

GCSE PHYSICS

SPACE PHYSICS



CHECKLIST

4.8.1 Solar System; Stability of Orbital Motions; Satellites			
Topic	Success Criteria	Progress	
Our Solar System	I can name the celestial objects that make up our Solar System.		
	I can name the galaxy that our Solar System is part of.		
	I can explain how the Sun was formed.		
	I can explain how fusion reactions are caused at the start of a star's life cycle.		
	I can explain how the fusion reactions lead to an equilibrium between the forces acting in the star.		
The Life Cycle of a Star	I can describe what determines the life cycle that a star goes through.		
	I can describe the life cycle of a star the size of the Sun.		
	I can describe the life cycle of a star much more massive than the Sun.		
	I can explain how naturally occurring elements with the mass of iron or lighter are produced.		
	I can explain how naturally occurring elements heavier than iron are produced.		
	I can explain how elements are distributed throughout the universe.		
Orbital Motion, Natural and Artificial Satellites	I can explain how planets and satellites maintain their circular orbits.		
	I can describe the similarities and distinctions between planets, moons and artificial satellites.		
	(HT only) I can explain how, for circular orbits, the force of gravity can lead to changing velocity but unchanging speed.		
	(HT only) I can explain why, for a stable orbit, the radius must change if the speed changes.		

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CHECKLIST

4.8.2 Red-Shift			
Topic	Success Criteria	Progress	
Red-Shift	I can explain what is meant by red-shift.		
	I can explain qualitatively the red-shift of light from galaxies that are receding.		
	I can explain that the change of each galaxy's speed with distance is evidence of an expanding universe.		
	I can explain how red-shift provides evidence for the Big Bang model.		
	I can explain how scientists are able to use observations to arrive at theories such as the Big Bang theory.		
	I can explain that there is still much about the universe that is not understood and give two examples.		

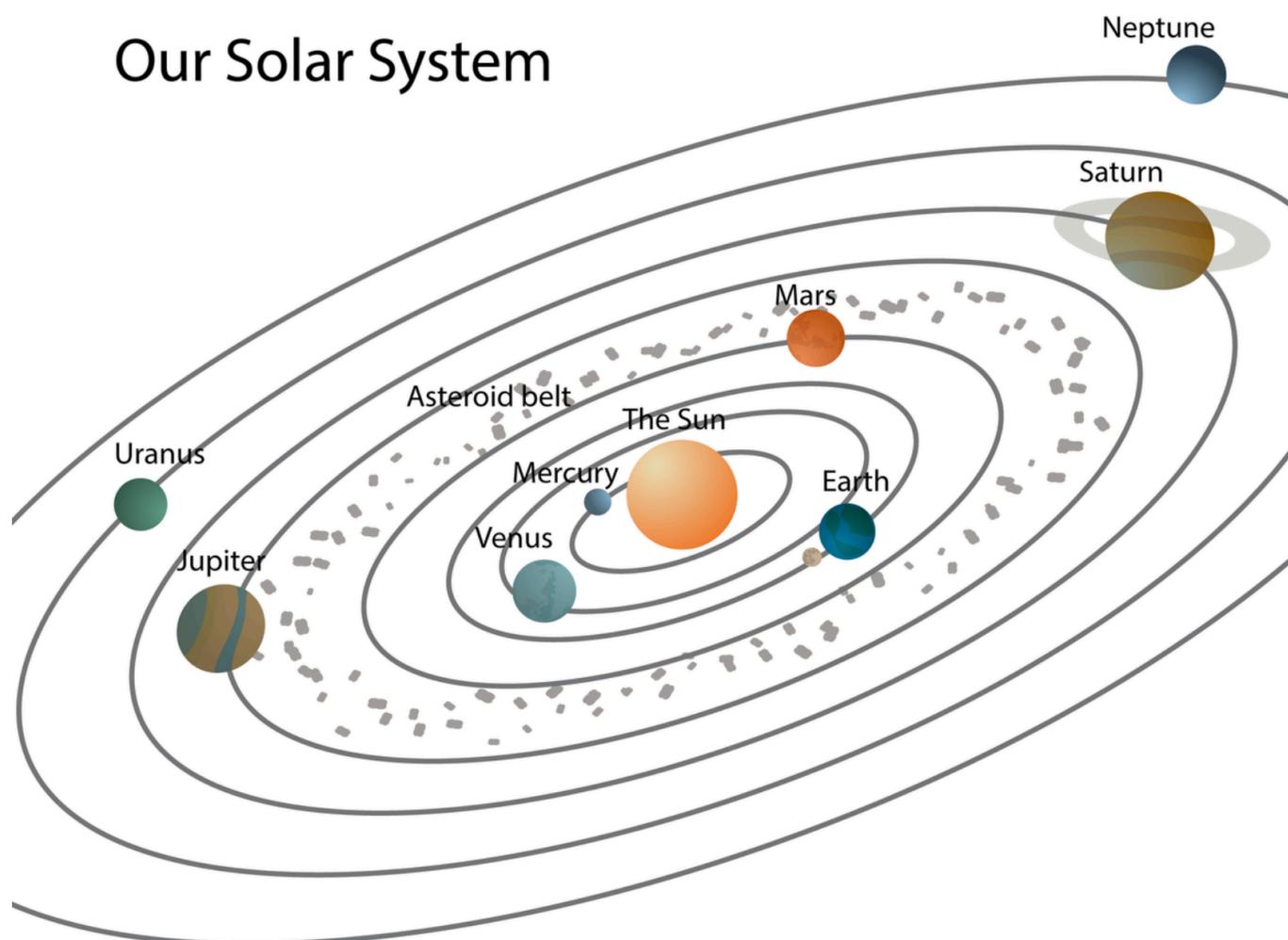
THE SOLAR SYSTEM

The Solar System consists of the Sun at the centre and all the objects that orbit around it. The Sun is a star and contains over 99% of the total mass of the Solar System. Planets, dwarf planets, moons, asteroids, and comets all move around the Sun due to gravity.

- Sun is at the centre of the Solar System
- Sun contains over 99% of the Solar System's mass
- Objects orbit the Sun due to gravity

Examples

- Planets
- Asteroids
- Comets



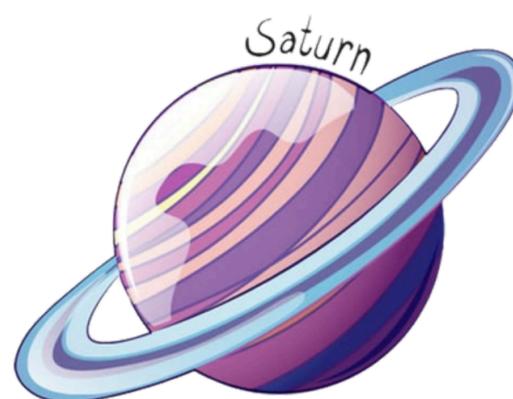
PLANETS IN THE SOLAR SYSTEM

There are eight planets that orbit the Sun. These planets are divided into rocky planets and gas planets. Rocky planets are smaller and solid, while gas planets are much larger and made mostly of gases.

- 8 planets orbit the Sun
- Divided into rocky planets and gas planets
- Rocky planets are solid, gas planets are mostly gases

Example

- Rocky planets: Mercury, Venus, Earth, Mars
- Gas planets: Jupiter, Saturn, Uranus, Neptune



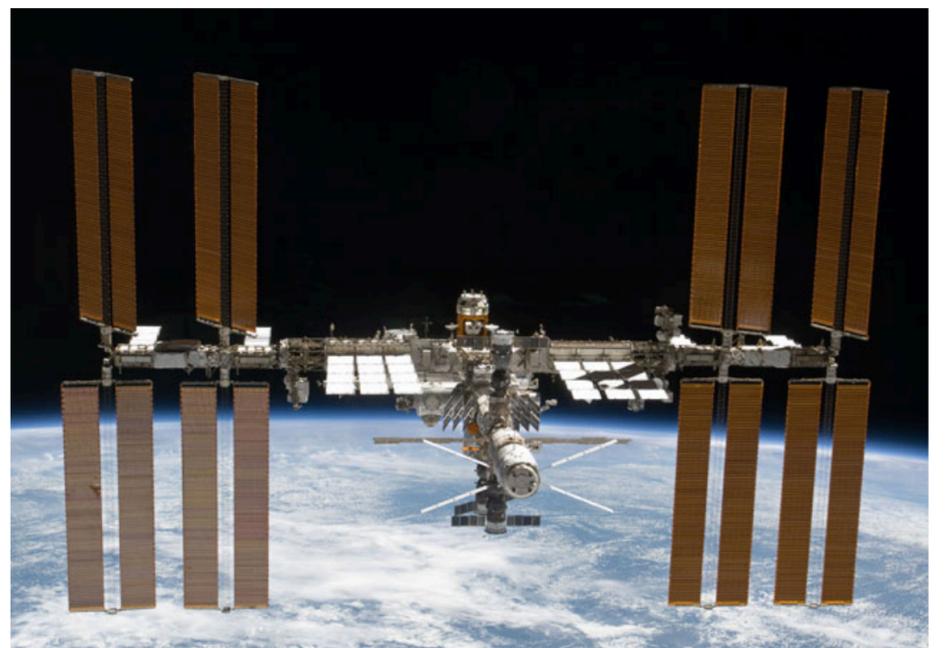
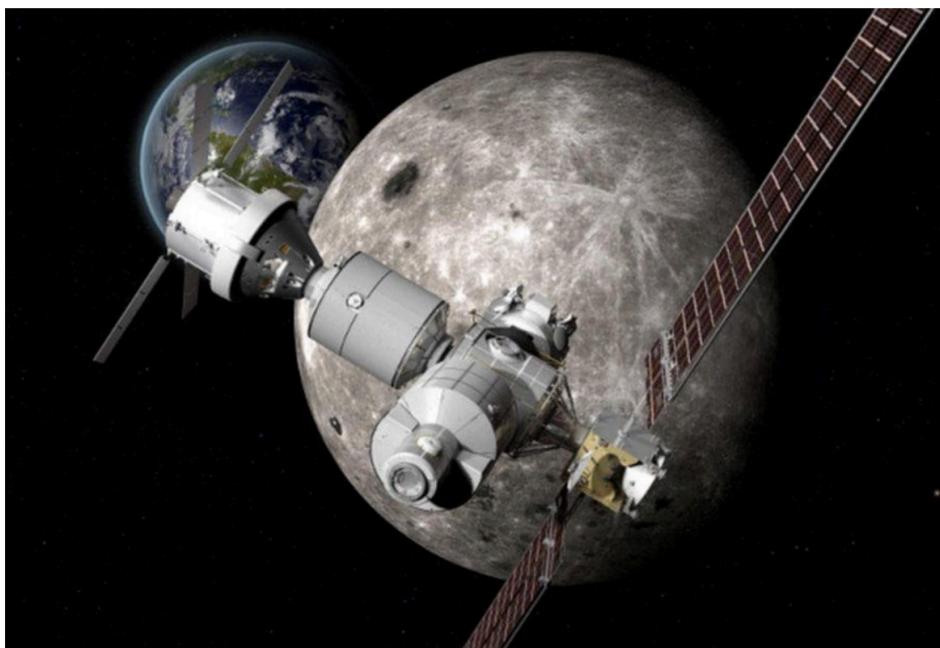
NATURAL AND ARTIFICIAL SATELLITES

Satellites are objects that orbit planets. Natural satellites are moons, while artificial satellites are human-made objects sent into orbit for communication, research, or observation.

- Satellites orbit planets
- Natural satellites are moons
- Artificial satellites are man-made

Examples

- Moon (natural satellite)
- International Space Station (artificial satellite)



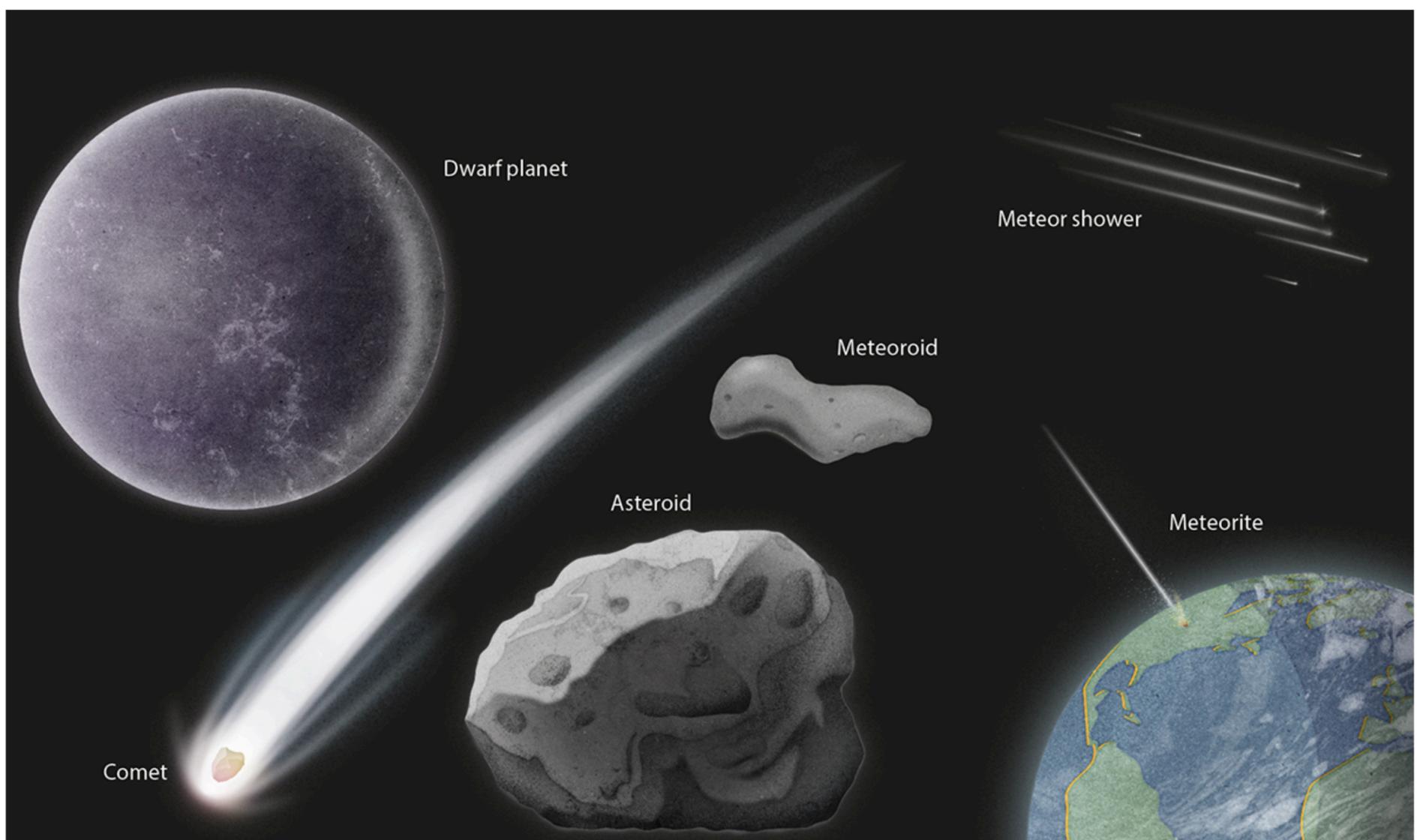
ASTEROIDS AND COMETS

Asteroids are small rocky objects that orbit the Sun, mostly found in the asteroid belt between Mars and Jupiter. Comets are made of ice and dust and develop a tail when they approach the Sun due to melting ice.

- Asteroids are small rocky objects orbiting the Sun
- Asteroid belt lies between Mars and Jupiter
- Comets are made of ice and dust
- Comets form a tail when near the Sun

Examples:

- Asteroid belt objects
- Comets with visible tails



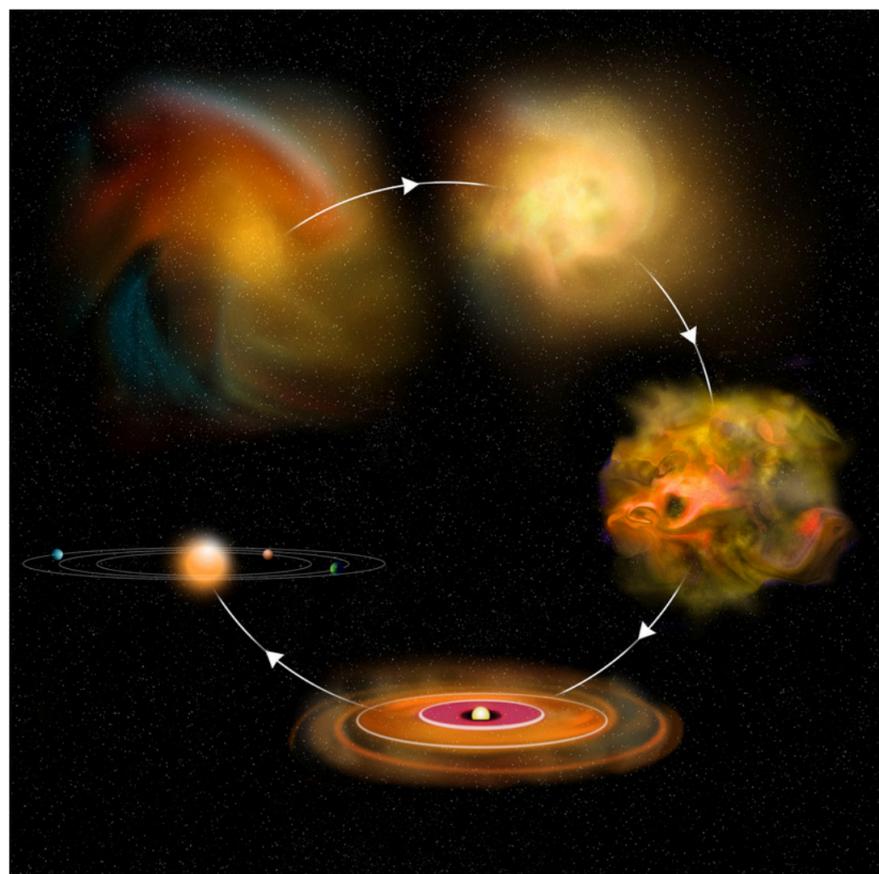
STAR FORMATION

Stars form from large clouds of gas and dust called nebulae. Gravity pulls the particles together, forming a hot, dense object called a protostar. When the temperature becomes high enough, nuclear fusion begins, and the star becomes stable as a main sequence star.

- Stars form from clouds of gas and dust called nebulae
- Gravity pulls particles together forming a protostar
- Temperature increases due to particle collisions
- Nuclear fusion begins when temperature is high enough
- Star becomes stable as a main sequence star

Examples:

- The Sun
- Other stars in the Milky Way



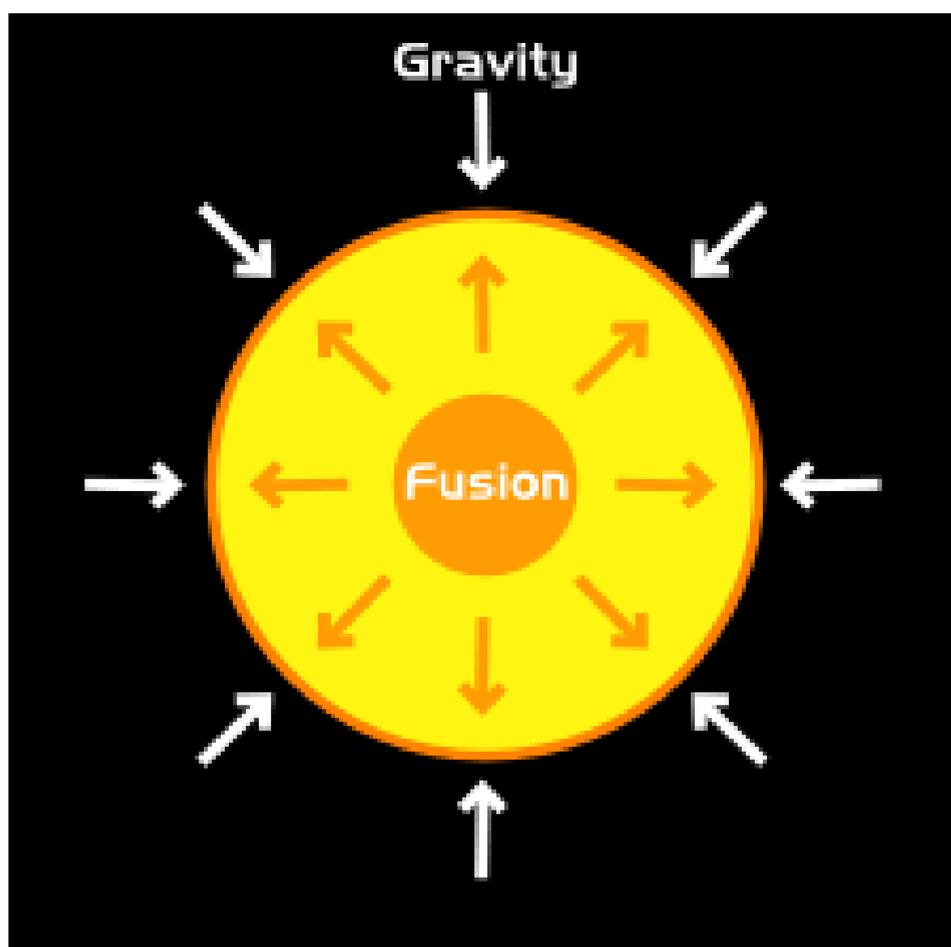
EQUILIBRIUM IN STARS

Stars remain stable due to a balance between two opposite forces. Gravity pulls matter inward, while pressure from fusion pushes outward. When these forces are equal, the star remains stable.

- Gravity pulls matter inward
- Pressure from fusion pushes outward
- Balanced forces keep the star stable
- If pressure increases, star expands
- If pressure decreases, star contracts

Example:

- Main sequence stars
- The Sun



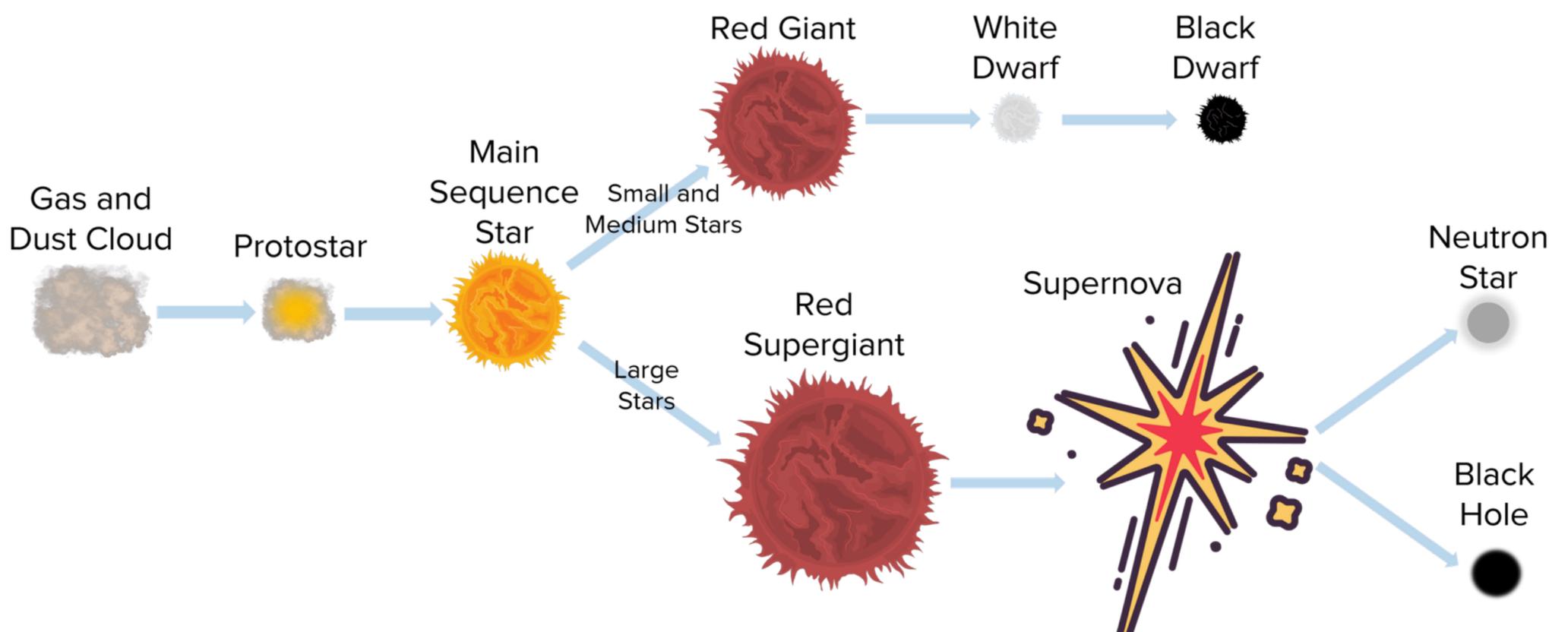
LIFE CYCLE OF SOLAR MASS STARS

Stars similar in size to the Sun follow a sequence of stages as they age. After the main sequence stage, the star expands into a red giant, then becomes a white dwarf, and eventually cools into a black dwarf.

- Life cycle depends on star size
- Solar mass stars expand into red giants
- Core collapses forming a white dwarf
- Star cools and becomes a black dwarf

Examples:

- The Sun (future life cycle)
- Other solar mass stars



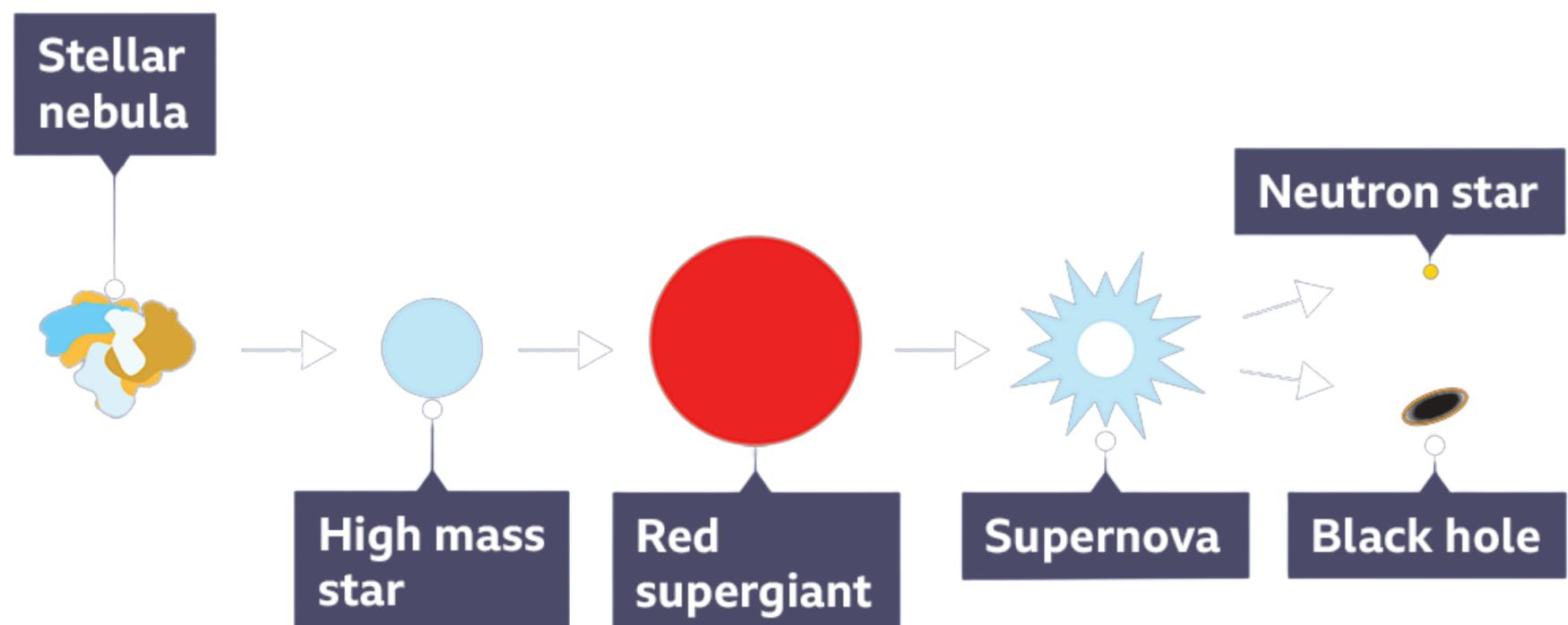
LIFE CYCLE OF LARGER STARS

Stars larger than the Sun go through more extreme stages. They expand into red supergiants and eventually explode in a supernova. The remaining core becomes either a neutron star or a black hole.

- Large stars become red supergiants
- Core collapses causing a supernova explosion
- Explosion releases energy and elements
- Core becomes neutron star or black hole

Examples:

- Speech is produced by vibrating vocal cords
- Thunder is caused by rapid expansion of air



NUCLEAR FUSION IN STARS

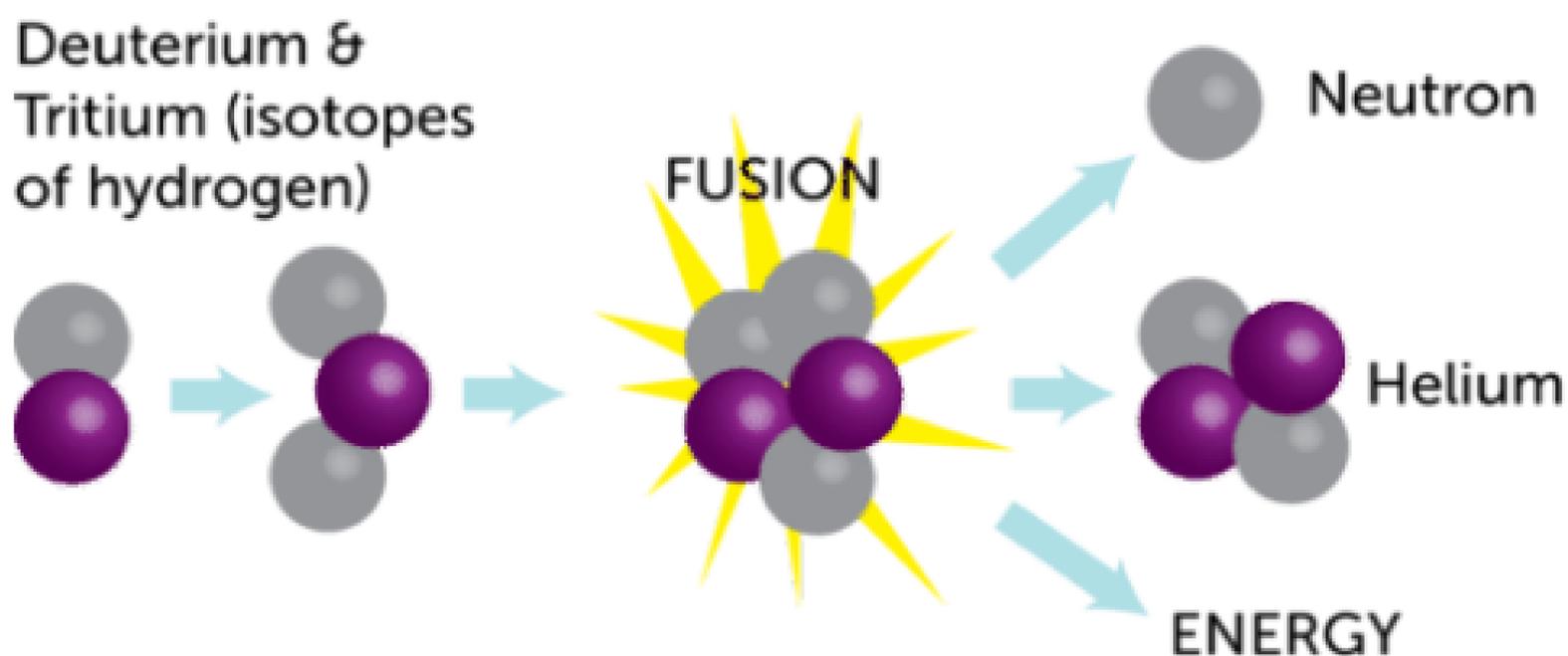
Fusion is the process where light nuclei combine to form heavier nuclei. This process releases energy in the form of heat and light and is responsible for producing elements in stars.

- Fusion combines light nuclei to form heavier nuclei
- Fusion releases heat and light energy
- Hydrogen fuses to form helium
- Heavier elements form in later fusion stages

Examples:

- Hydrogen fusion
- ${}^2_1\text{H} + {}^3_1\text{H} \rightarrow {}^4_2\text{He}$
- Helium fusion forming beryllium
- ${}^4_2\text{He} + {}^4_2\text{He} \rightarrow {}^8_4\text{Be}$

Nuclear Fusion



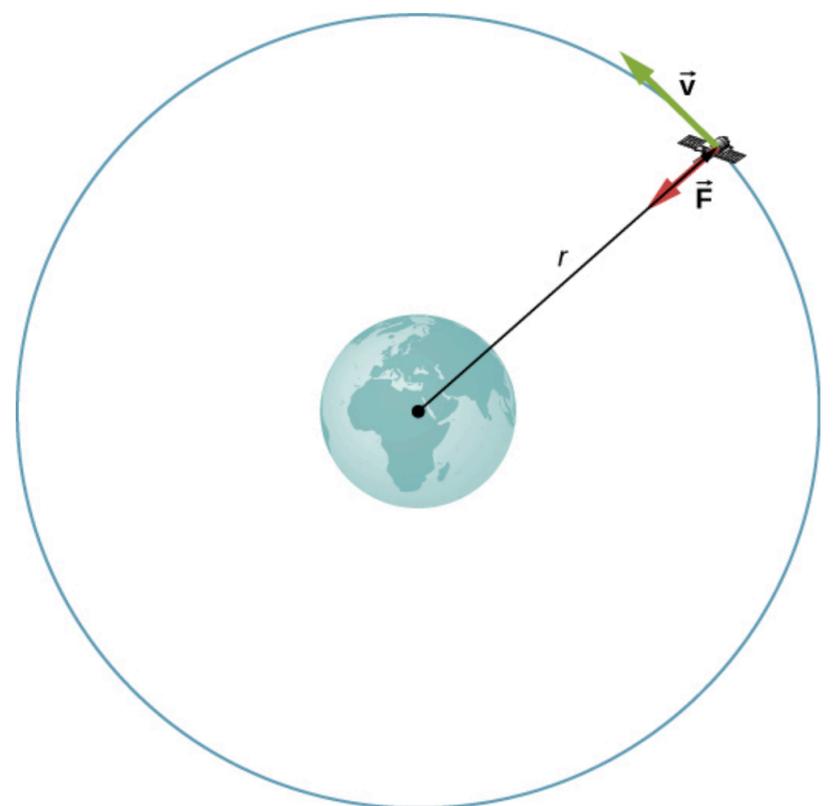
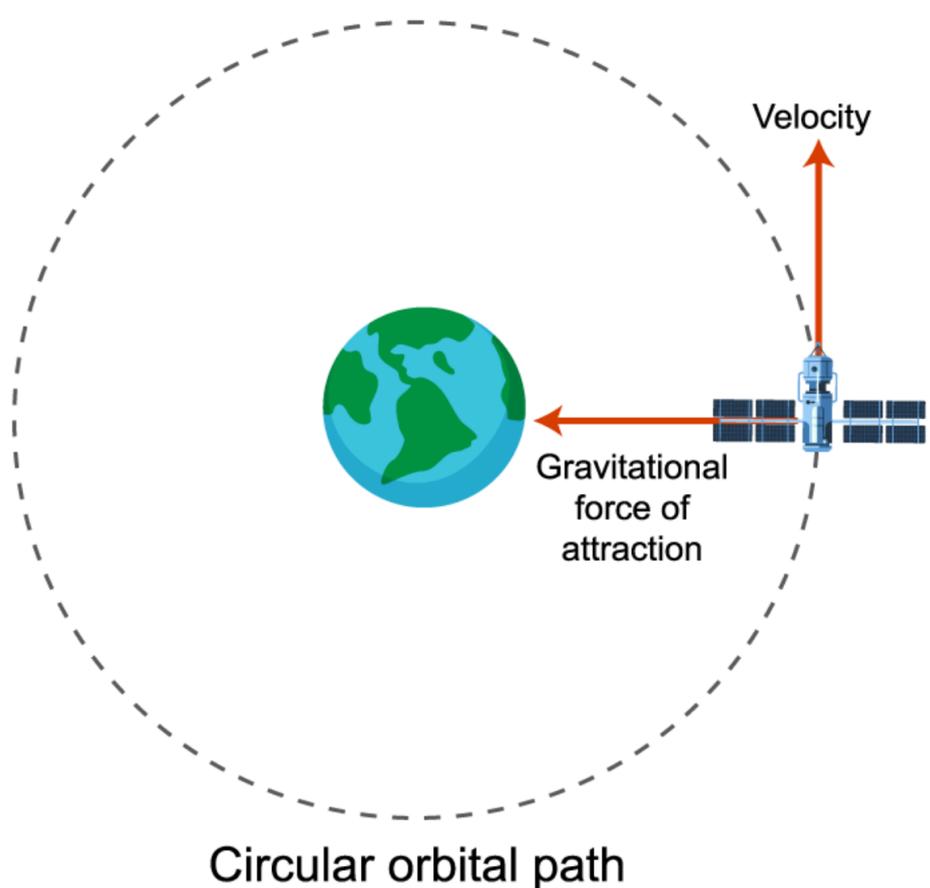
CIRCULAR ORBITS

Objects orbit larger bodies due to gravitational force. Gravity provides the centripetal force needed to maintain circular motion. The object moves at constant speed but constantly changes direction.

- Gravity causes objects to orbit larger bodies
- Gravity provides centripetal force
- Objects move at constant speed in circular orbit
- Direction constantly changes

Examples

- Earth orbiting the Sun
- Moon orbiting Earth



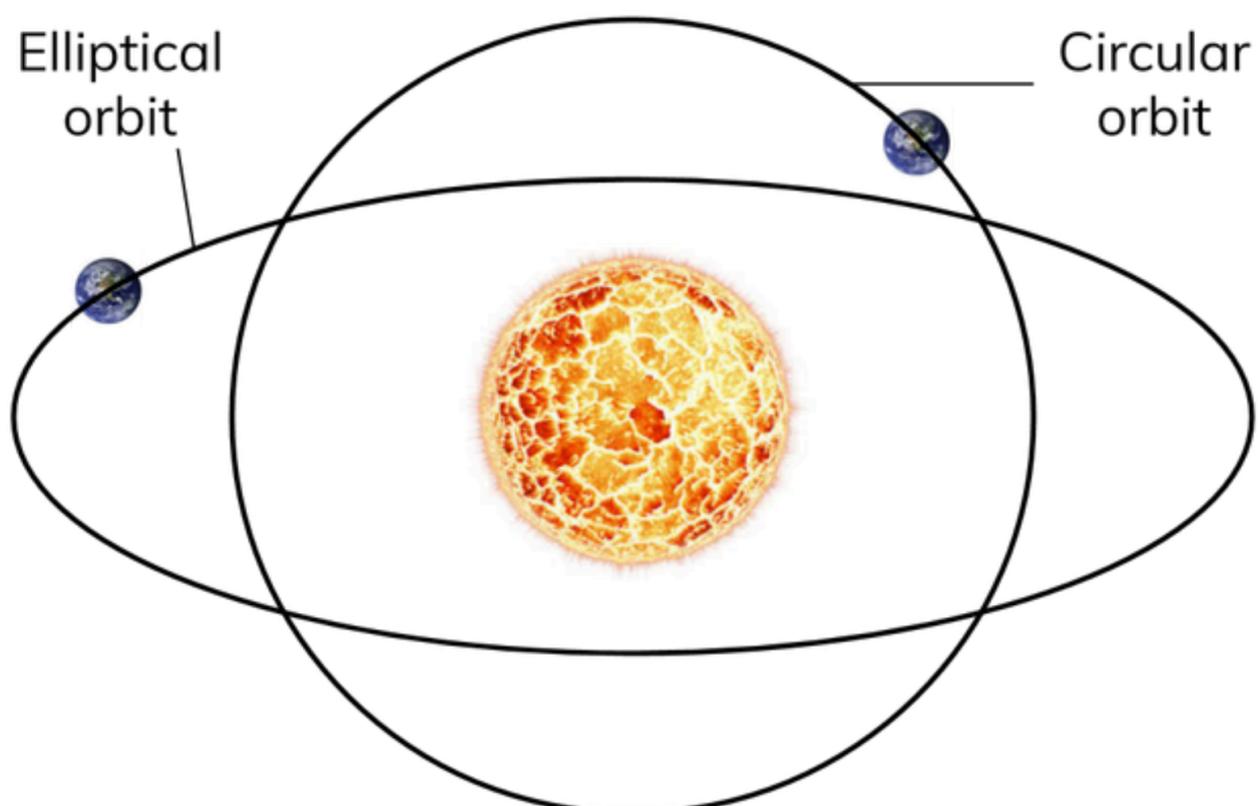
NON-CIRCULAR ORBITS (COMETS)

Comets follow highly elliptical orbits around the Sun. Their speed increases when closer to the Sun and decreases when farther away due to changes in gravitational potential and kinetic energy.

- Comets have elliptical orbits
- Speed increases when closer to Sun
- Speed decreases when farther from Sun
- Gravity controls motion

Example:

- Comets orbiting the Sun



GALATIC RED SHIFT

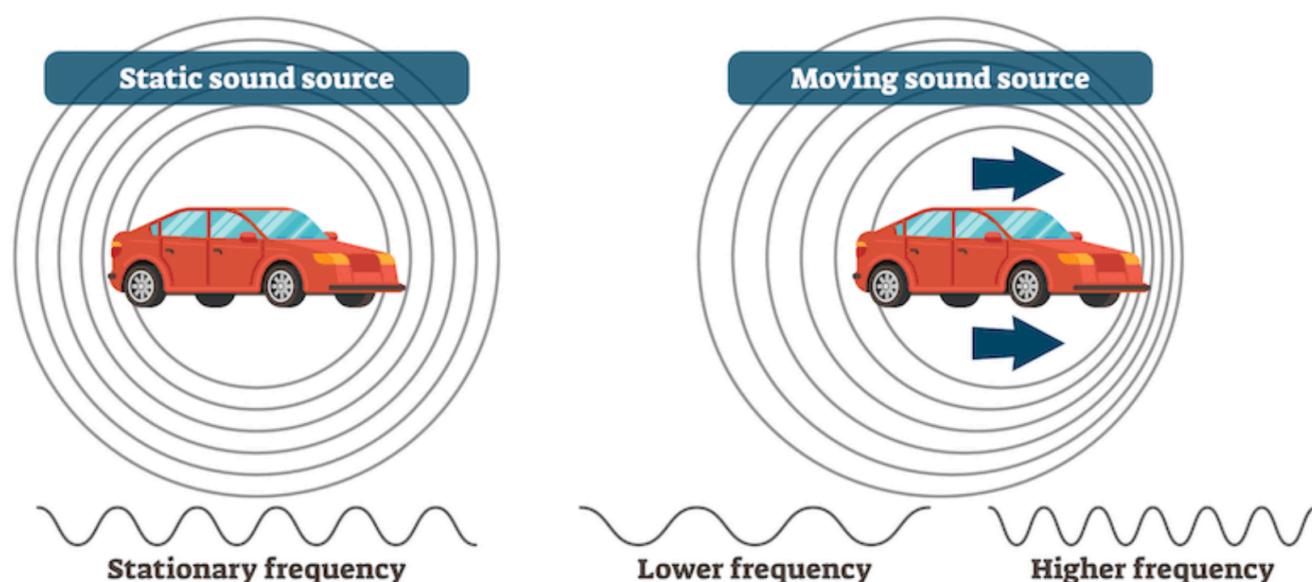
DOPPLER EFFECT

When an object emits waves, the wavefronts spread out symmetrically. If the source moves, the wavelength and frequency change. The wavelength decreases in front of the source and increases behind it. This effect is called the Doppler effect.

- Moving source changes wavelength and frequency
- Wavelength in front of source decreases ($\lambda - \Delta\lambda$)
- Wavelength behind source increases ($\lambda + \Delta\lambda$)
- Frequency increases when wavelength decreases
- Frequency decreases when wavelength increases

Examples:

- Moving sound source
- Moving light source



GALACTIC RED SHIFT

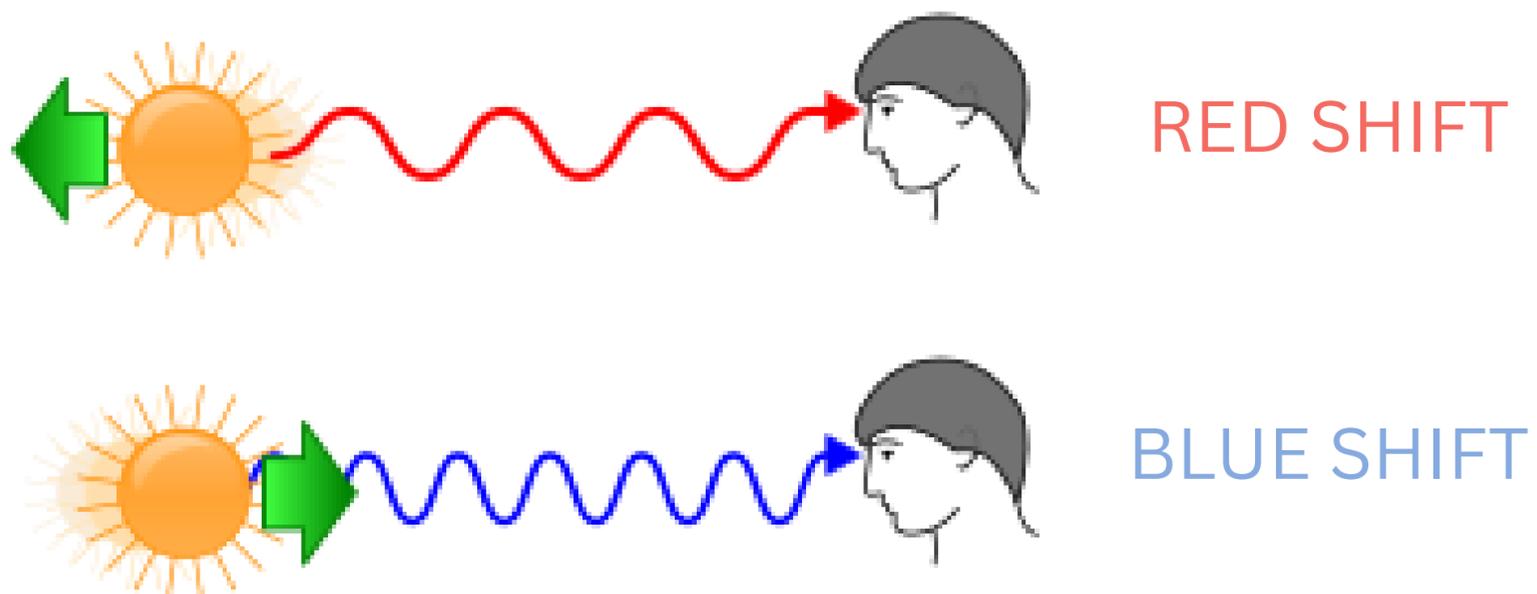
RED-SHIFT

Red-shift occurs when a light source moves away from an observer. The wavelength increases and the frequency decreases. The light shifts towards the red end of the spectrum.

- Occurs when source moves away from observer
- Wavelength increases
- Frequency decreases
- Light shifts towards red end of spectrum

Examples:

- Light from distant galaxies
- Light from stars moving away



GALACTIC RED SHIFT

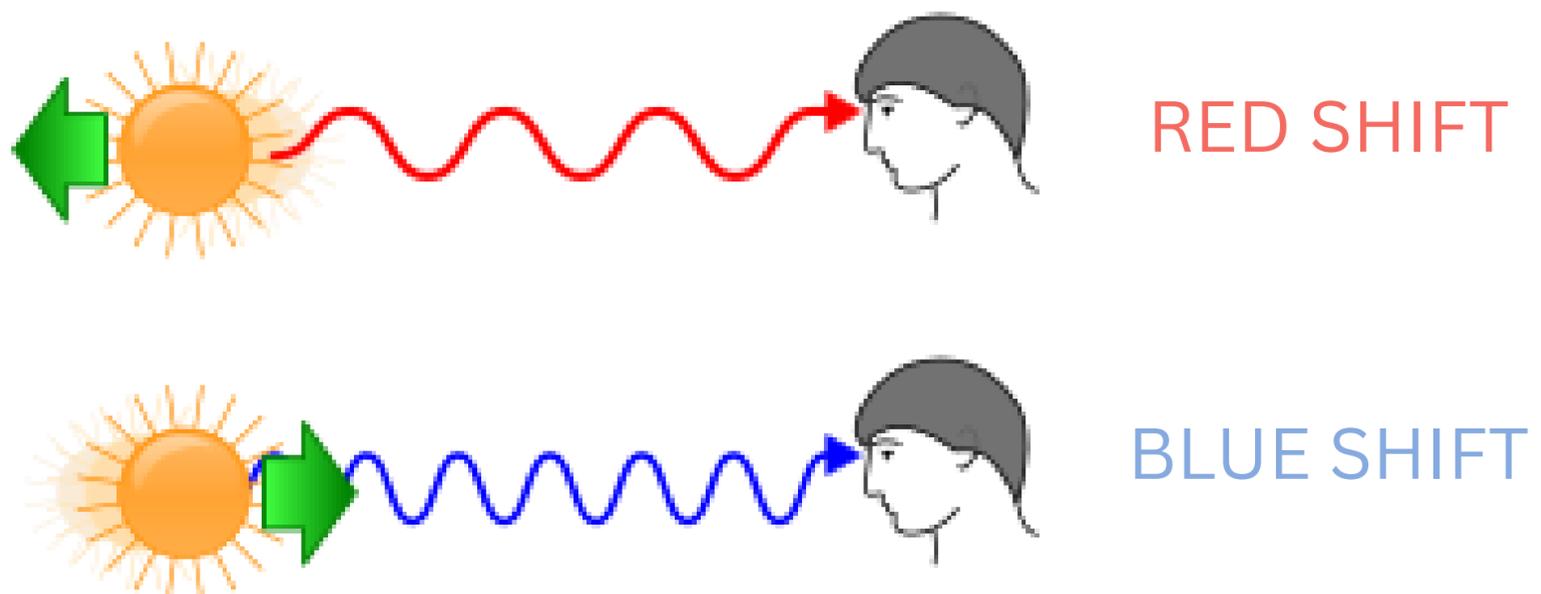
BLUE-SHIFT

Blue-shift occurs when a light source moves towards an observer. The wavelength decreases and the frequency increases. The light shifts towards the blue end of the spectrum.

- Occurs when source moves towards observer
- Wavelength decreases
- Frequency increases
- Light shifts towards blue end of spectrum

Examples:

- Light from stars moving towards observer



GALACTIC RED SHIFT

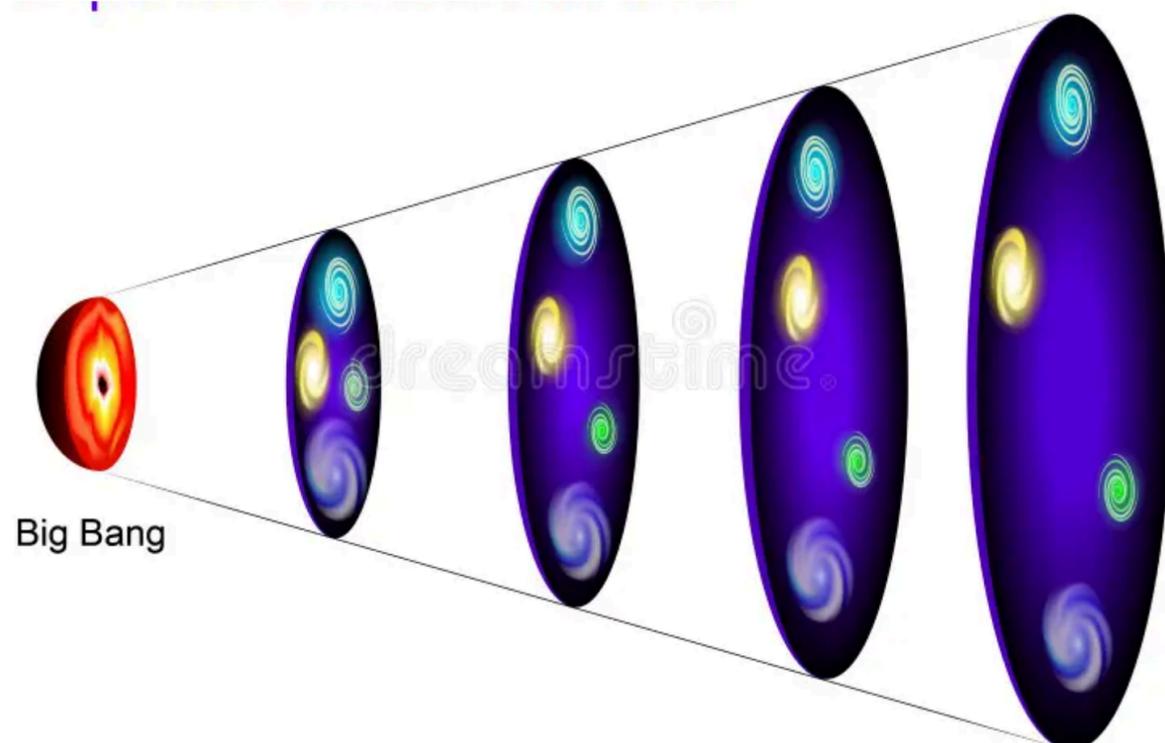
THE EXPANDING UNIVERSE

Light from distant galaxies is red-shifted. This shows that galaxies are moving away from Earth. The greater the red-shift, the faster the galaxy is moving away.

- Distant galaxy light is red-shifted
- Galaxies are moving away from Earth
- Universe is expanding
- Greater distance means greater red-shift
- Greater red-shift means greater speed

Examples:

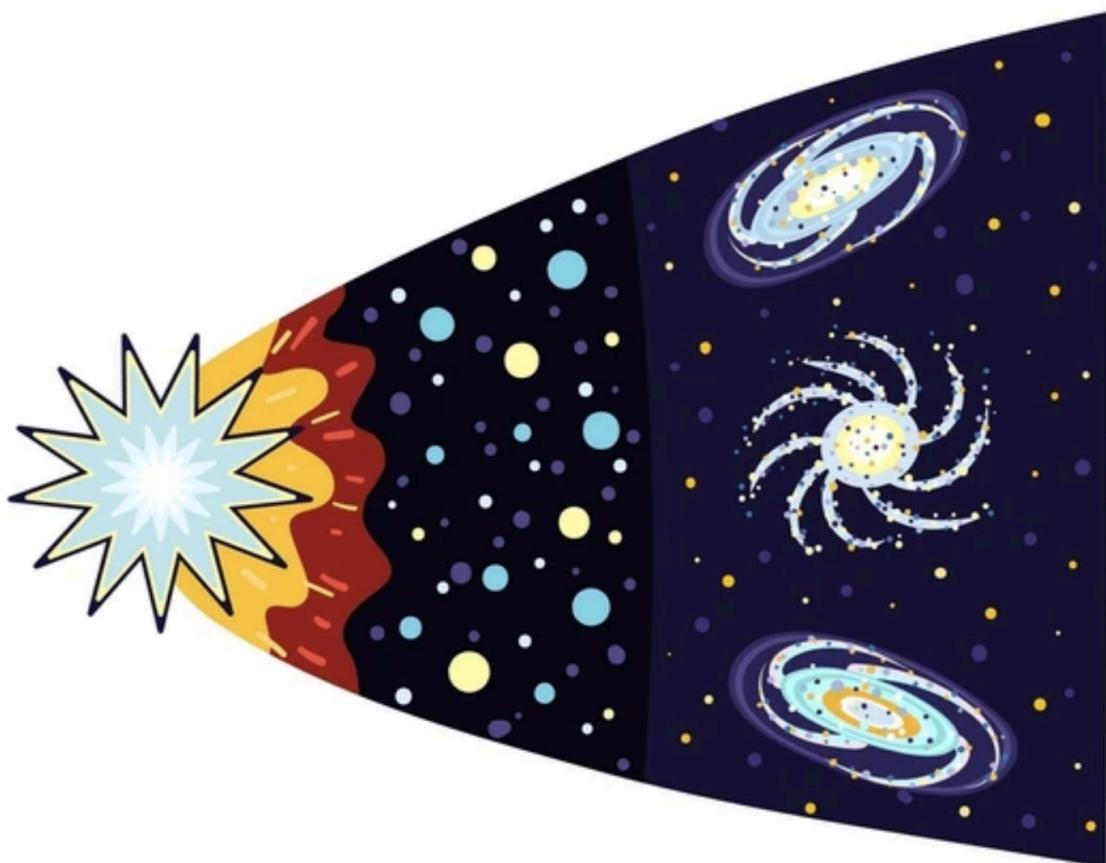
- Distant galaxies



THE BIG BANG THEORY

The universe began around 14 billion years ago from a very small, hot, dense region. The Big Bang caused the universe to expand, and it continues to expand today. Observations of red-shift in distant galaxies show that galaxies are moving away from each other, providing evidence that the universe is expanding.

- Universe began from hot, dense region
- Big Bang caused expansion
- Universe continues to expand
- Galaxies move away from each other
- Light from distant galaxies is red-shifted
- Red-shift shows galaxies are moving away
- Supports expanding universe theory
- Greater distance means greater separation



DARK ENERGY AND DARK MATTER

Observations of galaxies show that there is more matter than visible matter, called dark matter. Observations also show that the universe is expanding at an increasing rate, and dark energy is believed to cause this accelerated expansion.

- Matter exists that cannot be seen
- This unseen matter is called dark matter
- Explains galaxy rotation and motion
- Universe expansion is accelerating
- Dark energy causes expansion
- Dark energy acts against gravity

Examples

- Galaxy motion affected by invisible matter
- Accelerating expansion of universe

