BOARD OF STUDIES
NEW SOUTH WALES

2002

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)

Give a definition of *astronomical unit*.

Where in the universe is it an appropriate unit for scale?

Question 2 (2 marks)

Why do astronomers make telescopes bigger?

Question 3 (2 marks)

State briefly the major assumption in any geocentric theory of the universe.

Question 4 (2 marks)

Give one observational technique that is used in detecting hydrogen clouds for each of

(a) infrared; and

(b) radio wavelengths.

Question 5 (2 marks)

Calculate the distance (in metres, to two significant figures) to a star that has a parallax of 45 milliarcseconds (mas).

Question 6 (2 marks)

State and explain briefly the location principle in cosmology.

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)

Give acceptable definitions for each of the following objects and state briefly where in the universe one might find each object:

(a) pulsar;

(b) quasar;

(c) black hole.

Question 8 (6 marks)

What is the essential property of a reflecting surface in a telescope?

Explain why reflection is a challenge for X-ray telescopes and discuss how this problem is overcome.

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)

Multi-object spectroscopy (using fibre optics) is now possible with the instrument known as 2dF and is the key goal of its successor, AAOMEGA. Describe the technologies used in these instruments and outline how observations with them will help us understand the structure of the universe.

Question 10 (20 marks)

State the basic assumptions made in any steady state theory of the universe. Discuss reasons why Fred Hoyle's Steady State Theory is not now as widely accepted as big bang theories.

End of paper

Cosmology

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

SI secondary units

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

Indicative values

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

Conversion factors

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

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