Physics - Key Stage 4

Space

Space - Review lesson WORKSHEET

Mr C White

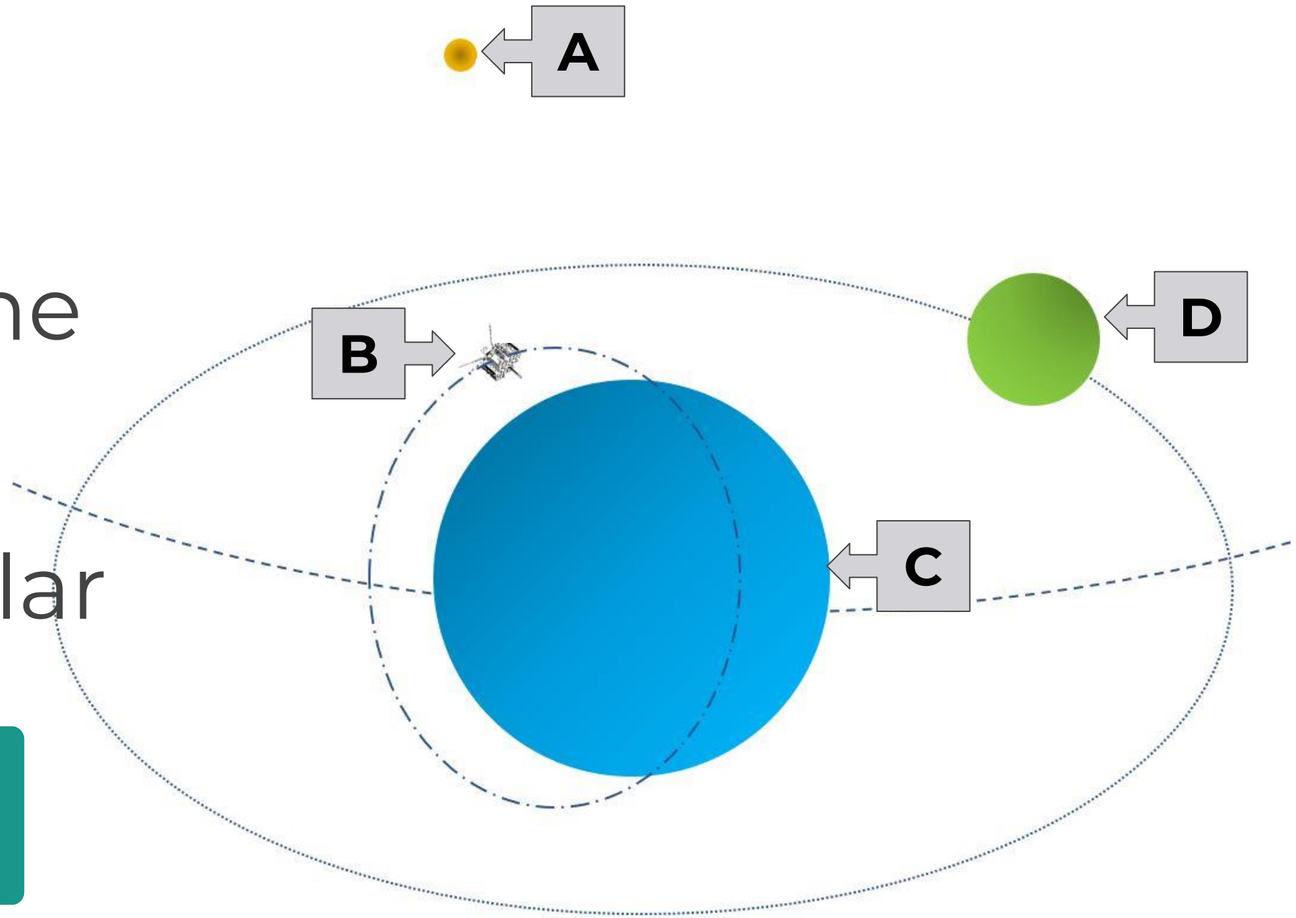
OAK NATIONAL ACADEMY

Match the definitions to the celestial objects.

UNIVERSE	A large cloud of gas and dust
GALAXY	A massive body that gives off light (and other electromagnetic radiation) due to fusion of hydrogen
NEBULA	A body in orbit around a star which has not cleared its orbit and is mostly spherical
SOLAR SYSTEM	All that can be observed in the cosmos; all of space and time.
STAR	A rocky/gaseous body in orbit around a planet
PLANET	A star orbited by planets (like our Sun) and other bodies
DWARF PLANET	A body in orbit around a star which has cleared its orbit and is mostly spherical
MOON (natural satellite)	A group of millions or billions of stars held together by gravitational attraction

Comparing celestial bodies

Pause the video and name the bodies A-D in the diagram of part of our solar system.



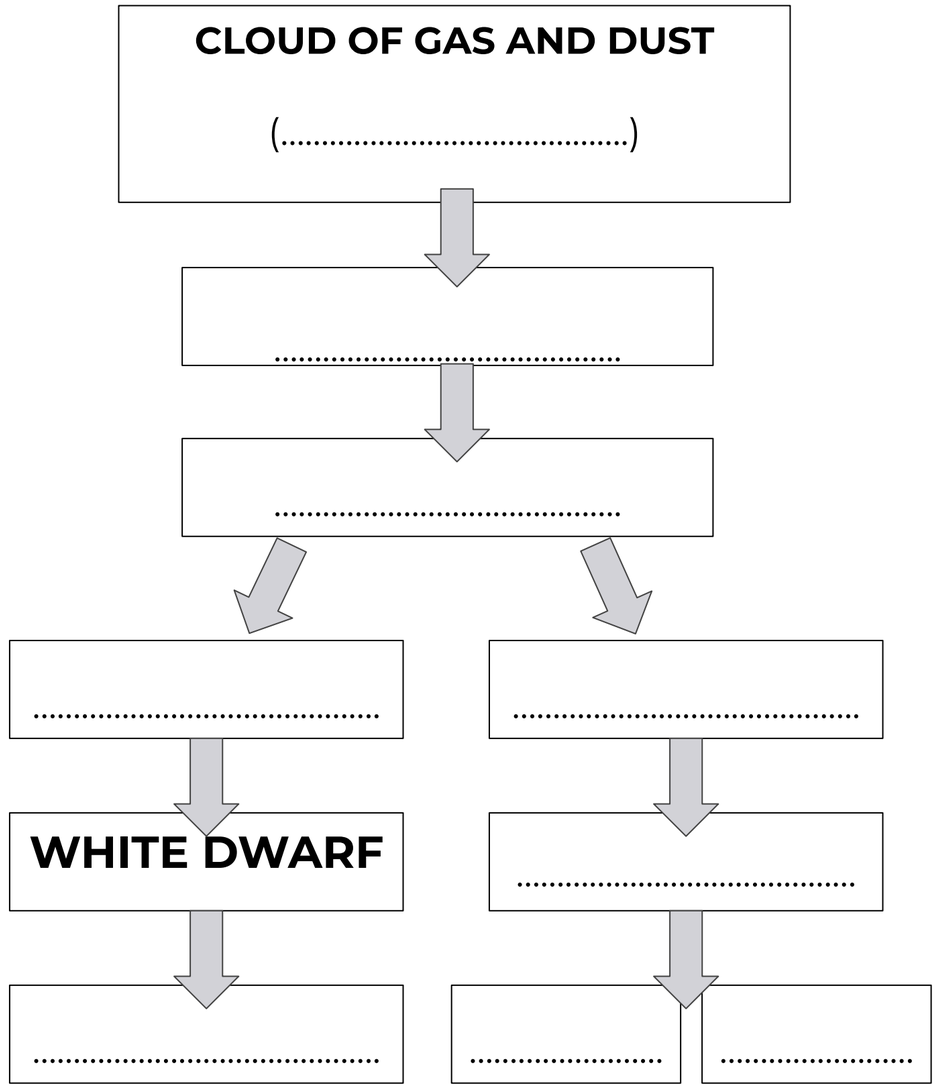
Credit: [CWhite]

Explain the following, with a diagram if necessary.

‘For circular orbits, the force of gravity leads to changing velocity but not a change in speed.’

Independent Task (1)

(1) Copy and complete the summary diagram on the right for the life cycles of stars. Indicate clearly the route taken for (a) stars of similar mass to our Sun (b) stars with a much higher mass than our Sun.



Independent Task (2)

(2) Describe the sequence of the life cycle of stars with the least initial mass.

(3) Put these stages in chronological order for a star with a mass much larger than the Sun. BLACK HOLE / PROTOSTAR / RED SUPERGIANT / MAIN SEQUENCE / SUPERNOVA

Independent Task (3)

(4) Explain how the following elements are synthesised in the life cycle of stars:

(a) helium;

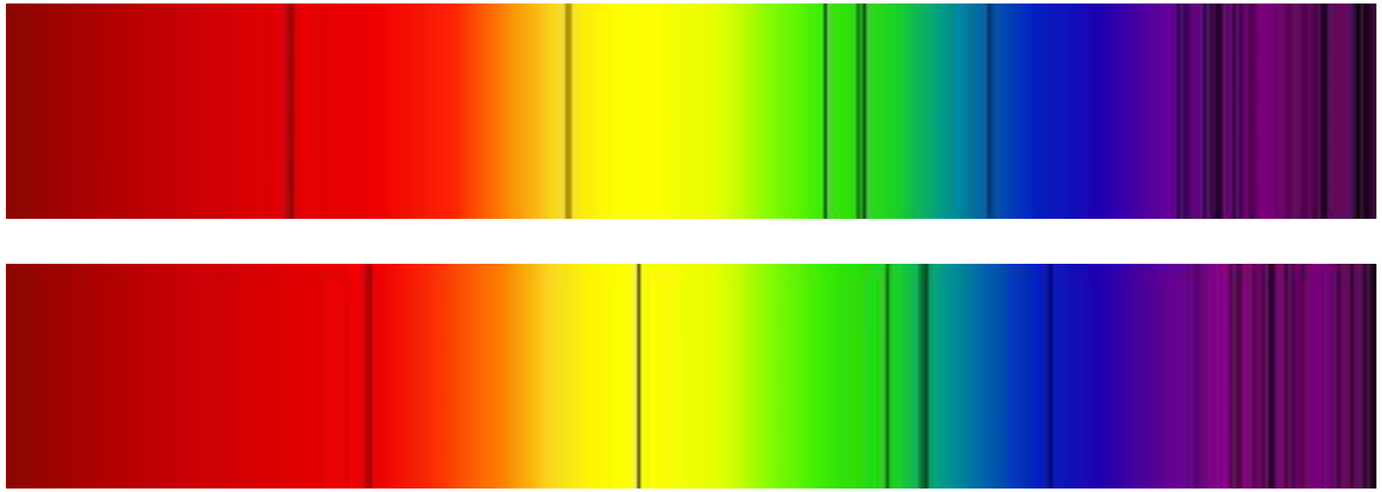
(b) elements up to and including iron;

(c) elements heavier than iron.

(5) Explain how heavy elements such as gold can be found on Earth.

Copy and complete the electromagnetic spectrum diagram below.

Region				**VISIBLE**			
Wavelength (m)	$>10^{0}$	10^{-1}-10^{-3}	10^{-4}-10^{-6}	10^{-7}	10^{-8}	10^{-9}-10^{-11}	$<10^{-12}$
Frequency (Hz)	$<10^{8}$	10^{9}-10^{11}	10^{12}-10^{14}	10^{15}	10^{16}	10^{17}-10^{18}	$>10^{19}$



SPECTRUM FROM DISTANT GALAXY ‘A’

SPECTRUM FROM OUR SUN

State one similarity and one difference between the spectrum from galaxy ‘A’ and our Sun’s spectrum. Explain the similarity and the difference, and the conclusions that could be reached about galaxy ‘A’.

Credits: edited from [Wikimedia Commons] - [Georg Wiora (Dr. Schorsch)] -[red shift]

Independent Task (4)

Answer these questions.

(1) What is meant by the term ‘Big Bang’ when explaining the origin of the universe?

(2) Why does the light from the early universe now have a very long wavelength compared to when it was emitted?

EXAM STYLE QUESTION

(1) Astronomers have collected many line spectra from distant galaxies to formulate a theory of the origin of the universe.

(a) Explain how astronomers use line spectra to deduce that the universe is expanding. (6 marks)

Binary star systems are where two stars are orbiting around each other. The spectra of these stars are collected and studied also.

(b) Describe how line spectra could be used to show the stars were orbiting around each other. (4 marks)

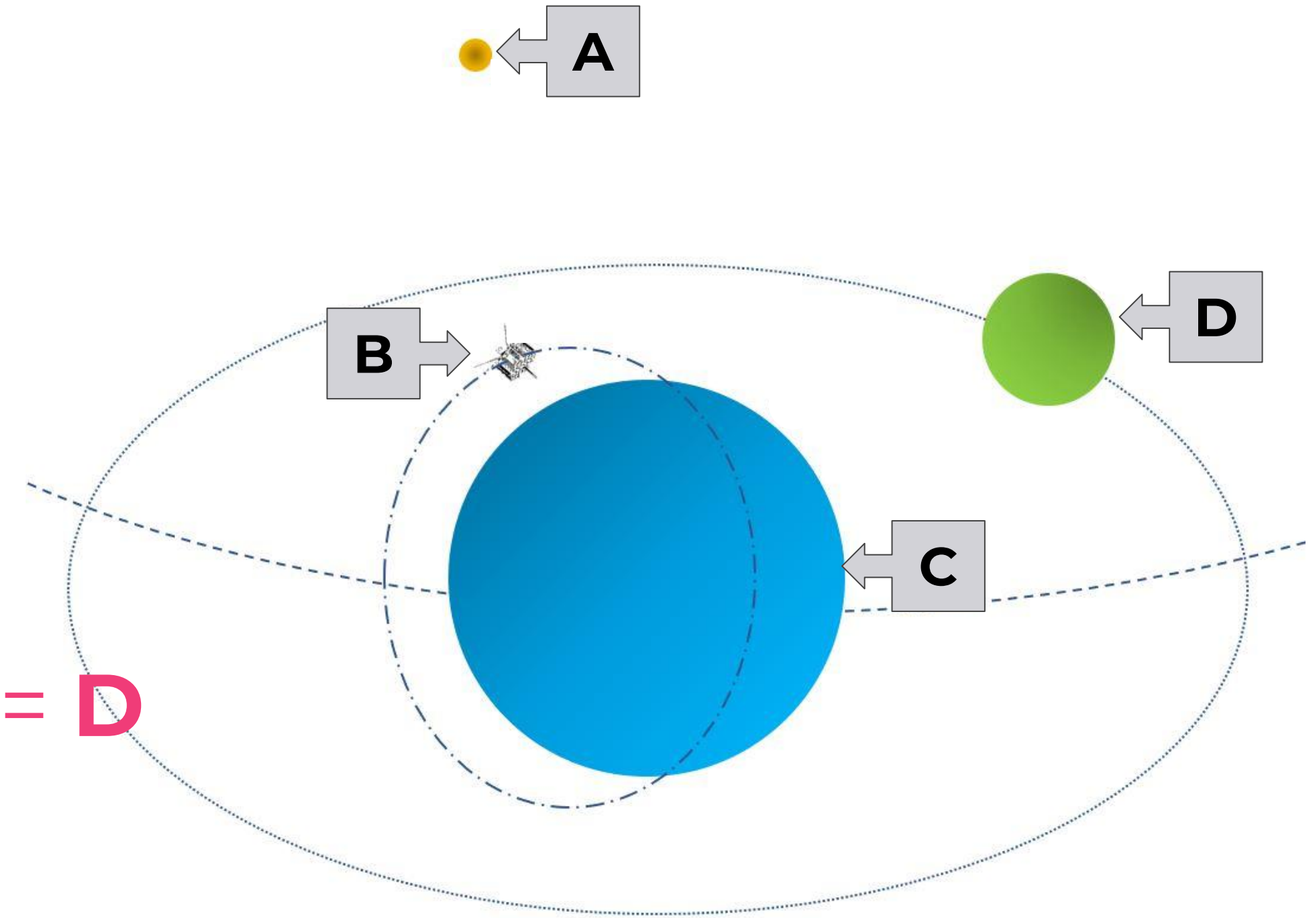
Answers

Matching exercise - SOLUTIONS

UNIVERSE	**All that can be observed in the cosmos; all of space and time**
GALAXY	**A group of millions or billions of stars held together by gravitational attraction**
NEBULA	**A large cloud of gas and dust**
SOLAR SYSTEM	**A star orbited by planets (like our Sun) and other bodies**
STAR	**A massive body that gives off light (and other electromagnetic radiation) due to fusion of hydrogen**
PLANET	**A body in orbit around a star which has cleared its orbit and is mostly spherical**
DWARF PLANET	**A body in orbit around a star which has not cleared its orbit and is mostly spherical**
MOON (natural satellite)	**A rocky body in orbit around a planet**

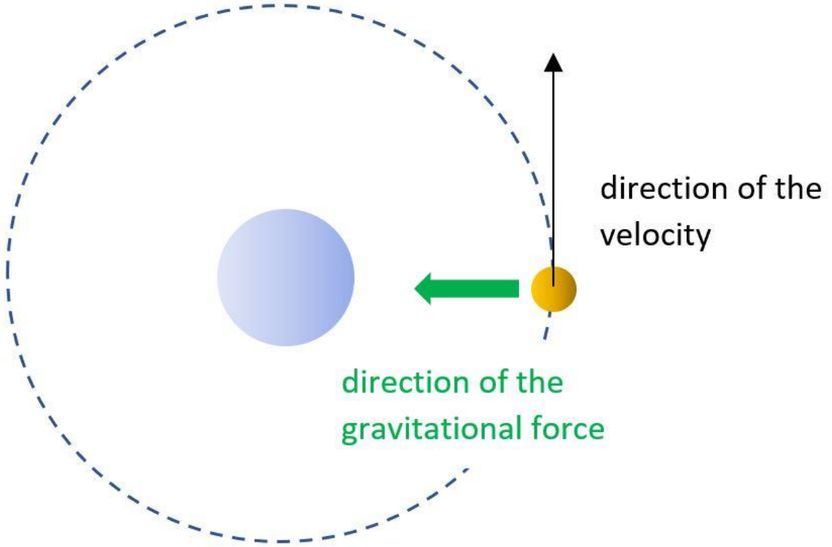
Comparing celestial bodies - SOLUTIONS

- star = **A**
- planet = **C**
- moon (natural satellite) = **D**
- artificial satellite = **B**



Credit: [CWhite]

The resultant force due to gravitational attraction is ALWAYS changing the direction of the orbiting body, i.e. its velocity is changing! The magnitude of the velocity is constant (i.e. the speed) but the direction is changing. When either the velocity's magnitude OR direction (or both) change, the velocity is changing.



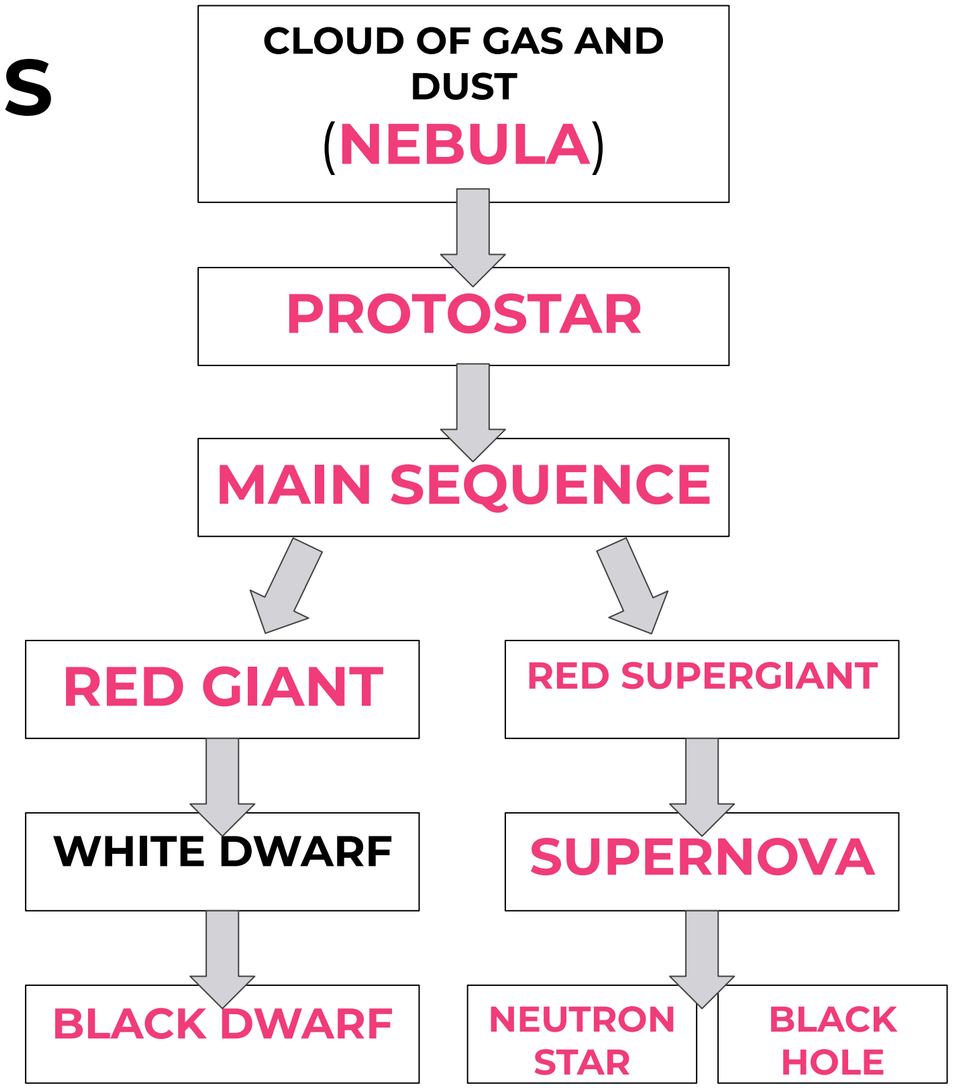
Independent Task (1&2) - SOLUTIONS

(1) See right

(2) Describe the sequence of the life cycle of stars with the greatest initial mass.

Nebula → protostar→ main sequence → red giant → white dwarf → black dwarf

(3) Put these stages in chronological order for a Sun-sized star. **1) PROTOSTAR 2) MAIN SEQUENCE, 3) RED SUPERGIANT, 4) SUPERNOVA, 5) BLACK HOLE**



Independent Task (3) - SOLUTIONS

(4) Explain how the following elements are synthesised in the life cycle of stars:

(a) helium **by fusion in main sequence stars**

(b) elements up to and including iron **by fusion in red giant/supergiant stars**

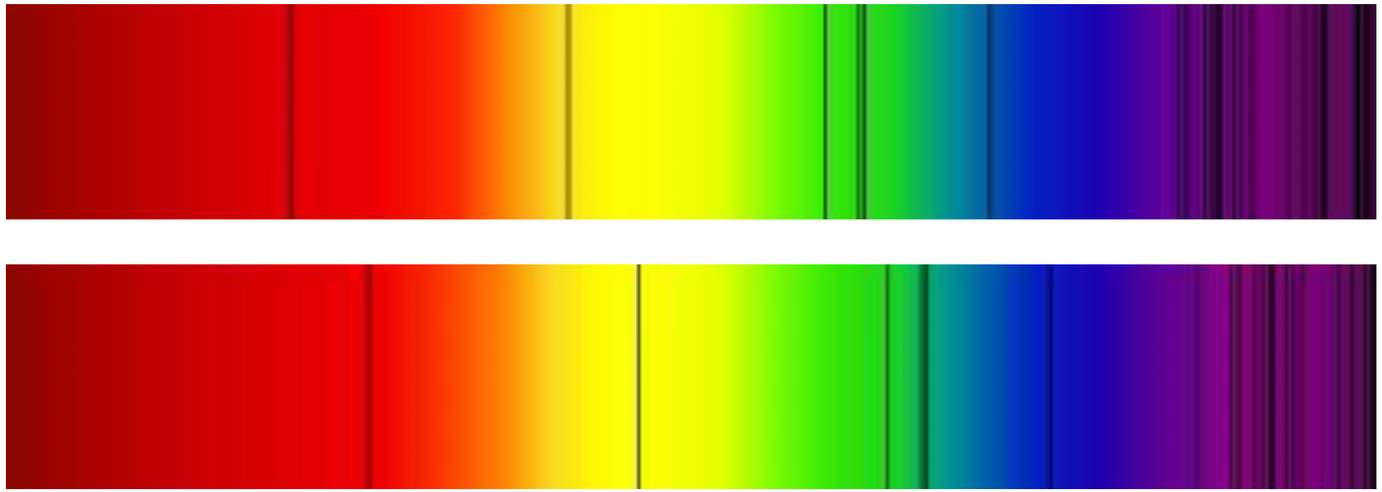
(c) elements heavier than iron **by fusion in supernova explosions/other highly energetic events such as neutron star mergers**

(5) Explain how heavy elements such as gold can be found on Earth.

Supernova explosions fuse nuclei together to form heavy elements/ explosion distributes elements throughout cosmos / some ended up in out local planetary nebula when the Sun/ planets were formed

SOLUTIONS - electromagnetic spectrum

Region	RADIO	MICRO WAVE	INFRA-RED	VISIBLE	ULTRA-VIOLET	X-RAY	GAMMA
Wavelength (m)	$>10^{0}$	10^{-1}-10^{-3}	10^{-4}-10^{-6}	10^{-7}	10^{-8}	10^{-9}-10^{-11}	$<10^{-12}$
Frequency (Hz)	$<10^{8}$	10^{9}-10^{11}	10^{12}-10^{14}	10^{15}	10^{16}	10^{17}-10^{18}	$>10^{19}$



SPECTRUM FROM DISTANT GALAXY ‘A’

SPECTRUM FROM OUR SUN

State one similarity and one difference between the spectrum from galaxy ‘A’ and our Sun’s spectrum. **The spectrum from galaxy A has the same pattern of (absorption) lines but they are redshifted/shifted to a longer wavelength.** Explain the similarity **the galaxy and the Sun contain similar elements** and explain the difference **the galaxy is moving with respect to the Earth, whereas the Sun is not**, and the conclusions that could be reached about galaxy ‘A’. **Galaxy A is receding (moving away) from Earth, and the amount of shift can be used to calculate its speed of recession.**

Credits: edited from [Wikimedia Commons] - [Georg Wiora (Dr. Schorsch)] -[red shift]

Independent Task (4) SOLUTIONS

(1) What is meant by the term ‘Big Bang’ when explaining the origin of the universe? **Universe started as small, hot and dense and has been expanding since**

(2) Why does the light from the early universe now have a very long wavelength compared to when it was emitted? **It has been red shifted as space has expanded**

EXAM STYLE QUESTION - SOLUTION (1)

(1) Astronomers have collected many line spectra from distant galaxies to formulate a theory of the origin of the universe.

(a) Explain how astronomers use line spectra to deduce that the universe is expanding. (6 marks)

Compare line spectra to Earth bound spectra (1)
Measure shift of line spectra (1)
Spectra show redshift/increase in wavelength/decrease in frequency (1)
Galaxies are therefore receding/moving away (1)
More distant galaxies show greater redshift (1)
More distant galaxies have a greater recessional velocity/moving faster (1)

EXAM STYLE QUESTION - SOLUTION (2)

Binary star systems are where two stars are orbiting around each other. The spectra of these stars are collected and studied also.

(b) Describe how line spectra could be used to show the stars were orbiting around each other.

Measure shift of spectra (1)

Compare to stationary/reference spectra (1)

One star will show redshift as it recedes (1)

One star will show blueshift as it approaches (1)