Physics 10
Midterm #1
10/24/2017

Family name: Liu **First name:** Muchen

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Problem #1	**a./**	10
	b./	10
Problem #2		20
Problem #3	**a./**	10
	b./	10
Problem #4		20
Problem #5		20

Total: 100

20

Family name: Liu **First name:** Mucheh

Problem # 1

A sprinter with a mass of 60kg can reach a speed of 10m/s in 1 second. If the sprinter acceleration is constant during that time,
a./ what is the sprinter acceleration?
b./ how much forward force must be exerted on the sprinter during this time?

a. $a = \frac{Vf - V0}{\Delta t} = \frac{10m/s - 0}{1s} = 10m/s^2$

b. $F = ma = 60kg \times 10m/s^2$

$= 600 N$

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Problem # 2

A highly compressed spring releases 2J of elastic potential when allowed to expand 1mm, a small fraction of its overall compression. How much force is the spring exerting on its end?

$1mm = 0.001m$

$$F = \frac{W}{\Delta x} = \frac{2J}{0.001m} = 2000N$$

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Problem # 3

A satellite is orbiting Earth just above its surface The centripetal force making the satellite follow a circular trajectory is just its weight, so its centripetal acceleration is $9.8m/s^2$ (the acceleration due to gravity near the Earth's surface) If the Earth's radius is about 6375km,
a./ how fast must the satellite moving?
b./ How long will it take for the satellite to complete one trip around the Earth?

a. Since $a_{cf} = \frac{v^2}{r}$ and $6375\,km = 6.375\times10^6 m$

$\therefore v = \sqrt{a_{cf}} = \sqrt{a_{cf}\times r} = \sqrt{9.8 m/s^2 \times 6.375\times10^6 m}$

$\approx 7904.1\ m/s$ ✓

b. Circum of earth is $2\pi r$

$\therefore t = \frac{2\pi r}{v} = \frac{2\pi r}{\sqrt{a_{cf}\times r}} = 2\pi \times \sqrt{\frac{r}{a_{cf}}}$ ✓

$= 2\times3.14\times\sqrt{\frac{6.375\times10^6\ m}{9.8\ m/s^2}} \approx 5065.1\ s$

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Problem # 4

If you and a friend 10 m away each have masses of 70 kg, how much gravitational force are you exerting on your friend?
(the gravitational constant G = 6.67 x 10^{-11} $m^3kg^{-1}s^{-2}$)

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

$$= \frac{6.67\times10^{-11}\ m^3/kg\,s^2 \times 70\ kg \times 70\ kg}{(10\ m)^2}$$

$$\approx 3.27\times10^{-9}\ N$$

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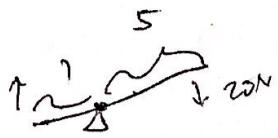
Problem # 5

When you push down on the handle of a doll-like wooden nutcracker, its jaw pivots upward and cracks a nut. If the point at which you push down on the handle is five times as far from the pivot as the point at which the jaw pushes on the nut, how much force will the jaw exert on the nut if you exert a force of 20N on the handle (Assume all forces are at right angles to the lever arms involved)



Assume distance from You to pivot is $5r$ and Jaw to pivot is r.

We have

$$\tau = 5r F_{\perp me} = r F_{\perp Jaw}$$

Thus $$\frac{F_{\perp Jaw}}{F_{\perp me}} = 5$$

$$\therefore F_{\perp Jaw} = 5 \times 20\,N = 100\,N$$