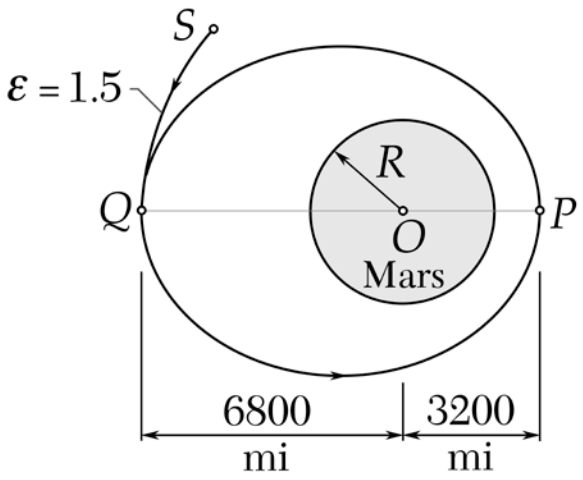
MEEG 4003 Quiz #12.m07.smuq.093

1. ⑦ A spacecraft approaches Mars along a hyperbolic trajectory *SQ* as shown. As it reaches *Q*, retrorockets are fired momentarily to insert it into an elliptic orbit as indicated. If the mass of Mars is 0.1077 times of the mass of the Earth, determine for the spacecraft (*a*) its speed $(v_Q)_{\text{hyp}}$ as it approaches *Q*, (*b*) its speed $(v_Q)_{\text{ell}}$ after firing of retrorockets, (*c*) the time t_{QP} required to travel from *Q* to *P*.



2. ③ Describe (*a*) Newton's second law, (*b*) Newton's law of gravitation, (*c*) central force.

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1. (*a*) $\dfrac{1}{r_Q} = \dfrac{GM_M}{h_1^2}(1+\varepsilon\cos\theta) = \dfrac{GM_E(M_M/M_E)}{r_Q^2(v_Q)_{\text{hyp}}^2}(1+\varepsilon\cos\theta), \qquad GM_E = g_E R_E^2$

$$\frac{1}{6800} = \frac{\frac{32.2}{5280}(3960)^2(0.1077)}{(6800)^2(v_Q)_{\text{hyp}}^2}(1+1.5\cos 0)$$

$(v_Q)_{\text{hyp}} = 1.946$ mi/s ③

(*b*) $\dfrac{1}{r_P}+\dfrac{1}{r_Q} = \dfrac{2GM_M}{h_2^2} = \dfrac{2GM_E(M_M/M_E)}{r_Q^2(v_Q)_{\text{ell}}^2}$

$$\frac{1}{3200}+\frac{1}{6800} = \frac{2\left(\frac{32.2}{5280}\right)(3960)^2(0.1077)}{(6800)^2(v_Q)_{\text{ell}}^2}$$

$(v_Q)_{\text{ell}} = 0.98458$ mi/s

(*c*) $t_{QP} = \dfrac{\tau}{2} = \dfrac{\pi(r_P+r_Q)\sqrt{r_P r_Q}}{2h_2} = \dfrac{\pi(3200+6800)\sqrt{3200(6800)}}{2(6800)(0.98458)}$ s = 10944 s

$(v_Q)_{\text{ell}} = 0.985$ mi/s ② $t_{QP} = 3.04$ hours ②

2. (*a*) The resultant force acting on a particle is proportional to the acceleration of the particle. ① (*b*) The mutual attractive forces between any two particles are directed along the line joining the particles, and their magnitude is directly proportional to the product of the particles' masses and inversely proportional to the square of the distance between the particles. ① (*c*) A central force acts on a body and passes through a fixed point at all times. ①