declinations for these stars at latitude I. At summer solstice, the Sun never sets at latitudes close to the North Pole. Find the range of latitudes for which this is true. Draw appropriate figures to support your answers. (6)

Constants

Universal Gravitational Consntant $G = 6.67 \times 10^{-11} m^3 kg^{-1} m^{-2}$

Boltzmann Constant $k_B = 1.38 \times 10^{-23} JK^{-1}$ Stefans Constant $\sigma = 5.67 \times 10^{-8} Wkm^{-2} K^{-4}$

Parsec $1\ pc = 3.1 \times 10^{16}\ m$ Astronomical Unit $1\ AU = 1.50 \times 10^{11}\ m$

Mass of Earth $M_E = 5.97 \times 10^{24}\ Kg$ Radius of Earth $R_E = 6.36 \times 10^{6}\ m$

Mass of Sun $M_\odot = 1.99 \times 10^{30}\ Kg$ Radius of Sun $R_\odot = 6.96 \times 10^{8}\ m$

Apparent Magnitude of the Sun $m_\odot = -26.72$ Solar constant $S = 1370\ Wm^{-2}$

Density of the solar photosphere $\rho_{photosphere} = 4.9 \times 10^{-6}\ kgm^{-3}$

Mass of He^3 nucleus $M_{He^3} = 2808.30\ MeV$ Mass of He^4 nucleus $M_{He^4} = 3727.40\ MeV$

Mass of He nucleus $M_H = 938.27\ MeV$ Naked Eye limit of Apparent Magnitude $m_e = 6$

Oort constants $A = 15\ kms^{-1} kpc^{-1}$ & $B = -10\ kms^{-1} kpc^{-1}$

Velocity and distance of Sun about Galactic Center $v_\odot = 218 kms^{-1}$ & $r_\odot = 8\ kpc$

Mass of electron $m_e = 9.1 \times 10^{-31}\ kg$ & Charge of electron $e = 1.6 \times 10^{-19}\ C$

[This question paper contains 8 printed pages.

Your Roll No.....

Sr. No. of Question Paper : 1242 C

Unique Paper Code : 32227506

Name of the Paper : Astronomy & Astrophysics

Name of the Course : **B.Sc. (Hons) Physics – DSE**

Semester : V

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. **1** which is compulsory.
3. Attempt any **four** questions from the remaining.

1. Attempt any **four** of the following : (5×3=15)

   (a) Aristarchus realized that when the Moon was exactly half illuminated it formed a right triangle with the Earth and the Sun. Now knowing the distance between the Earth and the Moon d_M, compute the distance of the Sun from earth d_S.

(b) Find an estimate of the effective surface temperature T_e of Sun given that the flux density at earth 5 = 1370 W/m^2 and the angular diameter of the Sun = 32″.

(c) You have available lenses of focal lengths 2.0 cm, 4.0 cm, 8.0 cm and 16 cm. If you were to use any two of these lenses to build a telescope, what is the lens separation for the maximum magnification telescope?

(d) Estimate the radius of a typical star in terms of the radius of the Sun. It is given that the star's temperature is two-thirds that of the Sun and its luminosity is 100 times the Sun's luminosity.

(e) Draw a schematic diagram showing the layers of solar atmosphere.

(f) Calculate the Schwarzschild radius for the Earth.

(g) For the Hyades cluster, $\theta = 37°$, $V_R = 39$ kms^{-1} and $\mu = 0.11$ arcsec yr^{-1}. Determine the distance to the Hyades cluster in parsecs.

2. (a) Define the essential elements of the Universal Equatorial Coordinate System and present them in an appropriate diagram. The hour angle of the

(b) The light curve for Mira shows that the visual apparent magnitude varies from 2 to 9.5.

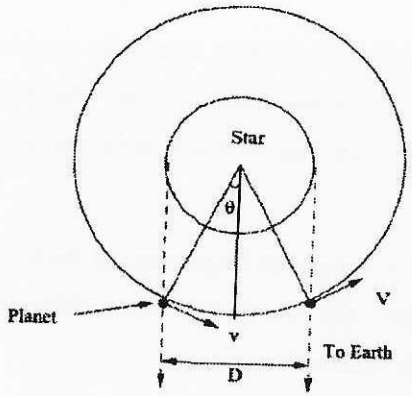
(i) Estimate the ratio of Mira's luminosity at visible wavelengths, when it is brightest to when it is dimmest.

(ii) Assume the light curve can be approximated as a sinusoid. For what fraction of its pulsation cycle is Mira visible to the naked eye? (6)

7. (a) Explain three types of spectra observed for different astronomical phenomenon. Describe any three Solar activities. (9)

(b) Show that a star attains its maximum altitude when it is on the observer's meridian. An observer at latitude 30° finds that the altitude of the upper transit U of a star is 45°. What is the altitude of the lower transit V of the star and its the zenith distance. At any latitude I there exists a group of stars that always remain either above or below the horizon (circumpolar stars). Find the range of

in the planet's atmosphere was also measured, corresponding to a difference in radial velocity of 30 km/s (relative to Earth) between the beginning and the end of the transit.



Assuming a circular orbit exactly edge-on to the observer, find the approximate radius and mass of the star and the radius of the orbit of the planet. (6)

6. (a) Prove that the magnetic flux linked to a cross section of perfectly conducting plasma remains unchanged as the plasma moves. Explain the significance of this result with respect to Solar activity. (9)

vernal equinox is called the sidereal time Θ. Shows that for any object, $\Theta = h + \alpha$ where h is the object's hour angle and α its right ascension. (9)

(b) Assume that a globular cluster has a diameter of 40 pc and contains 100,000 stars of one solar mass each. Assuming that the stars are almost uniformly distributed, find the average velocity of the stars. Also find the escape velocity. Comparing these velocities, can you tell something about the stability of the cluster? (6)

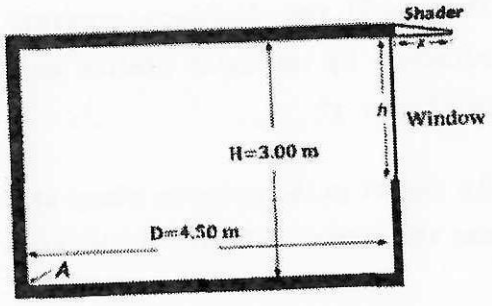
3. (a) Define the apparent magnitude and absolute magnitude of an astronomical object. Derive the expression for distance modulus? Two stars of a binary system have apparent magnitudes m_1 and m_2. Find the magnitude of the combined system. Explain meaning of Extinction of stellar light. How will the distance measure of a star get affected by an inter stellar medium of optical thickness τ? (9)

(b) An object in the galactic plane at longitude $l = 45°$ has the radial velocity of 30 km s^{-1} with respect

to the LSR. Given that the angular velocity of the Sun $\omega_0 = 25$ kms^{-1}kpc^{-1} and differential rotation $dv/dR|_0 = 5$ kms^{-1}kpc^{-1}, find the distance of the star? (6)

4. (a) Draw the Cosmic Distance Ladder. Use any two methods to explain the determination of cosmic distances using the Cosmic Distance ladder. (9)

(b) In a typical house architecture, on top of south side windows there is a protruding structure "shade", which controls sunlight in summer and winter. In summer when the Sun is high, shade prevents sunlight to enter rooms and keeps inside cooler. Figure shows a vertical section of this design at latitude of 36.0°N with window and shade.



Using the parameters given in the figure, calculate the maximum width of the shade (x), and maximum height of the window (h) in such a way that:

(i) No direct sunlight can enter to the room in the summer solstice at noon.

(ii) The direct sunlight reaches the end of the room (indicated by the point A in the figure) in the winter solstice at noon. (6)

5. (a) For a spherical system in hydrostatic equilibrium under its own gravity, derive the equation of hydrostatic equation

$$\frac{1}{r^2}\frac{d}{dr}\left(\frac{r^2 dP}{\rho\, dr}\right) = -4\pi G\rho$$

where the pressure P(r) and density $\rho(r)$ are at a distance r from the center. Assuming the system comprises of monoatomic gas, obtain the relation between the potential and total energies. (9)

(c) A transit of duration 180 min was observed for a planet which orbits the star with a period of 84 hrs. The Doppler shift of absorption lines arising