UNIVERSITY OF SRI JAYEWARDANEPURA
FACULTY OF APPLIED SCIENCES

B. Sc. Special Degree Fourth Year Second Semester Course Unit Examination

March 2021

DEPARTMENT OF PHYSICS

PHY 458 2.0 – Space and Atmospheric Physics

Time : Two hours
No of Questions : 06
No of Pages : 03
Total Marks : 60

Answer all questions

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01. Briefly explain the following features of the planetary system in terms of Physics.

i. Mercury's orbit has a significant eccentricity.
ii. Surface Temperature of the Venus (470 ^{o}C) is higher than that of any other planet in the solar system.
iii. Jupiter radiates much more heat than it receives from the Sun.
iv. Neptune is never visible to the naked eye.
v. Pluto does not visible for decades through telescopes.

(10 Marks)

02. In the Earth's atmosphere, the mean free path of the gas molecules, d (in meters) increases with height, h (in meters) as of the following equation,

$$d(h) = \alpha\ h^6 + \beta\ ,$$

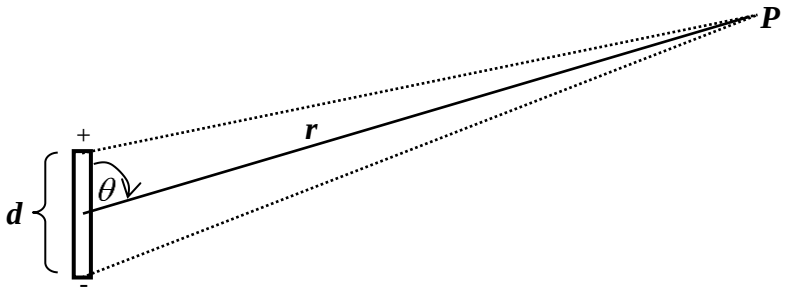
Where α and β are unknown constants.

The mean free path of the gas molecules at the mean sea level is $5.0 \times 10^{-8}\, m$ and the mean free path of the gas molecules at the $1\ km$ height is $1.0 \times 10^{-5}\, m$.

i. Determine the values of α and β of the above equation.
ii. Determine the height from the mean sea level where the mean free path of the gas molecules becomes $500.0\, m$.

(10 Marks)

03. The magnetic field of the Earth can be represented to a good approximation by a dipole magnetic field with the intensity of $40\ 000\ nT$ at the equator.



Magnetic field intensity $H(r,\theta)$ at a point P (on the plane of the magnet, as shown in the figure above) due to a short bar magnet of length d ($d << r$) is given by,

$$H(\ r,\ \theta\ ) = \frac{\mu_o}{4\ \pi} \cdot \frac{M}{r^3} \cdot \left(\ 1 + 3\ \cos^2\theta\ \right)^{1/2}.$$

Where, the other symbols have their usual meanings.

i. Find the intensity of the magnetic field at the poles of the Earth.

ii. Describe how you would calculate the magnetic field intensity at your current location. Assume the Longitude and the Latitude of the your location is (6.8545^o N, 79.9056^o E).

iii. Sketch the shape of the magnetic field of the Earth under the influence of the solar wind.

(10 Marks)

04. **i.** Sketch the profile of the day-time ionosphere of the Earth, and indicate heights of "**D**", "**E**", "$\mathbf{F_1}$" and "$\mathbf{F_2}$" regions.

ii. When a vertically incident radio wave of frequency f is reflected from the ionosphere, the free electron density, N_e at the reflection height is given as,

$$N_e \approx \frac{1}{80} f^{\,2}.$$

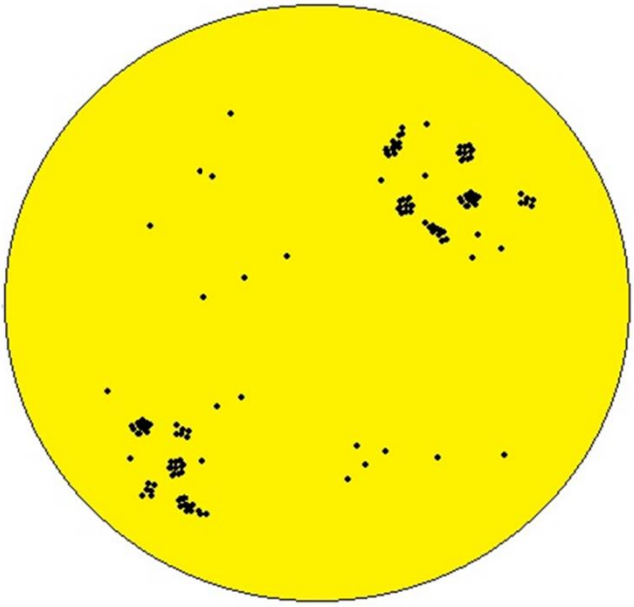
At a certain instance, the maximum free electron density of the F - region of the ionosphere is 10^{12} electrons/m^3. **Determine** the corresponding penetrating frequency, f_F of the F - region.

iii. **Hence**, **show that** the **UHF** (300 MHz) and the **VHF** (30 MHz) signals can be used for satellite transmission.

(10 Marks)

05. **i.** How would you determine the **sunspots number** if the number of individual sunspots as well as the number of sunspot groups visible on the Sun are known.
Explain the role of the **calibration factor** on the above calculation.

ii. It is observed that, the number of individual sunspots and the number of sunspot groups as shown in the figure below at a certain instance.



Calculate the corresponding sunspots number, if the calibration factor for the whole system is 1.6.

(10 Marks)

06. **i.** Write down the relationship between the "**absorption of radio waves**" and the "**frequency of the Radio waves**" in the lower atmosphere.

ii. The radio broadcasting station used a SW radio signal with a power of 120 kW. If they used the 8 MHz carrier frequency signal, the power of the received input signal is 12 kW. If they used 16 MHz signal, the received input power is 23 kW.

a. Find the suitable value for the carrier frequency of the radio waves, if they want to receive the signal with input power of 30 kW.

b. Is it possible to broadcast the above frequency signal using ionospheric modes ?

(10 Marks)

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