WJEC Physics GCSE
Topic 2.6: The universe
Questions by topic

1.

The diagram shows gas atoms in the cooler, outer atmosphere of a star in a galaxy that is 20 million light years away.

(a) Write down the time taken for light to get to us from the star. [1]

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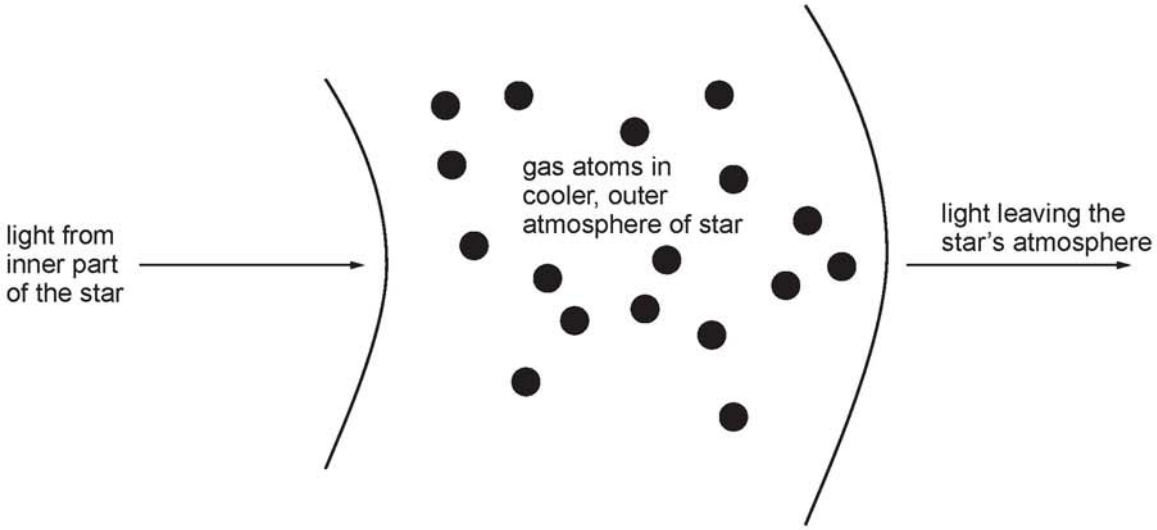
(b) The diagram shows light from the inner part of the star passing through its outer atmosphere. Some of the wavelengths are absorbed.



The diagrams below show three spectra.

Diagram A

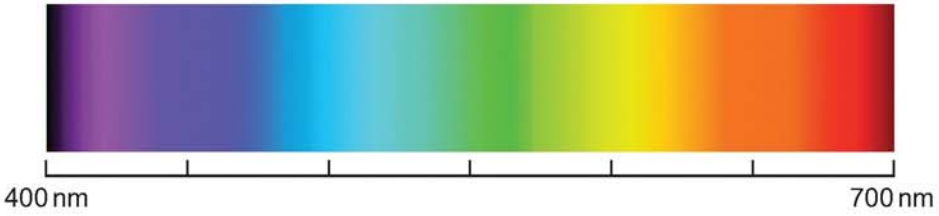


Diagram B

Diagram C

Put a tick (✓) in the correct column below to show which is the correct diagram for each statement. [2]

	Diagram A	Diagram B	Diagram C
Light leaving the star's atmosphere			
Light from inner part of the star			

(c) The spectrum below is from another star in the same galaxy.

Explain how the lines show that the stars are different. [2]

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(d) Lines in spectra from distant galaxies are shifted towards the red end of the spectrum.

(i) State what has happened to the **wavelengths** of those lines. [1]

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(ii) The lines in spectra from some other galaxies are further red shifted.
State what this tells us about those galaxies. [1]

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(e) Cosmological red shift supports the Big Bang theory. Name one other piece of evidence that supports this theory. [1]

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2.

The following diagrams show absorption spectra of hydrogen in a laboratory **(diagram A)**, from a distant galaxy X **(diagram B)** and from another distant galaxy Y **(diagram C)**.

Diagram A: Laboratory spectrum of hydrogen

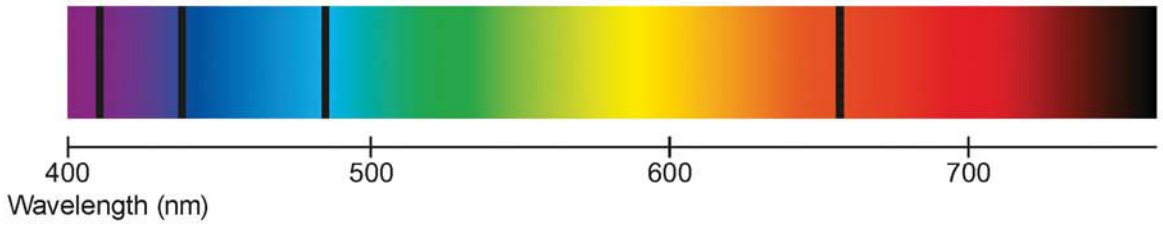


Diagram B: From galaxy X

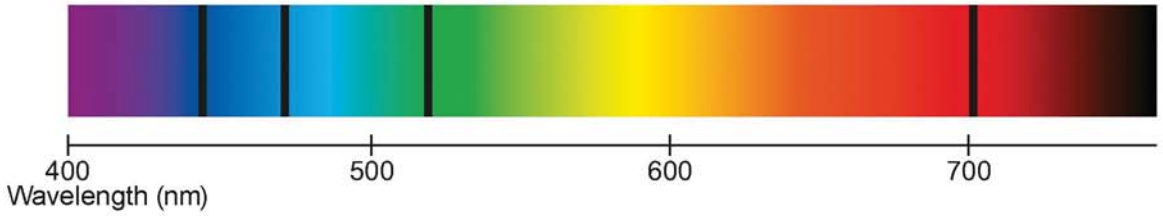
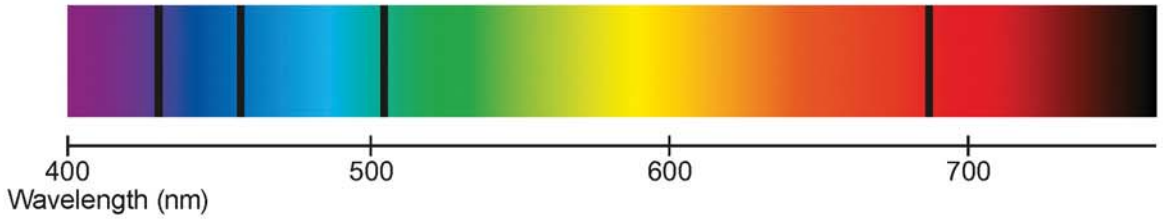


Diagram C: From galaxy Y



(a) (i) Compare the spectra in diagrams B and C with diagram A. [2]

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(ii) Explain what this tells us about galaxies X and Y. [2]

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(b) Cosmic Microwave Background radiation (CMBR) provides evidence for a theory of the origin of the Universe.

(i) Name the theory that CMBR supports. [1]

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(ii) Explain how CMBR fits in with this theory. [2]

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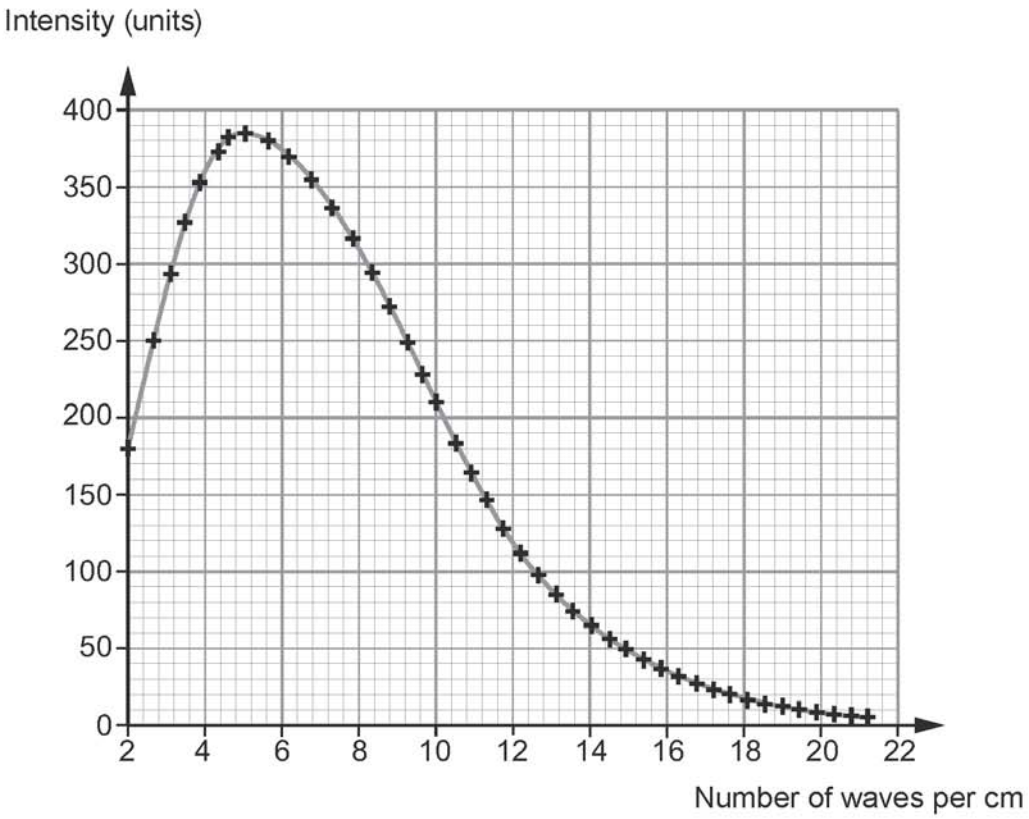
(iii) The variation of intensity of CMBR is shown in the graph below.



Use the graph to answer the following questions.

(I) Calculate the wavelength if the number of waves per cm is 2. [1]

wavelength = ... cm

(II) State what happens to the wavelength as the number of waves per cm increases. [1]

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(III) State the intensity of a wave that has a wavelength of 1 mm. [1]

intensity = ... units

3.

The first diagram below shows the spectrum of white light after it is passed through hydrogen in the laboratory.

The second spectrum comes from a galaxy that is 4×10^9 light years away.

(i) State the time taken for light to travel from the galaxy to us. [1]

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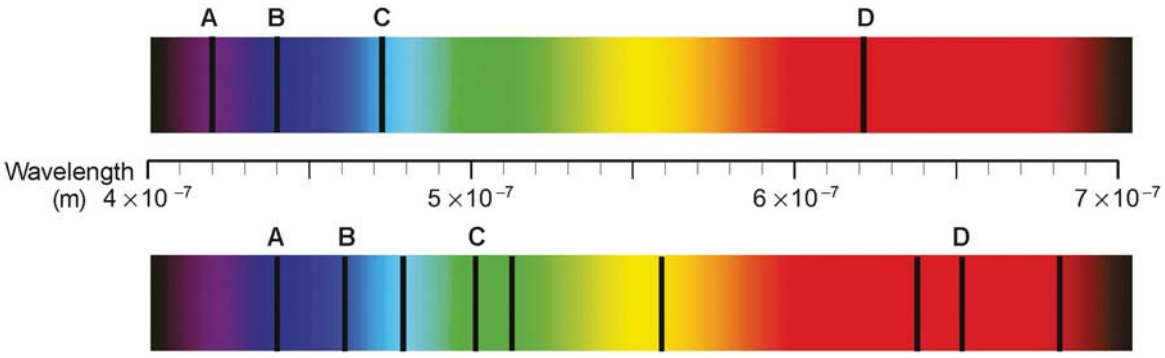

(ii) Calculate the change in wavelength of the line **A** between the laboratory spectrum and the galaxy's spectrum. [1]

wavelength change = ... m

(iii) Explain what information can be obtained about the galaxy by comparing the spectra opposite.
(Do not include in your answer the development of theories of the Universe.) [6 QWC]

4.

Discuss the evidence for the Big Bang theory.
Include in your answer reference to the following:

- cosmological red shift of spectra from distant stars and galaxies;
- Cosmic Microwave Background Radiation (CMBR). [6 QWC]

6

5.

The Big Bang theory of the origin of the Universe was built up based on some of the following facts.

Tick (✓) only **two** boxes alongside the facts that helped to set up this theory. [2]

Light from distant galaxies is red shifted.	☐
Our Sun is one of billions of stars in the Milky Way galaxy.	☐
Scientists have discovered that stars are made from gases.	☐
Scientists have detected Cosmic Microwave Background Radiation (CMBR).	☐
There are billions of galaxies in the Universe.	☐

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6.

Explain what is meant by the term 'cosmological red shift' **and** how it provides evidence for the origin of the Universe. [6 QWC]

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7.

State what is meant by absorption spectra **and** explain how they can provide information about stars and galaxies. [6 QWC]

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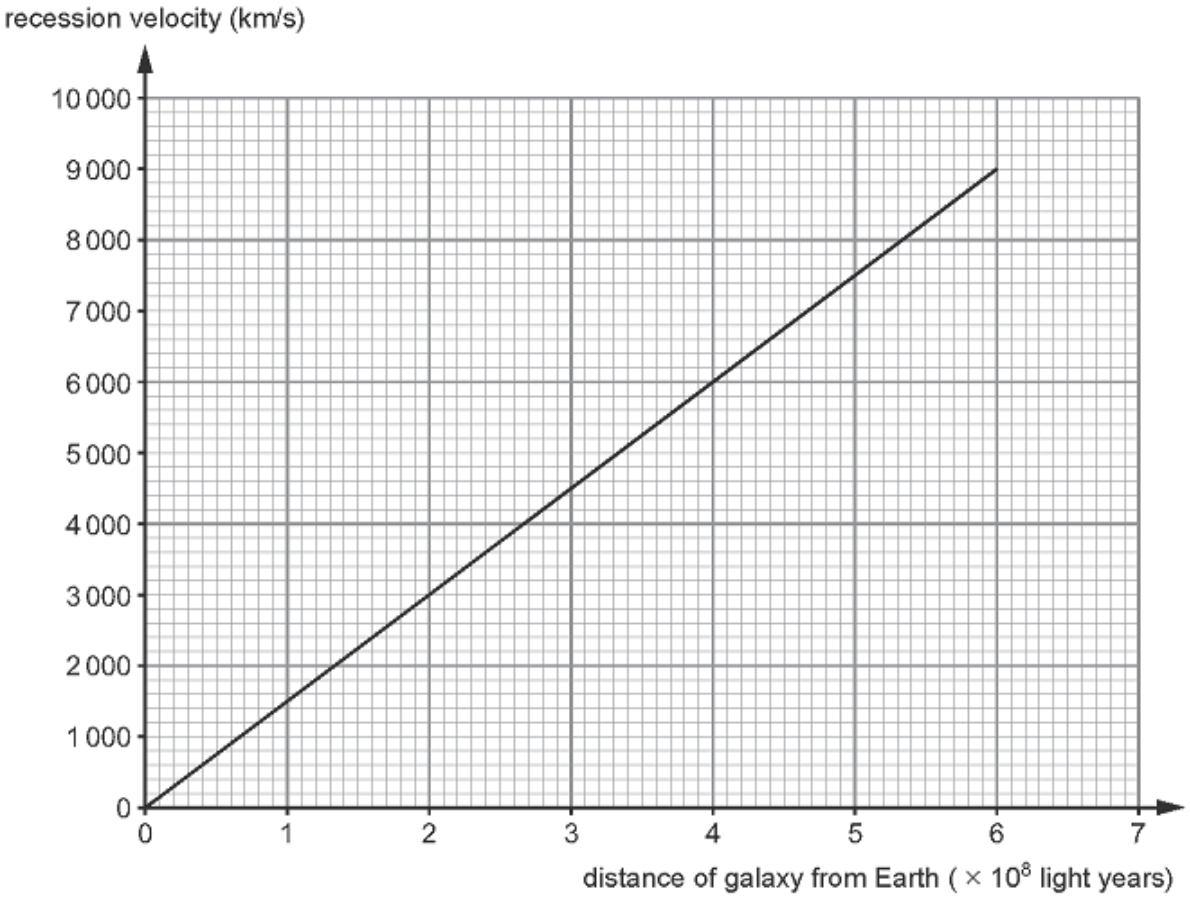
8.

The graph below shows how the velocity of galaxies moving away from the Earth (called their recession velocity) depends on their distance away from us (in light years).



Sir Edwin Hubble put forward this theory.
"*The recession velocity of a galaxy is directly proportional to its distance from Earth.*"

(a) (i) State how the graph supports Hubble's theory. [2]

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(ii) The gradient (steepness) of the graph is called the "Hubble constant".

Its value is given by: Hubble constant = $\frac{1}{\text{age of the Universe}}$

Explain how the gradient of this line will change in the future. [2]

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(b) The speed of recession of a distant galaxy is measured as 6000 km/s.
Use the graph to calculate the distance of this galaxy from Earth. Give your answer in km. (A light year is equivalent to 9.5×10^{12} km.) [2]

distance = ... km

(c) The wavelength of a particular absorption line from the distant galaxy is measured as 669.4 nm. It is found to have been red shifted by 13.1 nm. Calculate the expected frequency of the same absorption line if measured in a laboratory experiment on Earth.
You should use an equation from page 2 to obtain your answer.
(Speed of light in vacuum, $c = 3 \times 10^8$ m/s.) [5]

frequency = ... Hz

(d) (i) Explain how Cosmic Microwave Background Radiation (CMBR) provides evidence that supports the Big Bang Theory. [2]

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(ii) Space has a temperature of about –270 °C (3 K) and is filled with CMBR energy. Explain why the temperature of space will decrease as the Universe continues to expand. [Note that the energy of a wave is directly proportional to its frequency.] [2]

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9.

The Andromeda Galaxy is 2.22×10^6 light years away from Earth. Part of its spectrum is shown below.

(i) How long does light from Andromeda take to reach Earth? [1]

time = ...

(ii) Explain how the dark lines crossing the spectrum are produced. [3]

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(iii) Fred Hoyle proposed the Steady-State theory of the Universe in 1948. This suggested that the Universe has always looked the same over time. Explain why red shift measurements **and** the discovery of Cosmic Microwave Background Radiation (CMBR) did not support this theory. [3]

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