

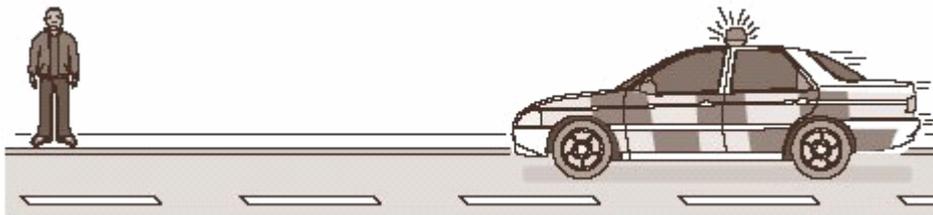
Doppler effect and red shift

1. This question is about what scientists know about the universe.
Match words, **A**, **B**, **C** and **D**, with the statements **1–4** in the table.

- A** a false statement
B an observation
C a belief which science cannot prove
D a theory

Statement about the universe	
God created the universe.	1
Red-shift, which suggests that galaxies are moving apart.	2
The universe was created by a 'big bang'.	3
You can see the universe expanding by looking through a telescope.	4

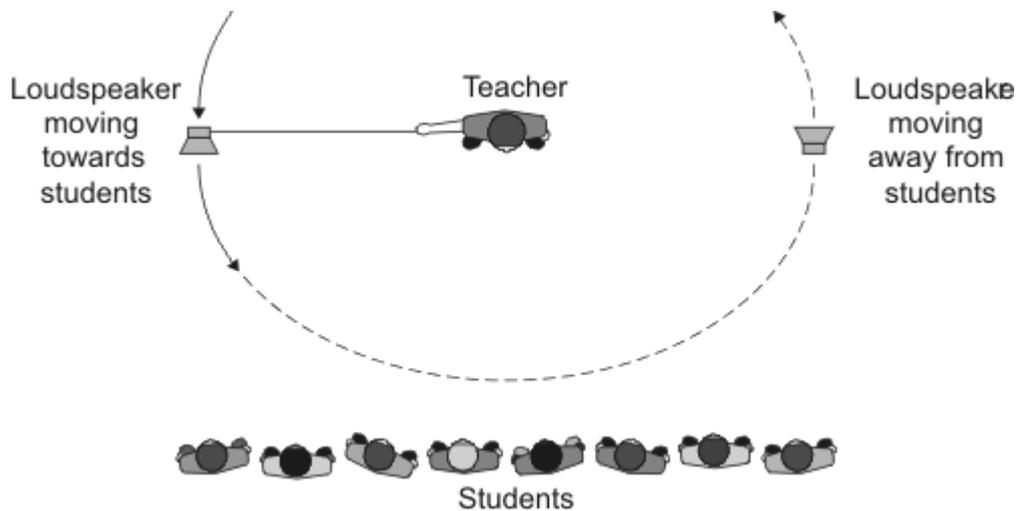
2. The diagram shows a police car moving towards a person who is standing at the side of the road.
The siren on the police car is sounding.



- (a) As the police car approaches, the person notices that the frequency of the note changes.
The frequency becomes . . .
- 1 lower because the wavelength increases.
 - 2 lower because the wavelength decreases.
 - 3 higher because the wavelength increases.
 - 4 higher because the wavelength decreases.
- (b) A driver in another car on the same road did not notice any change in the frequency of the note emitted by the siren.
This was because the cars were travelling in . . .
- 1 the same direction at the same speed.
 - 2 opposite directions at the same speed.
 - 3 the same direction at different speeds.
 - 4 opposite directions at different speeds.

A teacher wanted to demonstrate this effect in her laboratory.

She connected a loudspeaker to a signal generator. The loudspeaker produced a note of constant frequency. The teacher then swung the loudspeaker above her head, as shown in the diagram. The students in the class listened to the sound produced by the loudspeaker.



- (c) What sound will the students hear as the loudspeaker goes round and round?
- 1 a note of constant frequency
 - 2 a note of higher frequency
 - 3 a note of lower frequency
 - 4 a note of varying frequency
- (d) This demonstration is a model for spinning galaxies.
What is the purpose of a model in science?
- 1 It helps to explain a phenomenon.
 - 2 It proves that a theory is correct.
 - 3 It allows more data to be collected.
 - 4 It is to generate new ideas.

3. In 1927, the Belgian priest Georges Lemaitre proposed that the universe began with an explosion. His proposal came after astronomers had observed red-shift in light from distant galaxies.

(a) Red-shift is . . .

- 1 a decrease in wavelength of the light due to a galaxy moving away from the Earth.
- 2 an increase in wavelength of the light due to a galaxy moving away from the Earth.
- 3 a decrease in wavelength of the light due to a galaxy moving towards the Earth.
- 4 an increase in the wavelength of the light due to a galaxy moving towards the Earth.

(b) In 1929, Edwin Hubble found experimental evidence that distant galaxies are moving away from us with speeds that are proportional to their distance from the Earth.

This suggests that . . .

- 1 the universe is contracting.
- 2 the universe started from a small initial point.
- 3 the universe has always been the same.
- 4 the galaxies are getting slower.

(c) Later, in 1948, it was suggested that if the universe started with an explosion there should still be cosmic (microwave) background radiation in space left over from the explosion. This microwave radiation was discovered in 1964.

Its discovery . . .

- 1 proves that the universe started with a 'big bang'.
- 2 proves that the universe is expanding.
- 3 provides strong evidence that the universe started with a 'big bang'.
- 4 finally disproves all other theories of the origin of the universe.

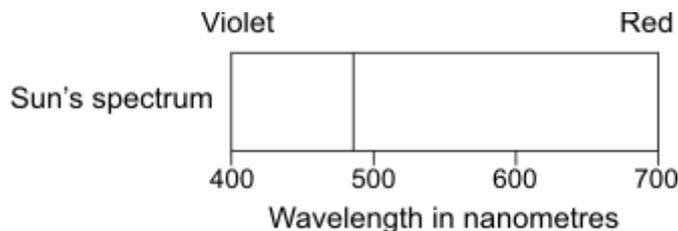
(d) According to the latest theory, the universe was created 13.7 billion years ago.

This figure . . .

- 1 is both accurate and precise.
- 2 is a guess.
- 3 is an estimate based on reliable data.
- 4 is an estimate based on unreliable data.

4 Dark lines on the spectra of light from galaxies represent chemical elements. The lines occur at specific wavelengths.

The line shown on the Sun's spectrum represents hydrogen. **K**, **L**, **M** and **N** are spectra of light from distant galaxies showing the same line.



(a) Which galaxy is furthest from the Sun?

- 1 K
- 2 L
- 3 M
- 4 N



(b) Which galaxy is moving towards the Sun?

- 1 K
- 2 L
- 3 M
- 4 N

(c) Observation and analysis of red-shift suggests that . . .

- 1 the universe began from a very small initial point and has been expanding ever since.
- 2 the universe contracted initially and then began to expand.
- 3 the universe expanded initially and then began to contract.
- 4 the universe has always existed as it is now.

(d) What causes red-shift?

- 1 a decrease in the frequency of light due to the galaxies moving closer to the Earth
- 2 a decrease in the frequency of light due to the galaxies moving away from the Earth
- 3 an increase in the frequency of light due to the galaxies moving closer to the Earth
- 4 an increase in the frequency of light due to the galaxies moving away from the Earth