Space physics

OxfordAQA International GCSE Physics 9203, topic 3.8: star life cycles, orbits, (P) red-shift and the Big Bang

From dust to the universe

> Gravity makes stars, stars make elements, and space is expanding.

- OxfordAQA International GCSE Physics 9203, topic 3.8.
- (P) red-shift and the **Big Bang** are Paper 2.

A star in balance

On the main sequence, gravity in balances fusion out.

- Smaller lumps become planets.
- More mass: hotter core, heavier nuclei made.

Two ways to die

> Sun-like: white dwarf. Massive: supernova, then neutron star or black hole.

- Mass decides the ending.
- Only the most massive stars make black holes.

Where the elements come from

> Every element heavier than helium was made in stars or supernovae.

- The early universe: almost only hydrogen and helium.
- Supernovae scatter the elements into space.

Two kinds of satellite orbit

Low polar orbits scan the whole Earth; geostationary orbits stay over one spot.

- Eight planets, moons, asteroids, dwarf planets, comets.
- The Milky Way: one of thousands of millions of galaxies.

Gravity keeps it turning

> Gravity is the centripetal force: it changes direction, not speed.

- Constant speed, changing direction: it accelerates.
- Change the speed and the orbit changes radius.

Higher orbit, slower speed

	Low polar	**Geostationary**
height	about 800 km	about 36 000 km
period	about 100 min	24 h
speed	faster	slower
over	the whole Earth	one point on the equator

(P) The Doppler stretch

A source moving away stretches its waves.

- Receding: longer wavelength, lower frequency.
- Approaching: shorter wavelength (blue-shift).

(P) Reading red-shift

> Four times the shift: about four times as fast, and further away.

- The further the galaxy, the bigger the red-shift.
- Every line moves; the galaxy does not look red.

(P) Evidence for the Big Bang

Red-shift

grows with distance

space is expanding

Microwave background

fills the universe

left from soon after the start

Common mistakes

Mistake	Fix
circular orbit: no acceleration	direction changes: it accelerates
higher orbit: faster	weaker gravity: slower
every star ends as a black hole	Sun-like: white dwarf
(P) galaxies fly from one centre	space itself expands

Check yourself

Question	**Answer**
After the main sequence (Sun-like)?	red giant, white dwarf, black dwarf
Elements heavier than iron?	made in supernovae
Two satellite orbits?	geostationary, low polar
(P) Two **Big Bang** evidences?	red-shift, CMB