BOARD OF STUDIES
NEW SOUTH WALES

2005
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)

State and explain briefly the concept known as the cosmological principle.

Question 2 (2 marks)

Rank the following four astronomical objects in sequence of increasing size:

- the Pleiades
- the Small Magellanic Cloud
- the globular cluster 47 Tuc
- the red supergiant Betelgeuse.

Question 3 (2 marks)

The Absolute Magnitude of the Sun is +4.8.

What is the limiting distance at which a sun-like star could be seen with a large telescope that can detect stars as faint as apparent magnitude 30?

Question 4 (2 marks)

Describe briefly the observed characteristics of a quasar.

Question 5 (2 marks)

Outline ONE advantage and ONE problem of observing at gamma-ray wavelengths.

Question 6 (2 marks)

List two key advantages of having six separate antennas in the Compact Array of the Australia Telescope.

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)

Outline the observational evidence for the Big Bang Theory of the universe.

Question 8 (6 marks)

Discuss some of the scientific justifications for building:

- an Extremely Large Telescope (ELT)

OR

- an Overwhelming Large Telescope (OWL).

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)

Describe the technology used in multi-object fibre spectroscopy and discuss its impact on telescopes such as the Anglo-Australian, Schmidt and Subaru Telescopes.

Question 10 (20 marks)

Over many centuries models of the Universe have attempted to answer the questions ‘Where did we come from?’, ‘What is our destiny?’ and ‘Are we alone?’.

Discuss these questions in relation to our present cosmological models, observations and technology.

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	$2.997\,924\,58 \times 10^{8}$ 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	$8.854\,187\,817\ldots \times 10^{-12}$ 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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