GCSE

3445U20-1A

S25-3445U20-1A

APPLIED SCIENCE (Double Award)

UNIT 2: Space, Health and Life

Pre-Release Article for use in the following examinations on MONDAY, 9 JUNE 2025 – MORNING:

GCSE Applied Science (D/A) Unit 2 Foundation Tier (3445U20-1)

GCSE Applied Science (D/A) Unit 2 Higher Tier (3445UB0-1)

To be opened on 6 MAY 2025.

A new copy of this Article will be given out in the examination.

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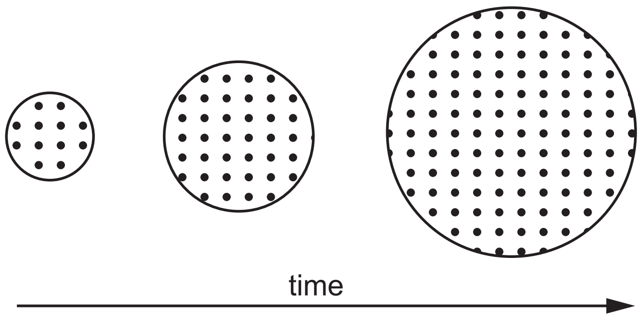
Our place in the Universe

How the Universe has changed over time

One theory about how the Universe has changed over time is called the Steady State Theory.
It describes the Universe as always expanding, but matter is continuously being created to form new stars and galaxies. The mean density remains the same.
A Steady State Universe has no beginning or end. It always looks the same from any point.
A Steady State Universe is represented in **Figure 1**.

Figure 1: Steady State Universe



Today, the Big Bang is a widely accepted theory of how the Universe was created and changed over time. It is the idea that the Universe began as a single point, then expanded to grow as large as it is now, and it continues to expand. Over time, galaxies have spread further apart, and no new matter is created to occupy the gaps between them.

Units for measurements

The scale of the Universe, galaxies and solar systems can be compared in terms of measuring distances using different units. The table in **Figure 2** shows conversions from light years (ly) to kilometres (km) and astronomical units (AU).

Figure 2: Conversion of units

Distance		
light year (ly)	kilometre (km)	astronomical unit (AU)
0.0001	946 000 000	6.32
0.001	9 460 000 000	63.2
0.01	94 600 000 000	632
0.1	946 000 000 000	6320
1	9 460 000 000 000	63 200
2	18 900 000 000 000	126 000
3	28 400 000 000 000	190 000
4	37 800 000 000 000	253 000
5	47 300 000 000 000	316 000

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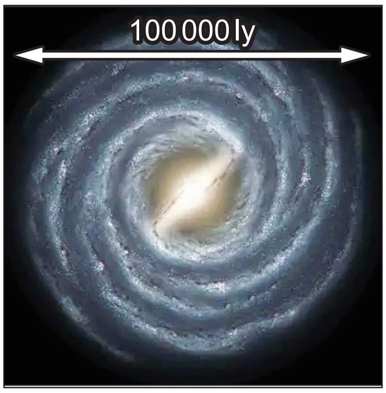
The distance between Earth and the Sun is 1 AU.

The diameter of our Solar System is 0.00127 ly.

The next nearest star to Earth is Proxima Centauri which is 4.24 ly away.

The Milky Way galaxy, shown in **Figure 3**, is approximately 100 000 ly in diameter.

Figure 3: The Milky Way



The Andromeda galaxy is the closest large spiral galaxy to the Milky Way. It is the brightest external galaxy visible in our night sky. It is the most distant thing humans can see with the unaided eye and is 2 500 000 ly away.

The diameter of the observable Universe is about 93 000 000 000 ly.

Models of the Solar System

The model of our Solar System has changed over time. **Figure 4** shows a model proposed by Aristotle over 2300 years ago. **Figures 5**, **6**, **7** and **8** give information about the up-to-date model.

Figure 4: Aristotle's model of our Solar System

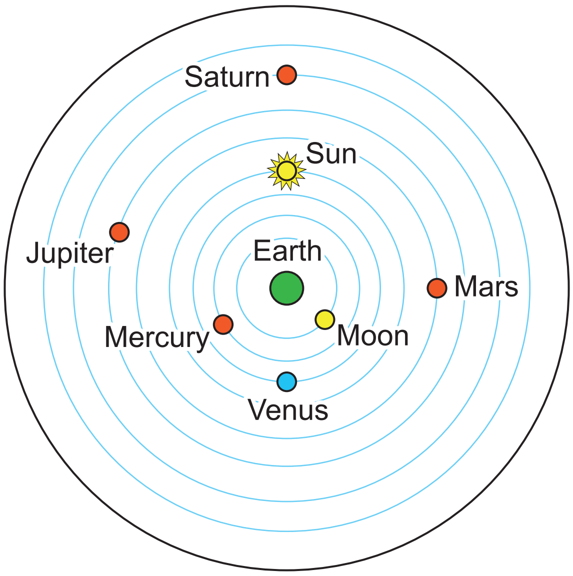
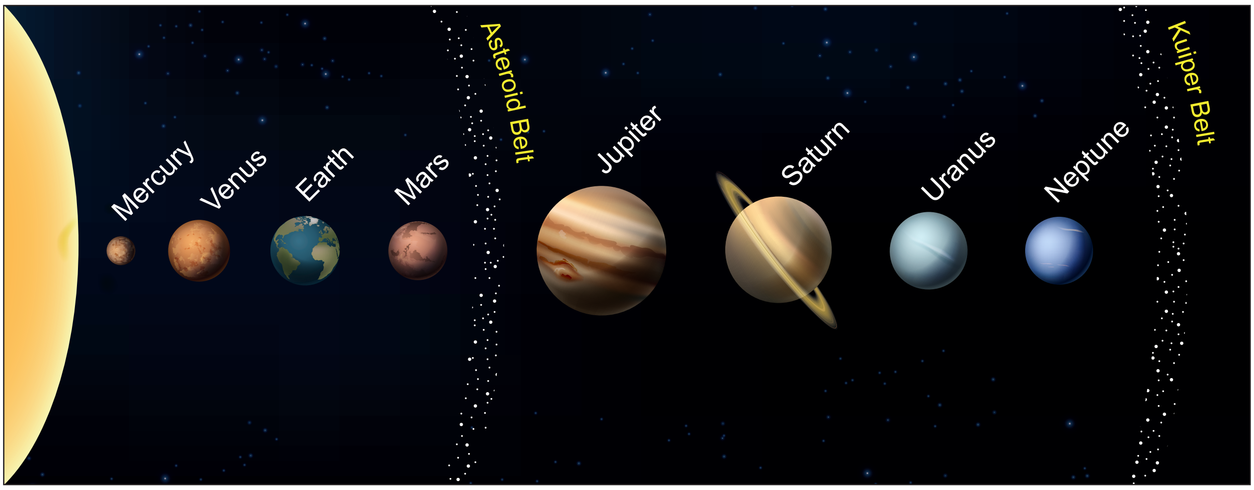


Figure 5: Modern model of the Solar System



The Oort Cloud (not shown in **Figure 5**) lies far beyond the Kuiper Belt. The Kuiper Belt is between 30 and 50 AU from the Sun. The planets of our Solar System orbit in a flat plane but the Oort Cloud is like a bubble around our Solar System, made of icy, comet-like objects. The inner edge of the Oort Cloud is between 2000 and 5000 AU from the Sun, and the outer edge is between 10 000 and 100 000 AU from the Sun.

Properties of objects found within our Solar System are shown in **Figures 6**, **7** and **8**.

Figure 6: Properties of planets

Planet	Mean distance from Sun (AU)	Radius (Earth radii)	Mass (Earth masses)	Time to spin on axis (Earth days)	Time to orbit Sun (Earth years)	Mean temperature (°C)	Main gases in the atmosphere	Number of known satellites	Mean density (g/cm^3)
Mercury	0.4	0.38	0.055	59	0.24	427	none	0	5.4
Venus	0.7	0.95	0.82	243	0.6	480	carbon dioxide, nitrogen	0	5.2
Earth	1	1	1	1	1	14	nitrogen, oxygen	1	5.5
Mars	1.5	0.53	0.11	1	2	–63	carbon dioxide, argon	2	3.9
Jupiter	5.2	11.2	318	0.41	12	–130	hydrogen, helium	61	1.3
Saturn	9.5	9.5	95	0.44	29	–130	hydrogen, helium	31	0.7
Uranus	19.2	4.0	15	0.72	84	–200	hydrogen, helium, methane	27	1.3
Neptune	30	3.9	17	0.67	165	–200	hydrogen, helium, methane	12	1.6

Figure 7: Properties of dwarf planets

Dwarf planet	Mean distance from the Sun (AU)	Time to orbit the Sun (Earth years)	Orbital speed (km/s)	Number of known satellites	Diameter (km)	Time to spin on axis (h)
Ceres	2.8	4.6	18	0	952	9.1
Pluto	39	250	4.7	5	2300	150
Haumea	43	290	4.5	2	1440	3.9
Makemake	46	310	4.4	0	1420	23
Eris	68	560	3.4	1	2330	26

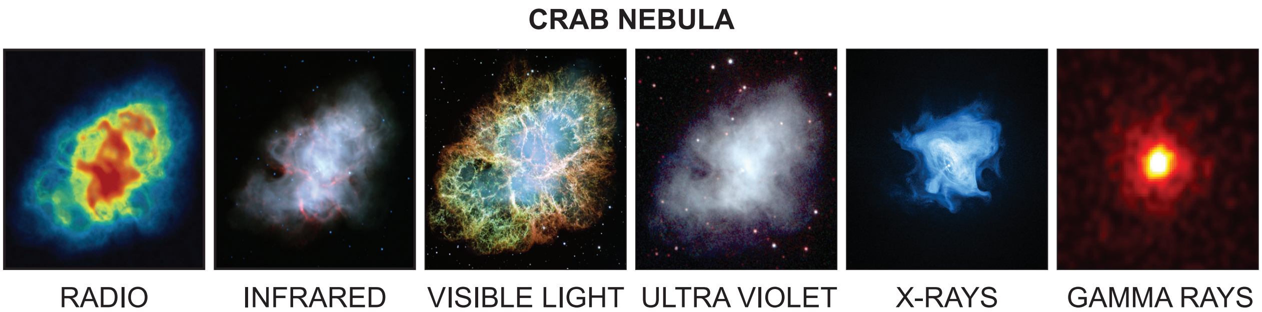
Figure 8: Properties of some natural satellites

Satellite	Parent planet	Diameter (km)	Mass (units)	Density (g/cm^3)	Atmosphere
Moon	Earth	3476	7.35	3.3	no
Io	Jupiter	3642	8.93	3.5	no
Europa	Jupiter	3130	4.80	3.0	no
Ganymede	Jupiter	5268	14.8	1.9	no
Callisto	Jupiter	4806	10.8	1.9	no
Titan	Saturn	5150	13.4	1.9	yes
Triton	Neptune	2706	2.15	2.1	no

Images of the Universe

The Crab Nebula is the remains of a star's supernova explosion. It has been expanding ever since, and is now about 11 ly in width. It is 6523 ly away from Earth. Images of the nebula have been taken using different regions of the electromagnetic (em) spectrum. Some of these are shown in **Figure 9**.

Figure 9: Images of the Crab Nebula



All waves in each region of the em spectrum travel at a speed of 300 000 000 m/s through space. Each of these regions has a different range of frequencies and wavelengths.

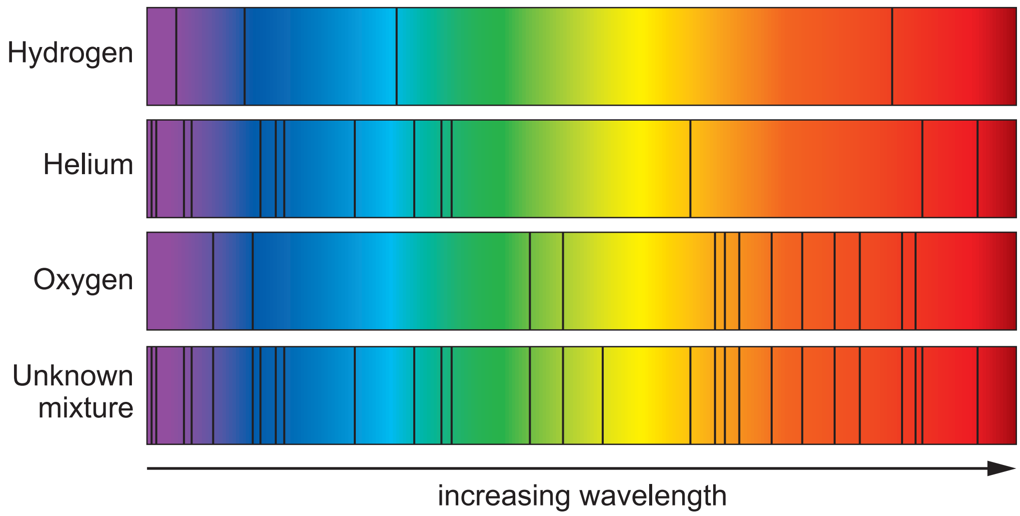
The frequency and wavelength are linked by the following equation:

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

Visible light can be used to produce absorption spectra of stars, which can be compared with absorption spectra of individual elements to identify the composition of a star's atmosphere.

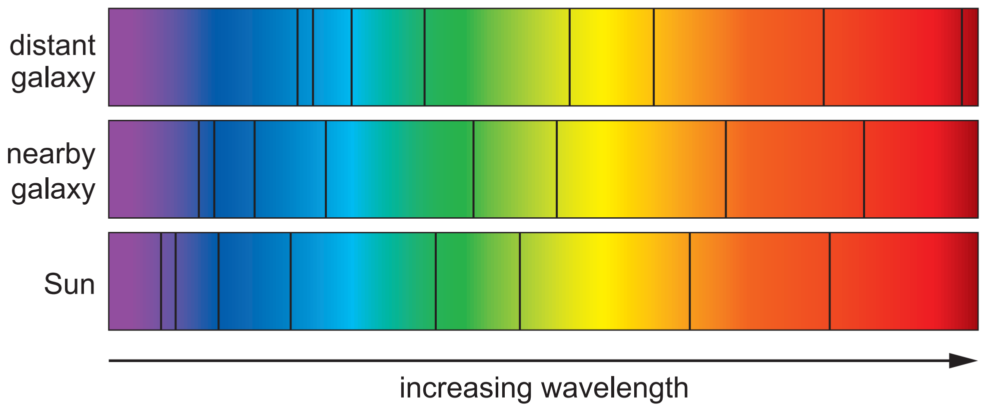
Figure 10 shows the absorption spectra of some elements and an unknown gas mixture on Earth. By making comparisons, the gases present in the mixture can be identified.

Figure 10: Absorption spectra of elements and unknown mixture (on Earth)



Spectra can also give information about the relative motion of stars and galaxies. **Figure 11** shows the absorption spectra from various objects in space. The spectra can be used to compare the distance of each object from Earth and the speeds that they are moving away.

Figure 11: Absorption spectra from space



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