



B O A R D O F S T U D I E S
NEW SOUTH WALES

2004

**HIGHER SCHOOL CERTIFICATE
EXAMINATION**

Cosmology

Distinction Course

Modules 1, 2 and 3 (including Residential 1)

General Instructions

- Reading time – 5 minutes
- Working time – 1 hour
- Write using black or blue pen
- Board-approved calculators may be used
- A data sheet is provided at the back of this paper

Total marks – 60

Section I Page 2

8 marks

- Attempt FOUR questions from Questions 1–6
- Allow about 8 minutes for this section

Section II Page 3

12 marks

- Attempt Questions 7–8
- Allow about 12 minutes for this section

Section III Page 4

40 marks

- Attempt Questions 9–10
- Allow about 40 minutes for this section

Section I

8 marks

Attempt FOUR questions from Questions 1–6

Allow about 8 minutes for this section

Answer all questions in the writing booklet provided. Extra writing booklets are available.

Question 1 (2 marks)

Describe briefly the cosmological concept of an isotropic universe.

Question 2 (2 marks)

Rank the four fundamental forces of nature in order of strongest to weakest within an atom.

Question 3 (2 marks)

The Space Interferometry Mission due to be launched in 2009 will measure the parallax of stars to an accuracy of four microarcseconds.

What distance does this parallax represent?

Question 4 (2 marks)

The magnitudes of two visible stars are listed in the table.

	<i>Apparent magnitude (m)</i>	<i>Absolute magnitude (M)</i>
Alpha Crucis	1.41	-3.8
Canopus	-0.72	-8.5

- (a) Which star is closest to Earth?
- (b) Which star is more luminous?

Question 5 (2 marks)

Describe the characteristics of a pulsar.

Question 6 (2 marks)

By combining Keck and HST images, astronomers recently reported ‘a galaxy at 13 billion light years distance’. This is a new record.

What is the distance in megaparsecs?

Section II

12 marks

Attempt Questions 7–8

Allow about 12 minutes for this section

Answer each question in the writing booklet provided. Extra writing booklets are available.

Question 7 (6 marks)

Contrast the techniques used to observe an object in optical and X-ray wavebands.

Question 8 (6 marks)

Outline the physical and philosophical bases for the Steady State Theory of the Universe.

Please turn over

Section III

40 marks

Attempt Questions 9–10

Allow about 40 minutes for this section

Answer each question in the writing booklet provided. Extra writing booklets are available.

Question 9 (20 marks)

Outline the concept of the anthropic principle.

Discuss the relevance of this principle to the statement ‘We observe, and are part of, the Universe’.

Question 10 (20 marks)

Astronomers always want larger telescopes.

Discuss why this is desired and how larger size is achieved in current and planned instruments.

End of paper

Data Sheet

Physical Constants and Conversion Factors

Recommended values

Abstracted from the consistent set of constants in CODATA Bull. No. 63 (1986) by the Royal Society, the Institute of Physics, and the Royal Society of Chemistry.

The number in parenthesis after each value is the estimated uncertainty (standard deviation) of the last digit quoted.

speed of light in a vacuum	c	$2.997\,924\,58 \times 10^8 \text{ m s}^{-1}$ (exact)
permeability of a vacuum	μ_0	$4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of a vacuum, $[\mu_0 c^2]^{-1}$	ϵ_0	$8.854\,187\,817\dots \times 10^{-12} \text{ F m}^{-1}$
elementary charge (of proton)	e	$1.602\,177\,33(49) \times 10^{-19} \text{ C}$
gravitational constant	G	$6.672\,59(85) \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Planck constant	h	$6.626\,0755(40) \times 10^{-34} \text{ J s}$
Avogadro constant	N_A	$6.022\,1367(36) \times 10^{23} \text{ mol}^{-1}$
molar gas constant	R	$8.314\,510(70) \text{ J K}^{-1} \text{ mol}^{-1}$
Boltzmann constant	k	$1.380\,658(12) \times 10^{-23} \text{ J K}^{-1}$
unified atomic mass constant	m_u	$1.660\,5402(10) \times 10^{-27} \text{ kg}$
rest mass of electron	m_e	$9.109\,3897(54) \times 10^{-31} \text{ kg}$

SI secondary units

astronomical unit	AU	$1.495\,978 \times 10^{11} \text{ m}$
parsec	pc	$3.0856 \times 10^{16} \text{ m} = 3.262 \text{ ly}$
Gregorian calendar year	y	$365.2425 \text{ days} = 31\,556\,952 \text{ s}$
jansky	Jy	$10^{-26} \text{ W m}^{-2} \text{ Hz}^{-1}$

Indicative values

earth mass	$5.977 \times 10^{24} \text{ kg}$
solar mass, M_\odot	$1.989 \times 10^{30} \text{ kg}$
galaxy mass	$10^{11} M_\odot$
Hubble constant, H_0	$100 h \text{ km s}^{-1} \text{ Mpc}^{-1}$ (typically h ranges from 1 to 0.5)

Conversion factors

distance (light-year)	ly	$9.460 \times 10^{15} \text{ m} = 63\,240 \text{ AU}$
energy (erg)	erg	10^{-7} J
magnetic field (gauss)	G	10^{-4} T
wavelength (angstrom)	Å	10^{-10} m

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