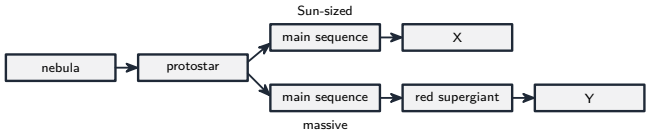
3.1 A satellite orbits Earth at a radius of 7.0×10^6 m. One orbit takes 5800 s. Calculate its orbital speed. [3]



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3.2 The diagram shows the possible life cycles of stars.

(a) Name stage X and stage Y. [2]



(b) Describe how a star forms from a nebula. [3]

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(c) Explain why a star becomes a red giant near the end of its main-sequence life. [3]

(d) Compare the life cycle of the Sun with that of a star 20 times more massive. Include what happens at the end of each. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- gravity (gravitational force)
- very elongated ellipse (highly elliptical)

2.2

- star B
- hotter stars give out more short-wavelength (blue) light

2.3

- main sequence
- the outward pressure from fusion balances the inward pull of gravity

3.1

- $v = 2\pi r \div T$
- $2 \times 3.14 \times 7.0 \times 10^6 \div 5800$
- about **7600** m/s (7.6 km/s)

3.2

(a) X: red giant; Y: supernova

(b) a nebula is a cloud of dust and gas; gravity pulls the material together into a protostar, which gets hotter; when it is hot enough, hydrogen nuclei fuse and the star begins

(c) the hydrogen in the core runs out; the core shrinks and heats up, and fusion of heavier elements starts; the outer layers expand and cool, so the star is large and red

(d) points to include:

- both form from a nebula and become main-sequence stars (K)
- the massive star burns its fuel faster, so its main-sequence life is much shorter (An)
- the Sun becomes a red giant; the massive star becomes a red supergiant (K)
- the Sun loses its outer layers and becomes a white dwarf, which cools (K)
- the massive star explodes as a supernova (K)
- it leaves a neutron star, or a black hole if the core is very massive (An)

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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