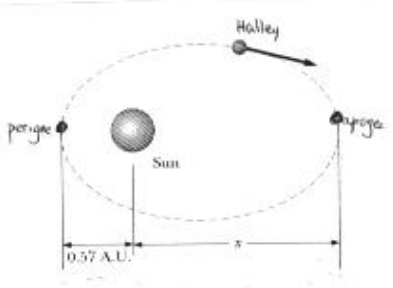
Physics 101Rec
Quiz # 10e

Instructor: Dr. A. Mekki

Name: Key Id: Sect:

Halley's comet approaches the Sun within a distance of 0.57 A.U., and its orbital period is 75.6 years. (1 A.U. = 1.50×10^8 km). $M_s = 1.99 \times 10^{30}$ kg and $G = 6.65 \times 10^{-11}$ Nm^2/kg^2

(a) How far from the Sun will Halley's comet travel before it start its return journey? (see the figure and calculate the distance x).



$$T^2 = \left(\frac{4\pi^2}{GM_s}\right)a^3$$

$$75.6\,y = 75.6 \times 365 \times 24 \times 3600 = 2.38 \times 10^9\ s$$

$$\left(2.38 \times 10^9\right)^2 = \frac{4\pi^2}{(6.65 \times 10^{-11})(1.99 \times 10^{30})}\,a^3$$

$$\Rightarrow a^3 = 1.9 \times 10^{37}\ m^3 \Rightarrow a = 2.67 \times 10^{12}\ m = 17.8\ A.U.$$

$$x + 0.57\,A.U = 2a \Rightarrow \boxed{x = 35\ A.U.}$$

(b) Find the ratio v_p/v_a Conservation of angular momentum

$$\Rightarrow v_p r_p = v_a r_a \Rightarrow \frac{v_p}{v_a} = \frac{r_a}{r_p} = 61.4$$

$r_p = 0.57\ A.U.$

$r_a = 35\ A.U$

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Quiz # 10c

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A satellite is orbiting the Earth at an altitude of 1×10^3 km.

(Given: Me = 5.98×10^{24} kg, Re = 6.37×10^6 m, G = 6.65×10^{-11} Nm^2/kg^2)

(a) What is its orbital speed?

$$F = m\frac{v_{orb}^2}{r} = \frac{GM_e m}{r^2} \Rightarrow v_{orb} = \sqrt{\frac{GM}{r}}$$

measured from the center of the Earth to the orbit! = Re + h

$$v_{orb} = \sqrt{\frac{6.65\times10^{-11} \times 5.98\times10^{24}}{6.37\times10^6 + 1\times10^6}}$$

$$= 7346 \text{ m/s} = \boxed{7.3 \text{ Km/s}}$$

(b) What is the escape speed of the satellite from that orbit?

$$E_i = E_f$$

$$\frac{1}{2} m v_{esc}^2 - \frac{GM_e m}{(R_e + h)} = 0$$

$$v_{esc} = \sqrt{\frac{2GM_e}{R_e + h}} = 10389 \text{ m/s}$$

$$= \boxed{10.4 \text{ Km/s}}$$

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Quiz # 10a

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The mass of planet Earth is about ten times that of planet Mars and its radius is about twice the radius of Mars. What would be the weight of a person on Mars if he weighs about 650 N on Earth? (Given: Me = 5.98 x 10^{24} kg, Re = 6.37 10^{6} m, G = 6.65 x 10-11 Nm^2/kg^2)

$M_e = 10\, M_m$ (M_e: mass of Earth; M_m: mass of Mars)

$R_e = 2\, R_m$ (R_e: radius of Earth; R_m: radius of Mars)

on Earth $a_g^e = \dfrac{G M_e}{R_e^2} = 9.8\ m/s^2$

on Mars $a_g^m = \dfrac{G M_m}{R_m^2}$

$$\frac{a_g^m}{a_g^e} = \frac{\dfrac{G M_m}{R_m^2}}{\dfrac{G M_e}{R_e^2}} = \left(\frac{M_m}{M_e}\right) \times \left(\frac{R_e}{R_m}\right)^2 = \frac{1}{10} \times (2)^2 = \frac{4}{10}$$

$$a_g^m = \frac{4}{10}\, a_g^e = 0.4 \times 9.8 = 3.9\ m/s^2$$

$$W_e = m\, a_g^e = 650\,N \Rightarrow m = \frac{650}{9.8} = 66.3\ kg$$

$$W_m = m\, a_g^m = 66.3 \times 3.9 = \boxed{259\,N}$$

The mass is the same on Earth and on Mars!!!

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Quiz # 10b

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Name: Key Id: Sect:

How much energy is required to move a 1000 kg mass from the Earth's surface to an altitude of three times the Earth's radius?

(Given: Me = 5.98 x 10^{24} kg, Re = 6.37 10^{6} m, G = 6.65 x 10-11 Nm^2/kg^2)

The mass start from rest and Comes to rest !

$v_i = 0$ and $v_f = 0$

Work done by the gravitational force

$\Rightarrow W = -\Delta U$ (chapter 8)

$$W = -(U_f - U_i) = U_i - U_f$$

$$= -\frac{GMm}{R_e} + \frac{GMm}{4R_e}$$

$$= \frac{GMm}{R_e}\left(\frac{1}{4} - 1\right) = -\frac{3GMm}{4R_e}$$

$$= -4.68 \times 10^{10}\ J$$

Energy required = $-$ W done by the gravitational force.

$$= \boxed{4.68 \times 10^{10}\ J}$$