

State Examinations Commission – Physics Higher Level, 2004.

Question 12a

State Newton's universal law of gravitation. (6)

Centripetal force is required to keep the earth moving around the sun.

(i) What provides this centripetal force?

(ii) In what direction does this centripetal force act?

(iii) Give an expression for centripetal force. (10)

The earth has a speed of $3.0 \times 10^4 \text{ m s}^{-1}$ as it orbits the sun. The distance between the earth and the sun is $1.5 \times 10^{11} \text{ m}$. Calculate the mass of the sun. (12)

(gravitational constant, $G = 6.7 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$)

State Newton's universal law of gravitation. (6)

Between any two point masses there is a force of attraction that is proportional to the product of their masses and inversely proportional to the square of the distance between them..

Centripetal force is required to keep the earth moving around the sun.

(i) What provides this centripetal force?

The gravitational force between the earth and the sun

(ii) In what direction does this centripetal force act?

Towards the center (the sun)

(iii) Give an expression for centripetal force. (10)

$F = mv^2/d$ where m = mass of orbiting body, v = linear velocity of orbiting body and d = separation of orbiting body and central body.

The earth has a speed of $3.0 \times 10^4 \text{ m s}^{-1}$ as it orbits the sun. The distance between the earth and the sun is $1.5 \times 10^{11} \text{ m}$. Calculate the mass of the sun. (12)

centripetal force = gravitational force

$$\frac{mv^2}{d} = \frac{GMm}{d^2}$$

$$v^2 = \frac{GM}{d}$$

$$M = \frac{v^2 d}{G}$$

$$M = \frac{(3.0 \times 10^4)^2 \times 1.5 \times 10^{11}}{6.7 \times 10^{-11}}$$
$$= 2.0 \times 10^{30} \text{ kg}$$