BOARD OF STUDIES
NEW SOUTH WALES

HIGHER SCHOOL CERTIFICATE EXAMINATION

2000

COSMOLOGY

DISTINCTION COURSE

MODULES 1, 2 AND 3

(60 Marks)

Time allowed—One hour
(Plus 5 minutes reading time)

DIRECTIONS TO CANDIDATES

- A data sheet is attached to this paper.
- Board-approved calculators may be used.
- Answer the questions in the Writing Booklet provided.
- You may ask for extra Writing Booklets if you need them.

SECTION I (8 marks)

- Attempt FOUR questions.
- Each question is worth 2 marks.
- Allow about 8 minutes for this Section.

SECTION II (12 marks)

- Attempt BOTH questions.
- Each question is worth 6 marks.
- Allow about 12 minutes for this Section.

SECTION III (40 marks)

- Attempt BOTH questions.
- Each question is worth 20 marks.
- Allow about 40 minutes for this Section.

SECTION I

(8 Marks)

Attempt FOUR questions.

Each question is worth 2 marks.

QUESTION 1

Give a concise definition of:

(a) a light year;

(b) an astronomical unit.

QUESTION 2

State the FOUR fundamental forces in nature.

QUESTION 3

Why is it beneficial to cool the *radiation detectors* used with modern telescopes?

QUESTION 4

What observational characteristics distinguish a pulsar from a quasar?

QUESTION 5

State and briefly explain the *anthropic principle* in cosmology.

QUESTION 6

Outline the key principles on which the Steady State Theory of the Universe is based.

SECTION II

(12 Marks)

Attempt BOTH questions.

Each question is worth 6 marks.

QUESTION 7

Current astrometric methods can measure a reliable parallax of 8 mas (milliarcsecond) for a star.

(a) Calculate the star's distance from Earth corresponding to this parallax.

(b) Calculate the apparent magnitude of our sun (Absolute Magnitude 4·8) seen from this star.

QUESTION 8

Discuss those concepts known to classical Greek philosophers that are still valid within the models of modern science and cosmology.

Please turn over

SECTION III

(40 Marks)

Attempt BOTH questions.

Each question is worth 20 marks.

QUESTION 9

Assess and evaluate the technological developments that challenged the concept of a stable unchanging Universe.

QUESTION 10

The observational principle of *interferometry* is used in both optical and radio astronomy.

(a) Briefly describe an interferometer.

(b) Identify some objects that might be observed with an interferometer and describe the information that would be obtained.

(c) Discuss the factors that limit the effectiveness of the interferometer for each waveband.

End of paper

Cosmology Distinction Course 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	$2{\cdot}997\,924\,58 \times 10^{8}$ m s^{-1} (exact)
permeability of a vacuum	μ_0	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of a vacuum, $[\mu_0 c^2]^{-1}$	ϵ_0	$8{\cdot}854\,187\,817\ldots \times 10^{-12}$ F m^{-1}
elementary charge (of proton)	e	$1{\cdot}602\,177\,33(49) \times 10^{-19}$ C
gravitational constant	G	$6{\cdot}672\,59(85) \times 10^{-11}$ N m^{2} kg^{-2}
Planck constant	h	$6{\cdot}626\,0755(40) \times 10^{-34}$ J s
Avogadro constant	N_A	$6{\cdot}022\,1367(36) \times 10^{23}$ mol^{-1}
molar gas constant	R	$8{\cdot}314\,510(70)$ J K^{-1} mol^{-1}
Boltzmann constant	k	$1{\cdot}380\,658(12) \times 10^{-23}$ J K^{-1}
unified atomic mass constant	m_u	$1{\cdot}660\,5402(10) \times 10^{-27}$ kg
rest mass of electron	m_e	$9{\cdot}109\,3897(54) \times 10^{-31}$ kg

SI secondary units

astronomical unit	AU	$1{\cdot}495\,978 \times 10^{11}$ m
parsec	pc	$3{\cdot}0856 \times 10^{16}$ 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	$5{\cdot}977 \times 10^{24}$ kg
solar mass, $M_\odot$	$1{\cdot}989 \times 10^{30}$ 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	$9{\cdot}460 \times 10^{15}$ m = 63 240 AU
energy (erg)	erg	10^{-7} J
magnetic field (gauss)	G	10^{-4} T
wavelength (angstrom)	Å	10^{-10} m