PHY203 - UNIT EXAM IV

UNIVERSITY OF RHODE ISLAND DECEMBER 5, 2002

NAME: _____

STUDENT ID: _____

SECTION: 9 AM 1 PM 2 PM 3 PM H

1:	/33
2:	/33
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TOTAL:	/100

1. An apple of mass 0.1 kg is located on the surface of the moon. The moon's radius is 0.272 times the earth radius, and its mass is smaller than the earth mass by a factor of 81.3. Assume that there are no other objects in the universe. — Parts (c) and (d) may be answered independently —

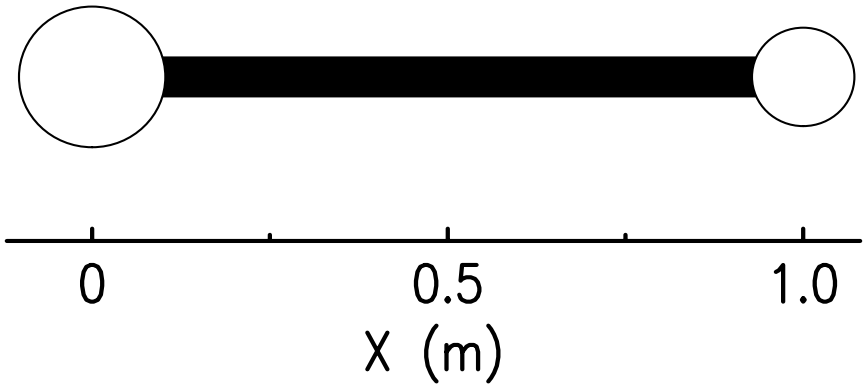
(a) What is the magnitude of the gravitational field on the apple? [8 pts]

(b) What is the apple's weight on the moon? [8 pts]

(c) With what velocity does the apple have to be launched in order to escape the moon's gravity? [8 pts]

(d) If the apple is thrown vertically upwards with an initial velocity of 10 m/s, what is the maximum height the apple reaches before falling back to the surface of the moon? [9 pts]

2. A dumbbell system consists of a thick rod of length 1 m and mass 1 kg, a solid sphere of mass 6 kg attached to the left end of the rod, and a solid sphere of mass 2 kg attached to the right end of the rod. — Parts (b) and (c) may be answered independently —



(a) Suppose you would like to support the dumbbell with a fulcrum and maintain the dumbbell horizontal. Roughly indicate the position of the fulcrum in the above diagram and identify all forces exerted on the dumbbell. [9 pts]

(b) How large is the supporting force exerted on the dumbbell by the fulcrum? [12 pts]

(c) Find the exact location of the fulcrum that will maintain the dumbbell perfectly horizontal. [12 pts]

3. A massless spring of force constant 400 N/m and equilibrium length 1 m is lying on a frictionless horizontal surface. One end of the spring is attached to a fixed wall. The other end of the spring is attached to a block of mass 4 kg.

Suppose you pull the block away from the spring, so that the spring is stretched by 40 cm. At time t = 0 s, you release the block and observe the motion of the block. — Parts (a)-(f) may be answered independently —

(a) Sketch qualitatively a graph of the displacement of the block versus time. [5 pts]

(b) At a later time when the spring is compressed, what is the shortest length the spring can have? [5 pts]

(c) What is the angular frequency of the motion of the block? [5 pts]

(d) Write the equation of motion of the block as a function of time. [5 pts]
$x(t) =$

(e) At what time after t = 0, does the block return to its initial position x(0)? [5 pts]

(f) What is the maximum speed of the block? [9 pts]

Crib Sheet — Unit Exam IV

Gravitational Force $\vec{F}_{12}(\vec{r}_{12}) = -\frac{Gm_1m_2}{r_{12}^2} \quad \hat{r}_{12}$

Gravitational Potential Energy: $U(r_{12}) = -\frac{Gm_1m_2}{r_{12}}$

Gravitational Field: $\vec{g}(\vec{r}) = -\frac{GM}{r^2} \quad \hat{r}$

Gravitational Constant: $G = 6.672 \times 10^{-11} \quad Nm^2kg^{-2}$

Earth Radius: $R_E = 6.378 \times 10^6 \quad m$

Earth Mass: $M_E = 5.972 \times 10^{24} \quad kg$

$\frac{GM_E}{R_E^2} = 9.81 \ m/s^2$

Static Equilibrium: $\sum_i \vec{F}_i = 0$ and $\sum_i \vec{\tau}_i = 0$

Torque: $\vec{\tau} = \vec{r} \times \vec{F}$

Simple Harmonic Oscillator: $x(t) = A\cos(\omega t + \delta)$

$v(t) = \frac{dx(t)}{dt}$

$a(t) = \frac{dv(t)}{dt}$

$\omega = \sqrt{\frac{k}{m}}$

Hooke's Law: $F(x) = -kx$

Spring Potential Energy: $U(x) = \frac{1}{2}kx^2$