

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

GX 922

Semester II Examinations, 2002/2003

Exam Code(s)	AT200
Exam(s)	2 nd Science
Module Code(s)	AT202
Module(s)	Introduction to Astrophysics
Paper No.	
Repeat Paper	Special Paper
External Examiner(s)	Professor E. Kennedy
Internal Examiner(s)	Professor S. G. Jennings
	Prof. R.M. Redfern
	Dr. A. Shearer

Instructions: Answer THREE questions.

Duration	2 hrs
No. of Answer Books	1

Requirements:

Handout	
MCQ	
Statistical Tables	
Graph Paper	
Log Graph Paper	
Other Material	

No. of Pages	
Department(s)	Experimental Physics

AT202 Introduction to Astrophysics

Q.1 (i) Describe the Bohr atom. [5marks]

Given that the ionisation potential of Hydrogen is 13.6 eV.

(ii) What is the energy, wavelength and frequency of the first 3 terms of the Balmer series? [3 marks]

(iii) What is the energy of the first three terms of the Balmer like series for singly ionised Helium? [2 marks]

Q.2 (i) What is blackbody radiation ? What is meant by the effective temperature of a star ? [5 marks]

(ii) Two stars in a binary system have effective temperatures of 10,048 and 4,000 K. If the ratio of their radii is 1.585 with the hotter star having the larger radius. What is the difference in their absolute bolometric magnitude? [5 marks]

Q.3 Answer two of the following questions:

A If the peak of a star's spectrum is at 5000 Å what is its temperature ? What is its spectral type ? [5 marks]

B Why do the strongest lines in the solar spectrum come from singly ionised calcium although there are roughly 500,000 hydrogen atoms for every calcium atom. [5 marks]

C Quasar 3C 446, which has a redshift parameter $z = 1.404$, is violently variable; its luminosity has been observed to vary by as much as a factor 40 in as little as 10 days. Calculate the time for this variation in the rest frame of the quasar. [5 marks]

D Calculate the value of v/c for a particle which has its kinetic energy equal to its rest energy [5 marks]

Q.4 Answer all parts of this question:

- (i) Derive an expression for the Doppler shift for light for both radial and transverse motion. [3 marks]
- (ii) Explain why this expression is different from that for Doppler shift in sound. [2 marks]
- (iii) Hence derive an expression for redshift, z , as a function of radial velocity for an object travelling directly away from the Earth. [4 marks]
- (iv) Calculate the recession velocity for a quasar which has a redshift of $z = 4.0$ [1 marks]

Q.5 Answer all parts of this question:

- (i) Discuss the principle of equivalence in General Relativity [3 marks]
- (ii) Hence derive an expression for the gravitational redshift for a photon travelling vertically in a gravitational field [3 marks]
- (iii) Calculate the redshift for a NaD photon ($\lambda = 589.6 \text{ nm}$) which has traveled upwards for a distance of 1000m from the surface of the Earth [4 marks]

Constants

The velocity of light, $c = 2.9979 \times 10^{10} \text{ cm sec}^{-1}$

Planck's Constant, $h = 6.6261 \times 10^{-27} \text{ erg sec}$

$1 \text{ eV} = 1.6 \times 10^{-12} \text{ ergs}$

Acceleration of gravity at the surface of the Earth, $g = 9.81 \text{ m s}^{-2}$

Wien's Constant = 0.290 cm K

Stefan-Boltzmann Constant = $5.670 \times 10^{-5} \text{ erg s}^{-1} \text{ cm}^{-2} \text{ K}^{-4}$