

# Astrophysics and cosmology

## Question Paper 2

Level	A Level
Subject	Physics
Exam Board	OCR
Topic	Newtonian world and astrophysics
Sub-Topic	Astrophysics and cosmology
Booklet	Question Paper 2

**Time Allowed:** 54 minutes

**Score:** / 45

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 (a) One estimate of the age of the universe is  $13.7 \times 10^9$  years.

(i) Calculate the Hubble constant in  $\text{km s}^{-1} \text{Mpc}^{-1}$  using this age.

$$1 \text{ pc} = 3.09 \times 10^{16} \text{ m}$$

Hubble constant = .....  $\text{km s}^{-1} \text{Mpc}^{-1}$  [3]

(ii) The wavelength of the hydrogen-alpha spectral line in the laboratory is 656 nm. Calculate the observed wavelength of this spectral line in the spectrum of the galaxy NGC 7469, which is 50.0 Mpc away from the Earth.

wavelength = ..... nm [4]



(c) Suggest how the microwave background radiation may evolve in the future.

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.....

.....

..... [2]

(d) Recent observations of very distant supernovae have shown that the expansion of the universe may be accelerating. It is suggested that this is caused by *dark energy* which has the mysterious property of exerting a repulsive force on the universe. The universe may therefore be *open* rather than *flat* or *closed*.



Fig. 11.1

Complete Fig. 11.1 by sketching a suitable graph to illustrate an open universe. [1]

[Total: 15]





- (d) Fig. 10.1 shows some absorption spectral lines of the spectrum of calcium as observed from a source on the Earth and from a distant galaxy.

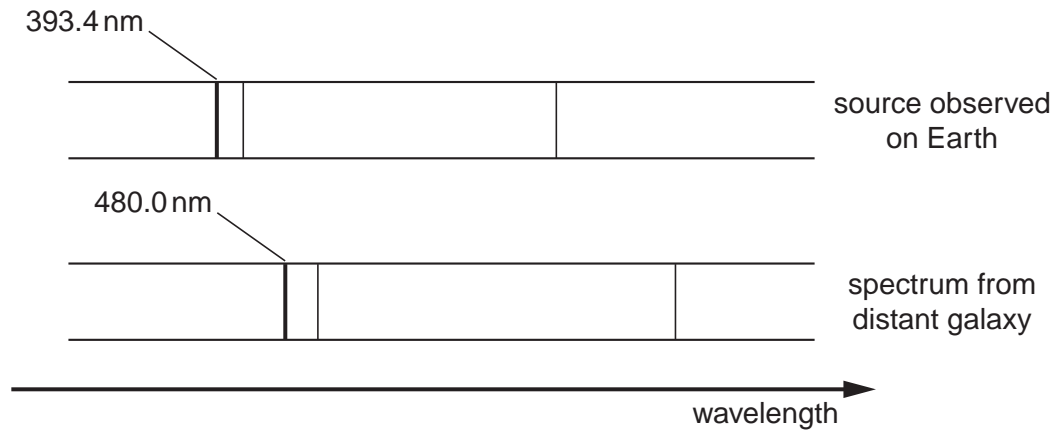


Fig. 10.1

- (i) Describe an absorption spectrum.

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..... [2]

- (ii) Use Fig. 10.1 to calculate the distance of the galaxy in Mpc. The Hubble constant has a value of  $50 \text{ km s}^{-1} \text{ Mpc}^{-1}$ .

distance = ..... Mpc [3]

[Total: 15]

4 (a) Explain what is meant by the *critical density* of the universe.

.....  
..... [1]

(b) Cosmologists have determined the Hubble constant to be  $65 \text{ km s}^{-1} \text{ Mpc}^{-1}$ . Calculate the Hubble constant in  $\text{s}^{-1}$  and hence determine the critical density of the universe.

$$1 \text{ pc} = 3.1 \times 10^{16} \text{ m}$$

Hubble constant = .....  $\text{s}^{-1}$

critical density = .....  $\text{kg m}^{-3}$  [3]



- (c) (i) Explain the terms *open*, *closed* and *flat* when describing the possible evolution of the universe. On Fig. 7.1 sketch and label graphs to illustrate your answer.



Fig. 7.1

open .....

.....

.....

closed .....

.....

.....

flat .....

.....

..... [3]

- (ii) Suggest a reason why it is difficult to predict the future of the universe.

.....

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..... [1]

[Total: 8]