

**CHUKA**



**UNIVERSITY**

**COLLEGE**

**UNIVERSITY EXAMINATIONS**

**THIRD YEAR EXAMINATION FOR THE AWARD OF DEGREE OF  
BACHELOR OF SCIENCE & BACHELOR OF EDUCATION (SCIENCE)**

**PHYS 316: ASTROPHYSICS**

**STREAMS: B.SC., B.ED (SC.) Y3S1**

**TIME: 2 HOURS**

**DAY/DATE: WEDNESDAY 19/12/2012**

**2.30 P.M.-4.30 P.M.**

**INSTRUCTIONS:**

This paper consists of FIVE questions. Answer question ONE which is compulsory and ANY other two questions.

SOME USEFUL CONSTANTS

University gravitational constant	$G = 6.67 \times 10^{-11} \text{ Nm}^2 / \text{kg}^2$
Hubble constant	$H_0 = 1.32 \times 10^{-18} \text{ s}^{-1}$
Light year	$1 \text{ ly} = 9.46 \times 10^{15} \text{ m}$
Astronomical unit	$1 \text{ AU} = 1.50 \times 10^{11} \text{ m}$
Radius of earth	$R_E = 6.38 \times 10^6 \text{ m}$
Radius of sun	$R_\odot = 6.96 \times 10^8 \text{ m}$
Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Mass of earth	$m_E = 5.97 \times 10^{24} \text{ kg}$
Mass of sun	$M_\odot = 1.99 \times 10^{30} \text{ kg}$
Luminosity of the sun	$L_\odot = 3.85 \times 10^{26} \text{ W}$
Planck's constant	$h = 6.63 \times 10^{-34} \text{ Js}$

**QUESTION ONE: Compulsory (40 Marks)**

- (a) (i) What is the big bang? [1 mark]  
(ii) Briefly explain the composition of our universe. [2 marks]
- (b) (i) What is an Azimuth? [1 mark]  
(ii) Use the altitude and azimuth to locate a star at halfway between the horizon and the zenith in the southwest. [2 marks]

- (c) (i) Define weight [1 mark]  
(ii) A body of mass 28 kg has a weight of 274 N on earth's surface. Calculate the radius of the earth. [2 marks]
- (d) (i) State Kepler's 2<sup>nd</sup> law of planetary movements. [1 mark]  
(ii) The orbital period of a planet was observed to be 6.55 years, what is its orbital distance in AU? [2 marks]
- (e) (i) Define gathering power of a telescope. [1 mark]  
(ii) Find the gathering power of a telescope having an objective mirror of diameter 10m. [2 marks]
- (f) (i) What did the word 'quasar' stand for in ancient astronomy? [1 mark]  
(ii) Give any two typical characteristics of a quasar. [2 marks]
- (g) (i) State Hubble's law. [1 mark]  
(ii) Using Hubble's law, determine the distance of a galaxy that has a recession speed of  $1.5 \times 10^7$  m/s. [2 marks]
- (h) (i) Define escape velocity. [1 mark]  
(ii) Find the escape velocity of a particle fired from the earth's surface. [2 marks]
- (i) (i) What is a parking orbit? [1 mark]  
(ii) A 1200 kg weather satellite is to be placed in an orbit 200 km above the earth's surface. Find its speed in orbit. [2 marks]
- (j) (i) Define a Black hole. [1 mark]  
(ii) Briefly describe how black holes produce their energy. [2 marks]
- (k) (i) What is a pulsar? [1 mark]  
(ii) A certain star has the same mass but a diameter three times that of the sun. Calculate the gravitational energy the star must have radiated. [2 marks]
- (l) (i) Define Red shift. [1 mark]  
(ii) Spectral lines of various elements are detected in light from a galaxy. The UV light from a singly ionized calcium  $\lambda = 393$  nm is observed with a light  $\lambda = 414$  nm. Find the red shift of the galaxy. [2 marks]
- (m)(i) Define eccentricity of an orbit. [1 mark]  
(ii) the asteroid Pallas has an orbital period of 4.62 yrs and eccentricity of 0.233. Find the semi major axis of its orbit. [3 marks]

**QUESTION TWO: Elective (15 Marks)**

- (a) (i) Distinguish between terrestrial, horizon and equatorial coordinates. [3 marks]
- (ii) Give one advantage and disadvantage of the horizon system. [2 marks]
- (b) (i) What is stellar parallax? [1 mark]
- (ii) A cluster of stars appear to have a parallax of  $0.05''$ . What is the:-
  - (a) Position in seconds of arc? [2 marks]
  - (b) Distance of the cluster in pc? [2 marks]
- (c) (i) State Newton's law of universal gravitation [1 mark]
- (ii) A Stellar particle is at a distance  $10^3$  AU of the sun. Determine its escape velocity. [2 marks]
- (iii) Three bodies with masses  $M_1 = 53$  kg,  $M_2 = 60$  kg,  $M_3 = 95$  kg exist in a straight line in the universe with  $M_3$  in the middle. If  $M_1$  and  $M_2$  are 20m and 12m away from  $M_3$  respectively, find the net force on  $M_3$ . [2 marks]

**QUESTION THREE: Elective (15 Marks)**

- (a) (i) State Kepler's 3<sup>rd</sup> law of planetary movements. [1 mark]
- (ii) The distance from the sun of a planet in a circular orbit was observed to be 3.5 AU, what is its;
  - (a) Orbital period in years? [2 marks]
  - (b) Orbital speed in m/s? [2 marks]
- (b) (i) Define the major axis of an orbit. [1 mark]
- (ii) A comet moves in an orbit such its aphelion is  $5.26 \times 10^9$  km while the perihelion is  $8.75 \times 10^7$  km. Find its;
  - (a) Semi-major axis [2 marks]
  - (b) Eccentricity [2 marks]
  - (c) Orbital period [2 marks]
- (c) (i) What is potential energy of a body in orbit? [1 mark]
- (ii) A 900 kg weather satellite is to be placed in an orbit 300 km above the earth's surface. Find the work required putting it in orbit. [2 marks]

#### QUESTION FOUR: Elective (15 Marks)

- (a) (i) Define a galaxy [1 mark]  
(ii) Distinguish between Elliptical and Spiral galaxies. [2 marks]  
(iii) A galaxy emitting  $\lambda = 450 \text{ nm}$  red shifted into the visible light. Find the speed at which the galaxy is receding. [2 marks]
- (b) (i) Define the Schwarzschild radius. [1 mark]  
(ii) Determine the Schwarzschild radius for a star whose mass is  $2.0 \times 10^{31} \text{ kg}$ . [2 marks]  
(iii) The luminosity of a certain quasar is estimated at  $10^9 L_{\odot}$ . Calculate The minimum mass of its nucleus required to attract surrounding gas. [2 marks]
- (c) (i) Define critical density of the universe. [1 mark]  
(ii) Use Hubble's law to calculate the;  
(a) Critical density of the universe [2 marks]  
(b) Age of the universe after the big bang [2 marks]

#### QUESTION FIVE: Elective (15 marks)

- (a) (i) Define electromagnetic radiation. [1 mark]  
(ii) A star produces light whose wavelength is  $500 \text{ nm}$ . Calculate the temperature of the star. [2 marks]  
(iii) The radiant power of light emitted by a star is  $3.8 \times 10^{27} \text{ W}$ . If the Radiation reaches the earth with a flux  $1.35 \times 10^3 \text{ W/m}^2$ , calculate the distance of the star from the earth. [2 marks]
- (b) (i) Define Optical telescope. [1 mark]  
(ii) Briefly describe the following terms as used in telescopes;  
(a) Interferometry [1 mark]  
(b) Spectroscopy [1 mark]  
(iii) A telescope whose objective is  $5 \text{ m}$  is used to observe an object producing light whose wavelength is  $600 \text{ nm}$ . Calculate, in seconds of an arc, the minimum angle that can be resolved. [2 marks]
- (c) (i) Define Doppler effect. [1 mark]  
(ii) The radio waves emitted by a star have a wavelength of  $20.0 \text{ cm}$ . The wavelength observed on earth is  $20.02 \text{ cm}$ . Find the;  
(a) Energy of a photon of the radiation [2 marks]  
(b) Speed of the star relative to the earth. [2 marks]
-

