085

The Open University of Sri Lanka
B.Sc. Degree Programme - Level 05
Final Examination – 2023/2024
PHU5311/PHE5311- Astronomy
Duration: Two (02) Hours

Index No.

Date: 20.03.2024 **Time: 1.30 p.m. – 3.30 p.m**

Electronic calculators are allowed.

All symbols have their usual meaning.

(Useful information: Mass of the Sun $M_\odot = 1.9891 \times 10^{30}$ kg, Radius of the Sun $R_\odot = 6.960 \times 10^8$ m, Speed of Light $c = 2.9979 \times 10^8$ m s^{-1}, Universal gravitational constant $G = 6.6726 \times 10^{-11}$ m^3 kg^{-1} s^{-2}, 1 AU = 1.5×10^{11} m)

Answer four (04) questions only

1. A). State Kepler's three laws of planetary motion. **(6 Marks)**

   A geostationary satellite is orbiting the earth at a height of 7 *R* above the surface of the Earth. (*R*- Radius of the earth).

   i) What is a geostationary satellite? **(4 Marks)**

   ii) Calculate the time period of a satellite at a height of 3R from the surface of earth. **(5 Marks)**

   B). i) What is meant by a solar eclipse? **(3 Marks)**

   ii) What are the three types of solar eclipses? **(3 Marks)**

   iii) What is meant by umbra and penumbra? Explain the phenomenon using a suitable diagram. **(4 Marks)**

2. A). Doppler effect is widely applicable in investigating the motion of faraway celestial objects.

   i) Briefly explain the blue shift and the red shift. **(5 Marks)**

   ii) Suppose a galaxy is moving away from the Earth at a speed of 0.825c. It emits radio waves with a wavelength of 0.525 m. At what wavelength would we detect them on the Earth? **(8 Marks)**

   B). The parallax method is used only for measuring the distances of nearby stars.

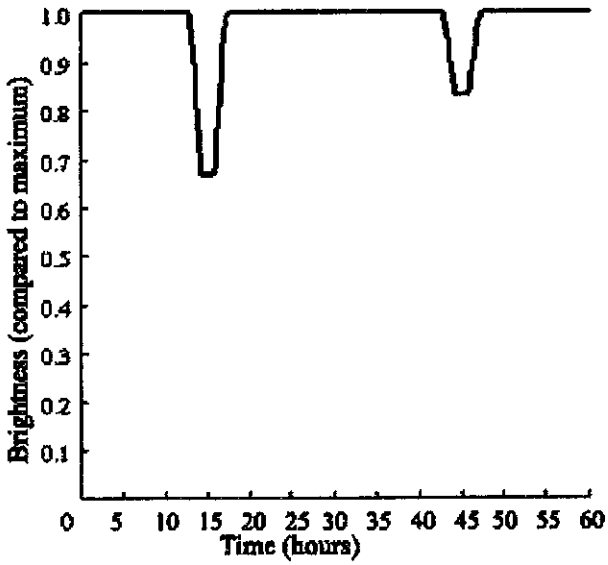
   i) What is meant by parallax angle? Explain by using a suitable diagram. **(5 Marks)**

ii) Calculate the parallax of a star (in sec) at a distance of 4.29 light years when viewed from two locations of the Earth six months apart in its orbit around the sun. (Give your answer up to 2 decimal points) (Assume diameter of Earths' orbit around sun to be 3×10^{11} m) **(7 Marks)**

3. A). A binary star or a binary star system is a system of two stars that are gravitationally bound to and in orbit around each other.

i) Briefly explain the following types of binary stars. **(6 Marks)**
   a) Visual binaries
   b) Spectroscopic binaries
   c) Eclipsing binaries

ii) An astronomer observes an object, producing the following relative light curve.



a) What type of object is this? **(3 Marks)**

b) Explain the shape of the observed light curve. **(4 Marks)**

c) What does the information on the time axes suggest about the physical properties of the object? **(4 Marks)**

B) The apparent brightness of a star depends on both its luminosity and its distance from the Earth.

i) Define the following terms. **(4 Marks)**
   a) Luminosity
   b) Apparent brightness

ii) Two stars are at the same distance from the Earth and their apparent brightnesses are 8.9×10^{-12} Wm^{-2} (star A) and 2.9×10^{-13} Wm^{-2} (star B). Calculate the ratio of luminosity of star A to star B. **(4 Marks)**

4. A) The Sun is the star at the heart of our solar system.

i) Briefly explain the following terms related to internal structure and atmosphere of the Sun. **(6 Marks)**

a) Core
b) Radiative Zone
c) Convection Zone

ii) What is the chemical composition of the Sun? What two atomic elements are most abundant in the Sun? **(4 Marks)**

B) The Sun behaves as an approximate black-body radiator with peak energy radiation occurring at a wavelength of 5.2×10^{-7} m. (Wien's constant is 0.0029 m K)

i) Show that the Sun has a surface temperature of about 5576 K. **(7 Marks)**

ii) The radius of the Sun is 7.0×10^5 km. Calculate the luminosity of the Sun in Watts. (Stefan-Boltzmann constant is 5.6×10^{-8} W m^{-2} K^{-4}) **(8 Marks)**

5. A). Fusion of nuclei generates energy within the Sun. In its present stage of evolution Hydrogen is being converted into Helium in the core of the Sun.

i) State and explain the conditions necessary for fusion to occur in a star. **(6 Marks)**

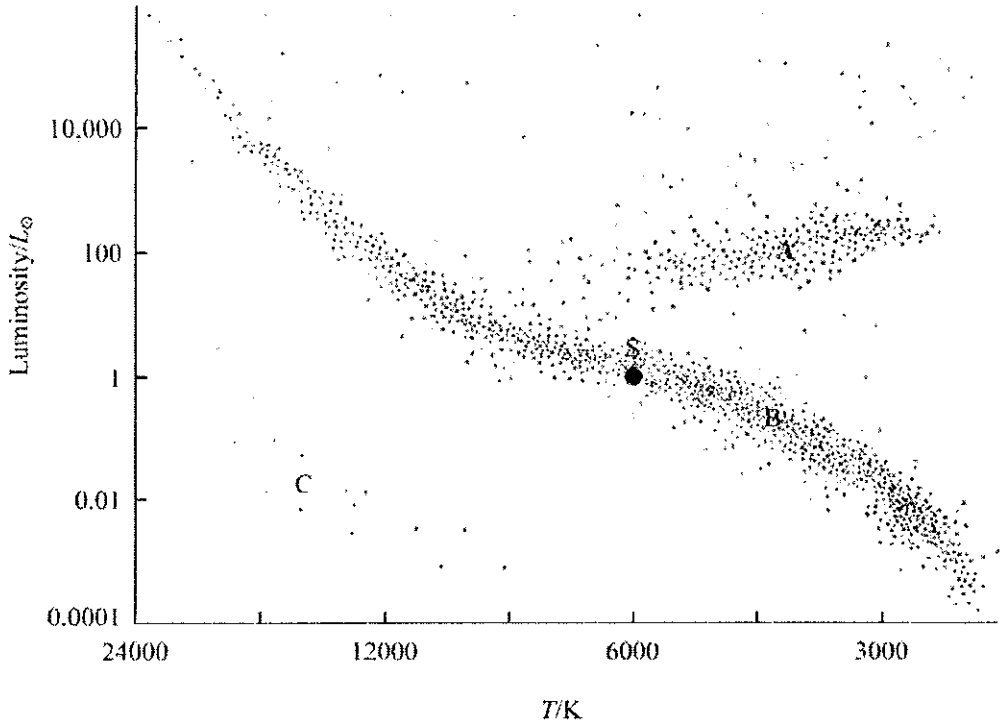
ii) In a star, fusion of Hydrogen into Helium takes place through number of stages. The final stage is,

$$^{3}_{2}\mathrm{He} + {}^{3}_{2}\mathrm{He} \longrightarrow {}^{4}_{2}\mathrm{He} + 2 \times {}^{1}_{1}\mathrm{H}$$

Calculate the energy released in MeV when one nucleus of the normal isotope of Helium is produced.

(Mass of Isotopes: ^{3}He - 5.008238×10^{-27}Kg, ^{4}He - 6.646483×10^{-27}Kg, ^{1}H - 1.673534×10^{-27}Kg) **(6 Marks)**

B). The position of our Sun, S is shown on the Hertzsprung – Russell (H-R) diagram below.



i) Identify the three main regions of the H-R diagram. **(3 Marks)**

A –

B –

C –

ii) Add lines to the diagram (Redraw the given plot in your answer sheet) to show the evolutionary path of our Sun from the time when it comes to the end of its Hydrogen – burning phase. **(4 Marks)**

iii) Explain how astronomers calculate the sizes of these stars using information from the H-R diagram. **(6 Marks)**

6. A) Answer all parts.

i) Describe briefly the Big Bang theory on universe. **(5 Marks)**

ii) What are the evidence for the Big Bang? **(5 Marks)**

B) Write short notes on any two (02) of the following topics. **(15 Marks)**

a) The Hubble sequence

b) White dwarfs

c) Interstellar medium

d) Cosmic Ray Background

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