3.25 Red-shift and the Expanding Universe: Test Pack

AQA 8463 · Calculator allowed · about 20 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The pitch of an ambulance siren appears to change as the ambulance passes a stationary observer.

(a) State what happens to the observed pitch (frequency) of the siren as the ambulance approaches the observer, and as it moves away. **(2)**

(b) State the general name for this effect, in which the observed frequency of a wave changes due to relative motion between a source and an observer. **(1)**

(Total for Question 1 is 3 marks)

2 The Big Bang theory describes both the origin and the ongoing evolution of the universe.

(a) Describe what the Big Bang theory says about the initial state of the universe. **(2)**

(b) Describe what has happened to the universe since this initial state, according to the theory. **(2)**

(Total for Question 2 is 4 marks)

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3 Astronomers can identify the elements present in a distant galaxy by analysing the pattern of dark lines in its light spectrum (absorption spectrum lines), because each element produces its own characteristic set of lines at specific wavelengths. Explain how astronomers can use these characteristic spectral lines to identify red-shift in the light from a distant galaxy.

(Total for Question 3 is 3 marks)

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4 A student summarises the key stages of evidence and theory as follows: 'Red-shift shows galaxies are moving apart. This means the universe must be expanding. If the universe is expanding now, it must have been smaller, hotter and denser in the past. This idea is the basis of the Big Bang theory.'

(a) State whether this is a valid summary of how red-shift evidence supports the Big Bang theory. **(1)**

(b) Explain how the discovery of CMBR added an independent test of this reasoning, beyond just red-shift. **(3)**

(Total for Question 4 is 4 marks)

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Mark scheme · 3.25 Red-shift and the Expanding Universe: Test Pack

Question 1

(a) as it approaches, the observed pitch/frequency is higher than the true pitch **B1**

(a) as it moves away, the observed pitch/frequency is lower than the true pitch **B1**

(a) Answer: Higher pitch as it approaches; lower pitch as it moves away.

(b) the Doppler effect **B1**

(b) Answer: The Doppler effect.

Question 2

(a) the universe began from a very small region of space **B1**

(a) which was extremely hot and extremely dense, oe **B1**

(a) Answer: The universe began from a very small, extremely hot and dense region.

(b) the universe has been continuously expanding ever since (and is still expanding today) **B1**

(b) as it has expanded, the universe has been cooling, oe **B1**

(b) Answer: It has been expanding and cooling ever since.

Question 3

the same element present in a distant galaxy produces the same pattern of spectral lines as it does in a laboratory on Earth **B1**

astronomers compare the wavelengths of these lines in light from the galaxy with their known wavelengths measured on Earth **B1**

if the lines from the galaxy are found at longer wavelengths than expected, shifted towards the red end of the spectrum, this shows the light is red-shifted, oe **B1**

Answer: Astronomers compare the wavelengths of known spectral lines in a galaxy's light with their laboratory values; if they are shifted to longer wavelengths, the light is red-shifted.

Question 4

(a) yes, it is a valid summary of the reasoning **B1**

(a) Answer: Yes.

(b) the reasoning above (based on red-shift) predicts that radiation released very early in the universe's history should still be detectable today, spread throughout space and stretched to microwave wavelengths by the expansion **B1**

(b) CMBR was subsequently observed and found to closely match this prediction, coming from every direction as expected **B1**

(b) because this evidence was independent of (not used to derive) the original red-shift reasoning, and still supported the theory, it significantly increased scientific confidence in the Big Bang theory, oe **B1**

(b) Answer: CMBR was an independent, later-tested prediction of the same theory, and matching it gave much stronger confidence than red-shift alone.

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