BOARD OF STUDIES
NEW SOUTH WALES

2001

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 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

Total marks (8)
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)

What is a *parsec*? Explain using a labelled diagram.

Question 2 (2 marks)

Why are charge-coupled devices cooled to low temperatures?

Question 3 (2 marks)

Describe the main function and application of *active optics systems*.

Question 4 (2 marks)

Most modern large telescopes have their names abbreviated. Write out the full names of FOUR of these instruments:

- AAT
- ALMA
- ELT
- HET
- HST
- NBT
- NGST
- OWL
- SALT
- VLA

Question 5 (2 marks)

Sketch and label the major features in the spectrum of light received from a distant quasar.

Question 6 (2 marks)

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

Section II

Total marks (12)
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)

The Sydney University Stellar Interferometer (SUSI) is an optical instrument used for determining fundamental properties of stars. Identify TWO of these properties and explain how SUSI helps us to measure the distance scale of the Universe.

Question 8 (6 marks)

Our Sun is a main sequence G2v star with a physical diameter 1.39 Gm. It appears to us as a bright disk with diameter 32.0 arcminute. If observed from near Alpha Centauri (α Cen) at a range of 1.33 pc, what would be the size of the Sun's disk?

Please turn over

Section III

Total marks (40)
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)

In 1609, Galileo Galilei made observations, of a type not possible in previous centuries, that supported a heliocentric model of the Solar System. Discuss these observations and explain how they were inconsistent with a geocentric model.

Question 10 (20 marks)

Astronomers have been observing radio galaxies since 1947, only 23 years after it was generally accepted that there was an extragalactic universe. Discuss the development of radio telescopes since 1947 and describe some of the objects 'seen' at radio frequencies.

End of paper

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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	$2.997\,924\,58 \times 10^{8}$ 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	J	y	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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