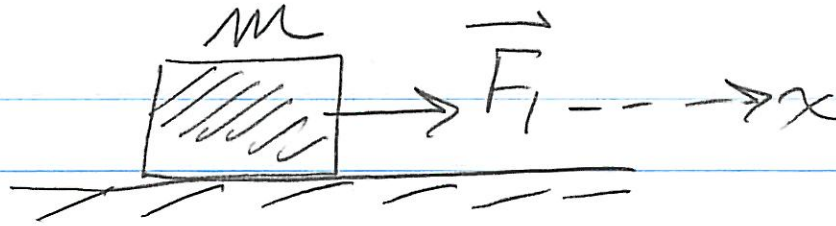
Part 1

4-3



$F_1 = 9N$
$m = 3kg$

$$\vec{F}_1 + \vec{F}_2 = m\vec{a}$$

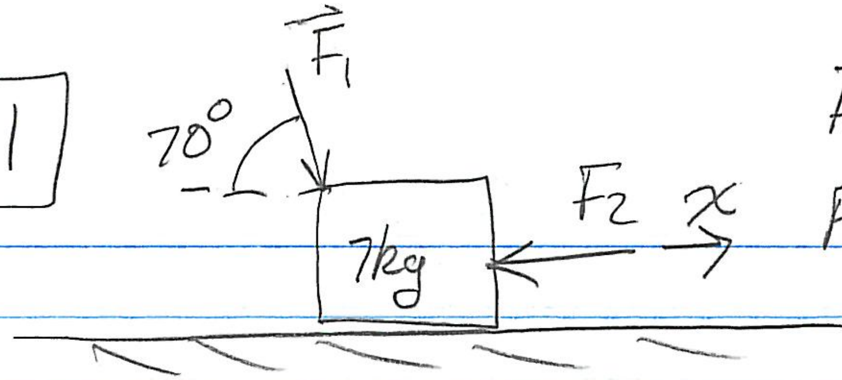
$$F_1 + F_2 = ma$$

(a) $F_2 = ma - F_1$
$= 3 \cdot (+5 m/s^2) - 9$
$= 15 - 9 = \underline{\underline{+6N}}$

(b) $F_2 = ma - F_1$
$= 3(-5 m/s^2) - 9$
$= -15 - 9 = \underline{\underline{-24N}}$

(c) $F_2 = -F_1 = \underline{\underline{-9N}}$

4-11



$F_1 = 59N$

$F_2 = 33N$

Take $+x \longrightarrow$

$$\Sigma F_x = m a_x$$

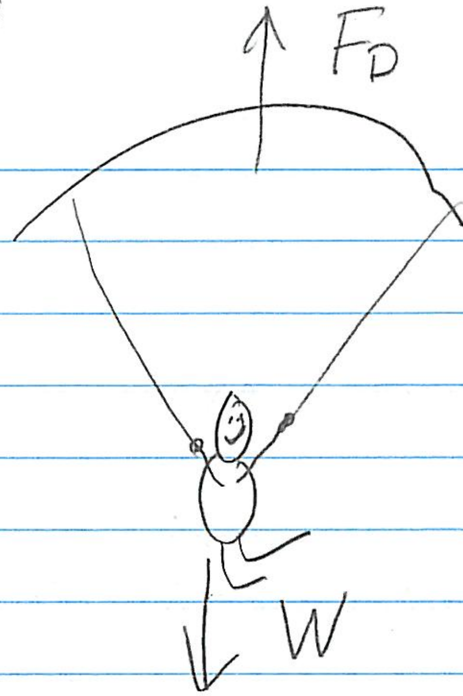
$$F_1 \cos 70 - F_2 = m a_x$$

$$59 \cos 70 - 33 = 7 a_x$$

$$20.2 - 33 = 7 a_x$$

$$a_x = -1.8 \ m/s^2 \ (\leftarrow)$$

4-14



$$\Sigma F = F_D - W = ma$$

$$1027 - 915 = 93.4\,a$$

$$a = +1.2\ m/s^2 \uparrow \text{up.}$$

4-15 Avg accel $\bar{a} = \frac{\Delta v}{\Delta t} = \frac{220\ m/s}{6.5 \times 10^{-3}\ s}$

$$\bar{a} \simeq 33846\ m/s^2$$

$$\bar{F} \simeq m\bar{a}$$

$$\simeq 1.39 \times 10^6\ N$$

4-25

$$F_G = \frac{G\, m\, M_{SAT}}{R_{SAT}^2}$$

$$= m \underbrace{\left(\frac{G M_{SAT}}{R_{SAT}^2}\right)}_{g_{SAT}}$$

(a)

$$g_{SAT} = \frac{G M_{SAT}}{R_{SAT}^2} = \frac{6.67\times10^{-11} \times 5.67\times10^{26}\ \text{kg}}{(6\times10^{7}\ \text{m})^2}$$

$$= \underline{10.5\ \text{m/s}^2}$$

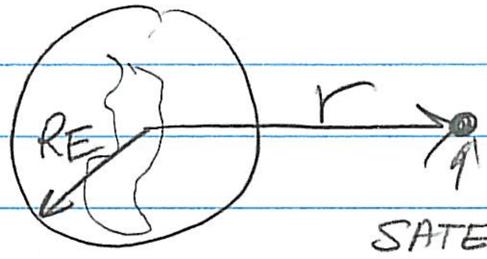
(b)

$$\frac{W_{SAT}}{W_{EARTH}} = \frac{\cancel{m}\, g_{SAT}}{\cancel{m}\, g_{EARTH}} = \underline{1.07}$$

you weigh <u>7%</u> more on <u>SATURN</u>

4-27

$$a = \frac{G M_E}{r^2}$$



$r = R_E + h$

where h is the altitude (distance above surface)

$r = 6.38 \times 10^6 m + 3.59 \times 10^7 m$

$= 4.2 \times 10^7 m$

$M_E = 5.98 \times 10^{24} m$

$$a = \frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24} kg}{(4.2 \times 10^7 m)^2}$$

$a = 0.22 \, m/s^2$

4-29

(a) $F = \dfrac{G m_S M_E}{r^2}$, $r = 2R_E$

$$F = \frac{6.67\times10^{-11} \times 425\,kg \times 5.98\times10^{24}\,kg}{(2\cdot 6.38\times10^{6}\,m)^2}$$

$F = 1.04\times10^{3}\ N$

(b) $F_{E\to S} = F_{S\to E} = 1.04\times10^{3}\ N$

(c) $m_S a_S = F_{E\to S} = 1.04\times10^{3}\ N$

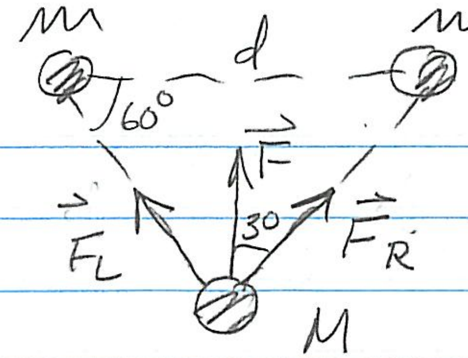
$a_S = 2.45\ m/s^2$

(d) $M_E a_E = F_{S\to E} = 1.04\times10^{3}\ N$

$a_E = 1.74\times10^{-22}\ m/s^2$

So, even though $F_{E\to S} = F_{S\to E}$ by Newton's 3RD LAW, $a_E \ll a_S$

4-32



let M be the MASS of the bottom sphere

$m = 2.8\ kg$
$d = 1.2 m$

F_L is the force on M due to the sphere on the left and F_R is the force on M due to the sphere on the Right. Since the left & right masses are the same and the distances to the bottom sphere are also the same

$$F_L = F_R = \frac{G m M}{d^2}$$

$\vec{F}_M = \vec{F}_L + \vec{F}_R$, we must add only the vertical components of $\vec{F}_L$ and $\vec{F}_R$ because the horizontal components are in opposite directions and add to 0

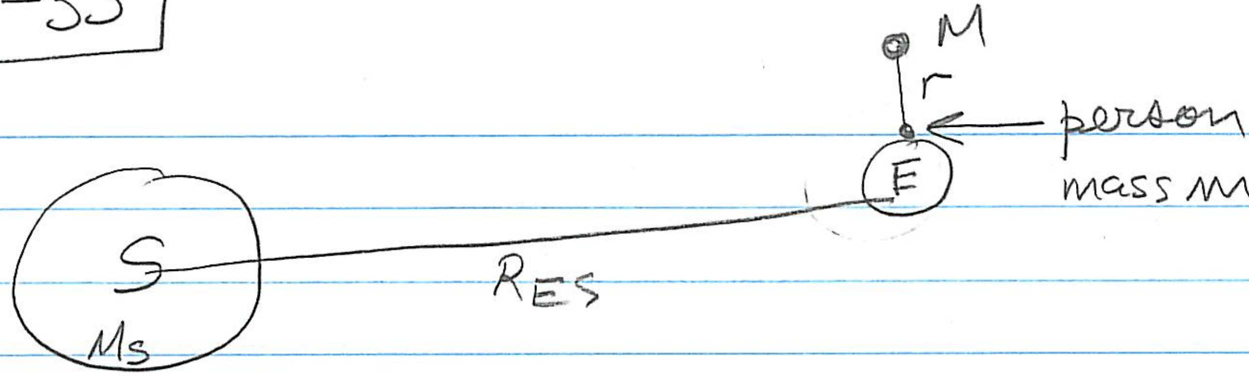
$$F_M = F_L \cos 30^\circ + F_R \cos 30^\circ = 2F_L \cos 30$$

$$2 \cdot \frac{G m \not{M}}{d^2} \cos 30^\circ = \not{M} a_M$$

$$a_m = \frac{2 \times 6.67 \times 10^{-11} \times 2.8 kg \cos 30}{(1.2 m)^2}$$

$$= 2.25 \times 10^{-10} \ m/s^2$$

4-35



$R_{ES} = 1.5 \times 10^{11}$ m $\qquad M_S = 1.99 \times 10^{30}$ kg

$R_{EM} = 3.85 \times 10^{8}$ m $\qquad M_M = 7.35 \times 10^{22}$ kg

$R_E = 6.38 \times 10^{6}$ m

(DATA from inside cover of text)

Since $R_{EM} \gg R_E$, $r \approx R_{EM}$

$$\frac{F_{sun}}{F_{moon}} = \frac{\frac{G m M_S}{(R_{ES})^2}}{\frac{G m M_M}{(R_{EM})^2}} = \frac{M_S}{M_M}\left(\frac{R_{EM}}{R_{ES}}\right)^2$$

$$= \frac{1.99 \times 10^{30}}{7.35 \times 10^{22}} \cdot \left(\frac{3.85 \times 10^{8}}{1.5 \times 10^{11}}\right)^2$$

$$= \underline{\underline{178}}$$