Physics 20 - Lesson 21
Universal Gravitation

possible 31 /26

1)

$$F_g = G\frac{m_1 m_2}{r^2}$$

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$$F_g = 6.67\times10^{-11}\ \tfrac{Nm^2}{kg^2}\ \frac{(1.8\times10^{8}\,kg)(1.8\times10^{8}\,kg)}{(94_m)^2}$$

$$\boxed{F_g = 2.4\times10^{2}\,N}$$

2)

$$F_g = G\frac{m_1 m_2}{r^2}$$

/3

$$F_g = 6.67\times10^{-11}\ Nm^2/kg^2\ \frac{(5.98\times10^{24}\,kg)(50.0_{kg})}{(6.38\times10^{6}\,m)^2}$$

$$\boxed{F_g = 4.9\times10^{2}\,N}$$

3)

$$F_g = G\frac{m_1 m_2}{r^2} \qquad 36\,N = G\frac{m_1 m_2}{r^2}$$

/3

One of the masses is doubled (x 2) and the distance is tripled (x $\frac{1}{3^2}$)

$F_g' = 36$ N (x 2)(x $\frac{1}{3^2}$)

$\boxed{F_g' = \mathbf{8.0\ N}}$

4)

$$m = \frac{F_g}{a_g} \qquad F_{gMars} = G\frac{m_1 m_2}{r^2}$$

$$m = \frac{600N}{9.81\,N/kg} \qquad F_{gMars} = 6.67\times10^{-11}\ Nm^2/kg^2\ \frac{(6.37\times10^{23}\,kg)(61.162_{kg})}{(3.43\times10^{6}\,m)^2}$$

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$$m = 61.162kg \qquad \boxed{F_{gMars} = 221N}$$

5)

$$F_g = G\frac{m_1 m_2}{r^2}$$

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$$F_g = 6.67\times10^{-11}\ Nm^2/kg^2\ \frac{(70_{kg})(60_{kg})}{(0.10_m)^2}$$

$$\boxed{F_g = 2.8\times10^{-5}\,N}$$

6)

$$F_g = G\frac{m_1 m_2}{r^2}$$

$$r = \sqrt{\frac{G m_1 m_2}{F_g}}$$

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$$r = \sqrt{\frac{6.67\times10^{-11}\ {Nm^2}/{kg^2}\,(3.0\times10^8\,kg)(3.0\times10^8\,kg)}{37.5N}}$$

$$\boxed{r = 400\,m}$$

7)

$m_2 = 5\ m_1$

$$F_g = G\frac{m_1 m_2}{r^2}$$

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$$F_g = G\frac{m_1(5m_1)}{r^2}$$

$$F_g = G\frac{5m_1^{\,2}}{r^2}$$

$$m_1 = \sqrt{\frac{F_g r^2}{5G}}$$

$$m_1 = \sqrt{\frac{333.5N(500m)^2}{5(6.67\times10^{-11}\ {Nm^2}/{kg^2})}}$$

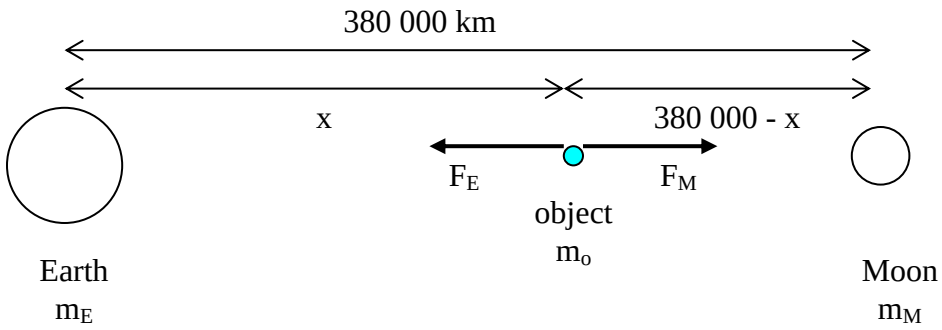
$$\boxed{m_1 = 5.0\times10^8\,kg}$$

$$m_2 = 5(5.0\times10^8\,kg)$$

$$\boxed{m_2 = 2.5\times10^9\,kg}$$

8)

bonus /5



$$F_E = F_M$$

$$G\frac{m_E m_o}{x^2} = G\frac{m_M m_o}{(380000-x)^2}$$

$$\frac{m_E}{x^2} = \frac{m_M}{(380000-x)^2}$$

$$(380000-x)^2\frac{m_E}{m_M} = x^2$$

$$\sqrt{(380000-x)^2\frac{m_E}{m_M}} = \sqrt{x^2}$$

$$(380000-x)\sqrt{\frac{m_E}{m_M}} = x$$

$$380000\sqrt{\frac{m_E}{m_M}} - \sqrt{\frac{m_E}{m_M}}\,x = x$$

$$380000\sqrt{\frac{m_E}{m_M}} = x + \sqrt{\frac{m_E}{m_M}}\,x$$

$$380000\sqrt{\frac{m_E}{m_M}} = x\left(1+\sqrt{\frac{m_E}{m_M}}\right)$$

$$\frac{380000\sqrt{\frac{m_E}{m_M}}}{\left(1+\sqrt{\frac{m_E}{m_M}}\right)} = x$$

$$\frac{380000\sqrt{\frac{5.98\,x10^{24}}{7.34\,x10^{22}}}}{\left(1+\sqrt{\frac{5.98\,x10^{24}}{7.34\,x10^{22}}}\right)} = x$$

$$x = 3.42 \text{ x } 10^5 \text{ km}$$