

Quiz 4

Name: _____ Student Number: _____

1. (5 marks)

a) State Kepler's 3 laws.

- 1) Planet orbits are ellipses with sun at one focus.
- 2) Radial line segment from sun to planet sweeps out equal areas in equal times.
- 3) Square of planet period proportional to cube of average distance to sun

b) If Saturn has a period of 29.5 years and the distance of the Earth from the sun is 1.5×10^8 km, use Kepler's third law to estimate Saturn's distance from the sun.

Kepler
3rd law $T^2 \propto R^3$

$$\therefore \frac{R_S^3}{T_S^2} = \frac{R_E^3}{T_E^2}$$

← Earth

Saturn →

$$R_S = R_E \left(\frac{T_S}{T_E} \right)^{2/3}$$

$$= 1.5 \times 10^8 \text{ km} \left(\frac{29.5}{1} \right)^{2/3}$$

$$= 1.4 \times 10^9 \text{ km}$$

2. (5 marks) Consider two isolated (i.e. very far from any other objects) heavenly bodies of masses m_1 and m_2 separated by a large distance r .

a) What happens to the gravitational force between the two objects if r triples?

$$F_{\text{Grav}} = \frac{G m_1 m_2}{r_{12}^2}$$

$$r_{12} \rightarrow 3r_{12} \Rightarrow F_{\text{Grav}} \rightarrow \frac{F_{\text{Grav}}}{9}$$

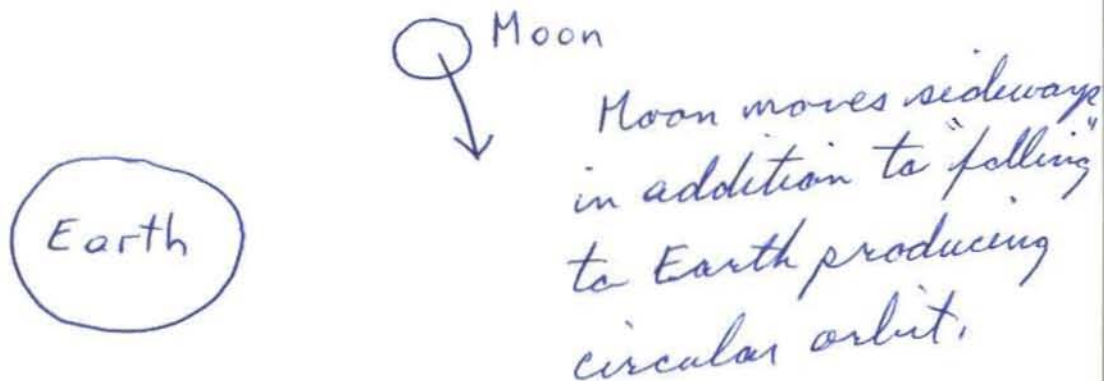
b) What happens to the gravitational force between the two objects if m_1 and m_2 both double?

$$\left. \begin{array}{l} m_1 \rightarrow 2m_1 \\ m_2 \rightarrow 2m_2 \end{array} \right\} \Rightarrow F_{\text{Grav}} \rightarrow 4F_{\text{Grav}}$$

c) Qualitatively describe the motion that would occur if two such objects were initially held motionless and then released.

Gravitational force is attractive. Hence, objects would accelerate towards each other and collide.

d) Given your answer in c, why doesn't that happen to the moon and the Earth?



Total = 10 marks