Dynamics Review Probs (Ch 2+3)

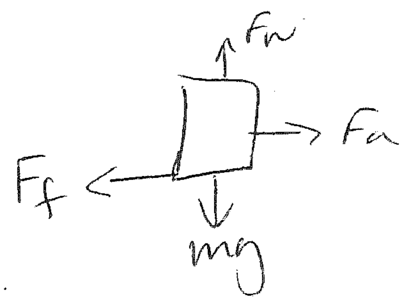
1. $F = ma$

$= m\left(\frac{v_f - v_i}{\Delta t}\right)$

$= (0.250\,kg)\left(\frac{6-0}{0.2}\right)$

$\boxed{F = 7.50N}$

2.



$F_f = \mu F_N$

$\Sigma F_x = 0 = F_a - F_f$

$F_a = \mu F_N$

$\mu = \frac{F_a}{mg} = \frac{210N}{(22.7kg)(9.8)}$

$\boxed{\mu = 0.94}$

3. $\Sigma F = ma$

$\boxed{\Sigma F = 32N}$

4. $\Sigma F = ma = m\left(\frac{v_f - v_i}{\Delta t}\right)$

$= (5kg)\left(\frac{3-7}{3}\right)$

$\boxed{\Sigma F = -6.7N}$

5. (a) $F_f = ma = m\left(\frac{v_f^2 - v_i^2}{2\Delta d}\right)$

$v_f^2 = 2a\Delta d + v_i^2$

$a = \frac{v_f^2 - v_i^2}{2\Delta d}$

$= (600)\left(\frac{0 - 30^2}{2 \times 70}\right)$

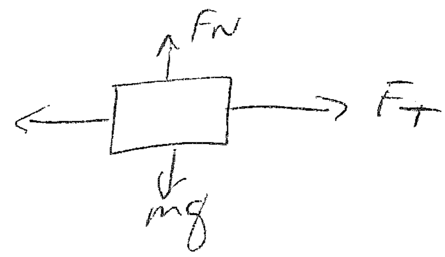
$\boxed{F_f = -3.86 \times 10^3\,N}$

(b) $F_f = \mu F_N$

$\mu = \frac{3857}{(600) \times (9.8)}$

$\boxed{\mu = 0.656}$

6.



(a) $\Sigma F_x = ma = F_T - F_f$

$$a = \frac{1500 - 950}{700}$$

$$\boxed{a = 0.79 \text{ m/s}^2}$$

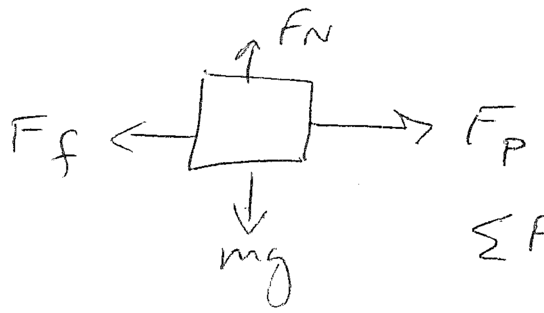
(b) $\Sigma F_x = ma = F_T - F_f$

$$a = \frac{750 - 950}{700}$$

$$\boxed{a = -0.29 \text{ m/s}^2}$$

car is slowing down

7.



$F_N = mg$

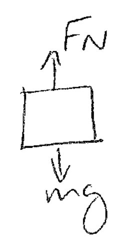
$\Sigma F_x = ma = F_p - F_f$

$$a = \frac{F_p - \mu F_N}{m}$$

$$a = \frac{400 - (0.5)(70)(9.8)}{70}$$

$$\boxed{a = 0.81 \text{ m/s}^2}$$

8. $\overset{+}{\uparrow}\overset{-}{\downarrow}$



$\Sigma F = ma = F_N - mg$

$F_N = m(a + g)$

$\boxed{F_N = \text{apparent weight}}$

(a) $a = +1.8 \text{ m/s}^2$ $F_N = (71.4)(1.8 + 9.8)$ $\boxed{F_N = 828 \text{ N}}$

(b) $a = -1.8 \text{ m/s}^2$ $F_N = (71.4)(-1.8 + 9.8)$ $\boxed{F_N = 571 \text{ N}}$

(c) $a = -9.8 \text{ m/s}^2$ $F_N = (71.4)(-9.8 + 9.8)$ $\boxed{F_N = 0 \text{ N}}$

(d) $a = 0 \text{ m/s}^2$ $F_N = (71.4)(0 + 9.8)$ $\boxed{F_N = 670 \text{ N}}$ ← weight.

Dynamics Review Problems

9. $F_N = mg = (65\,kg)(1.60\,N/kg) = \boxed{104\,N}$

10. Static friction: force between two surfaces that are <u>not moving</u> relative to each other. The force is due to the roughness between the surfaces (resistance to sliding across each other).
Kinetic friction: force between two surfaces that are in motion relative to each other - <u>sliding</u> across each other. This force resists the sliding.
Static friction is greater than kinetic.

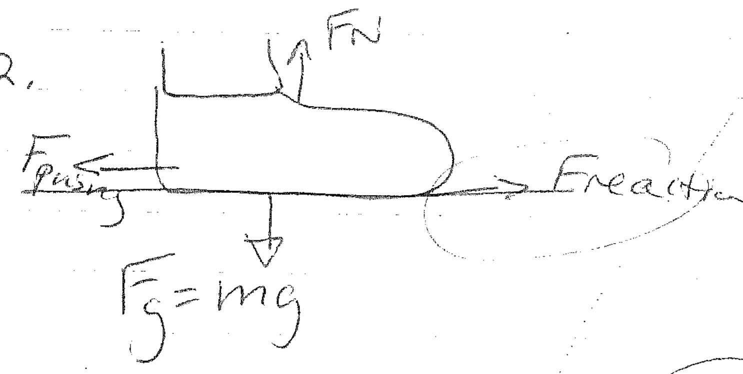
11. (a) <u>Newton's 3rd Law:</u> action-reaction
- the skateboarder exerts a force on the tree when he/she hits the tree, and the tree exerts an equal and opposite force on the boarder.

(b) <u>Newton's 1st Law</u> = inertia
- the cart was already moving, and tended to continue moving. In order to change the state of motion of the cart, the librarian had to apply a force

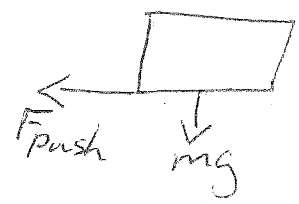
and <u>Newton's 2nd Law</u>: $\Sigma F = m\vec{a}$
- in order to push the cart at a constant speed ($\vec{a} = 0$) the librarian had to push with a force equal and opposite to the resistive forces (friction). But, in order to stop the cart ($\vec{a} \neq 0$) the librarian had to apply an unballanced force.

(c) <u>Newton's 1st Law</u> inertia
- all people in the car were moving at the speed of the car. <u>Inertia</u> means that they all tend to continue to move. When the car stopped, the woman was stopped by her seat belt, but the baby kept moving (use seat belts/restraints!)

12.



fbd forces the foot exerts on the ground



fbd

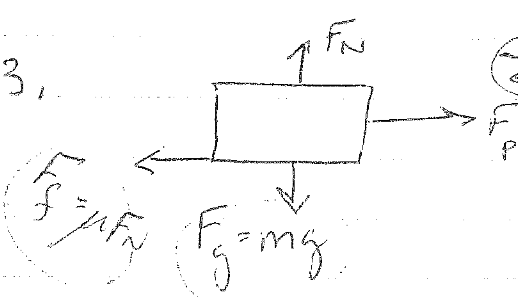
(reaction to push)

forces the ground exerts on the foot

- the foot presses downward against the ground (F_g) and the ground reacts with an upward force (F_N)
- The foot pushes backward on the ground (F_{push})
- If the coefficient of static friction (μ_s) between the foot and the ground is large enough to prevent slipping, the ground will react with a forward force of static friction (F_{fs}). The magnitude of $\boxed{F_{fs} = \mu_s F_N}$.

The F_{fs} prevents the foot from sliding, and the person can lean forward to shift their other foot to a location in front of them. That is one step.

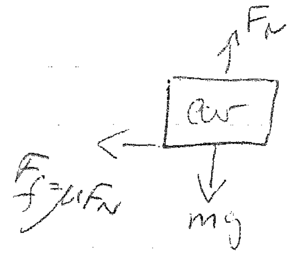
13.



$\rightleftarrows +$

$$\Sigma F_y = 0 = F_N - mg$$
$$\therefore F_N = mg$$
$$\Sigma F_x = ma_x = F_p - F_f$$
$$\therefore ma = F_p - \mu F_N$$
$$\therefore \mu = \frac{F_p - ma}{F_N} = \frac{F_p - ma}{mg}$$
$$\mu = \frac{255\,N - (25\,kg)(3.5\,m/s^2)}{(25\,kg)(9.8\,N/kg)}$$
$$\boxed{\mu = 0.68}$$

14. fbd



$\longrightarrow +$

$(F_N - mg = 0)$
$\therefore F_N = mg$

$\Sigma F_x = ma_x = -\mu F_N$

$\therefore \cancel{m}a = -\mu \cancel{m}g$

$\therefore a = -\mu g$

$V_i = \frac{120\ km/h}{3.6\ m/s} =$

$V_f = 0$

$\Delta d = ?$

$V_f^2 = 2a\Delta d + V_i^2$

$\Delta d = \frac{V_f^2 - V_i^2}{2a}$

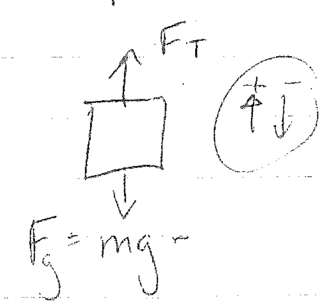
$= \frac{0 - \left(\frac{120}{3.6}\right)^2}{2(-0.68 \times 9.8)} = \boxed{83.4\,m}$

Yikes! The stopping distance is too long!! The deer must wake up and RUN!

15. (a) the rope exerts the reaction force = 150 N (down)

(b) rope

(c)



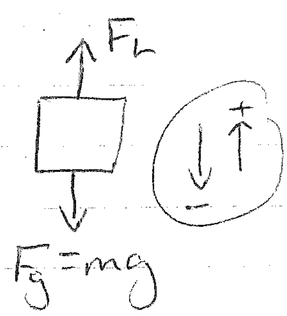
(d) $\Sigma F = F_T - F_g$
$= 150N - 130N$
$\boxed{\Sigma F = 20N \text{ (up)}}$

(e) $\Sigma F = m\vec{a} = 20N$ (up)
$a = \frac{20N}{m} = \frac{20N}{(130/9.8)}$

$F_g = mg = 130N$
$\therefore m = \frac{130N}{g}$

$\boxed{a = 1.5\,m/s^2 \text{ (up)}}$

16.



$\Sigma F = m\vec{a} = F_L - mg$
$\therefore F_L = ma + mg = m(a+g)$

$F_L = (3500\,kg)(-2.5\,m/s^2 + 9.8\,m/s^2)$
$\boxed{F_L = 2.56 \times 10^4\,N \text{ (up)}}$

17. $v_i = 1.56\,m/s$

$t = 20.0\,s$

$v_f = 6.3\,m/s$

$a = ?$

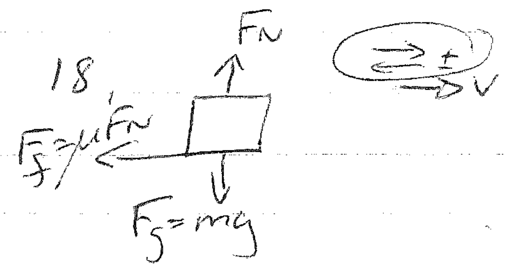
$$a = \frac{v_f - v_i}{\Delta t}$$

$$\Sigma F = ma = m\left(\frac{v_f - v_i}{\Delta t}\right)$$

$$= (45\,kg)\left(\frac{6.3\,m/s - 1.56\,m/s}{20.0\,s}\right)$$

$$\boxed{\Sigma F = 11\,N}$$

18.



$v_i = 27\,m/s$

$\Delta d = 45\,m$

$v_f = 0\,m/s$

$a = ?$

$$\Sigma F_x = ma = -F_f$$

$$\therefore F_f = -ma$$

$$v_f^2 = 2a\Delta d + v_i^2$$

$$a = \frac{v_f^2 - v_i^2}{2\Delta d}$$

$$\therefore F_f = -m\left(\frac{v_f^2 - v_i^2}{2\Delta d}\right)$$

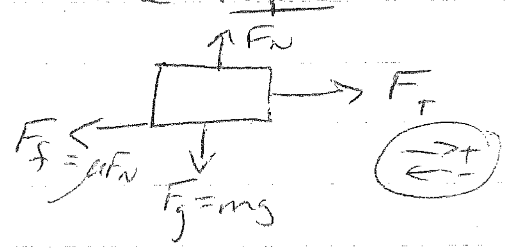
$$= -(1800\,kg)\left(\frac{0^2 - 27^2}{2(45)}\right)$$

$$\boxed{F_f = 1.2\times10^4\,N}$$

19. (a) $F_{reaction} = 95\,N$ [East]

(b) the rope

(c)



(d) $\Sigma F_x = F_T - F_f$

$= F_T - \mu F_N$

$\Sigma F = F_T - \mu mg$

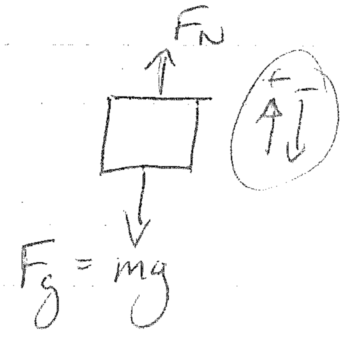
$= 95\,N - (0.45)(150)$

$$\boxed{\Sigma F = 27.5\,N}$$

(e) $\Sigma \vec{F} = m\vec{a}$

$$\vec{a} = \frac{\Sigma F}{m} = \frac{27.5\,N}{(150\,N / 9.8\,N/kg)} = \boxed{1.80\,m/s^2}$$

20. (a)



$$\Sigma F = ma = F_N - mg$$
$$F_N = m(a+g)$$
$$= 55(-0.98 m/s^2 + 9.8 m/s^2)$$
$$\boxed{F_N = 485 N}$$

(b) ~~mass~~ $ma = F_N - ma$

$$\therefore a = \frac{F_N - mg}{m} = \frac{585 - (55)(9.8)}{55}$$
$$\boxed{a = 0.84 m/s^2}$$

(c) $\boxed{F_N = 0 N}$

21. (a) $\text{mass} = \frac{F_g}{g} = \frac{555 N}{9.8 N/kg} =$

mass on the Moon is the <u>same</u> as on Earth.

(b) Weight $= F_g = 10 \times 555 N$

$$\boxed{F_g = 5550 N}$$

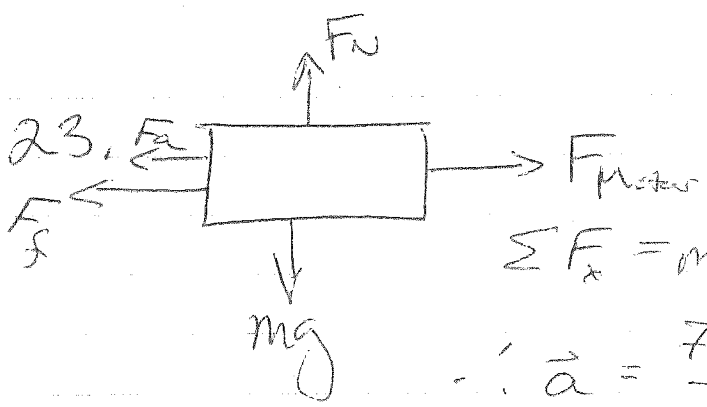
22. $\Sigma F_{Rock} = M_{Rock}\, a_{Rock} = M_{Rock}\, g$

$\Sigma F_{Earth} = M_{Earth}\, a_{Earth}$

<u>3rd law</u> $\Sigma F_R = \Sigma F_E$

$$M_R g = M_E a_E$$
$$\therefore a_E = \frac{M_R g}{M_E} = \frac{(5.50 \times 10^4 kg)(9.8 N/kg)}{5.98 \times 10^{24} kg}$$
$$\boxed{a_E = 9.0 \times 10^{-20} m/s^2}$$

23.



$$\Sigma F_x = ma_x = F_{motor} - (F_a + F_f)$$

$$\therefore \vec{a} = \frac{7.5\times10^3 N - (2.5\times10^3 + 2.2\times10^3)}{1.3\times10^3 kg}$$

$$\boxed{\vec{a} = 2.1 \ m/s^2 \text{ (to right)}}$$

24.

$$F_g = \frac{G m_1 m_2}{r^2} = m_2 g \quad \cdot \quad g = \frac{GM_E}{R_E^2}$$

$$g' = \frac{G(2M_E)}{(3R_E)^2} = \frac{2GM_E}{9R_E^2} = \frac{2}{9}g$$

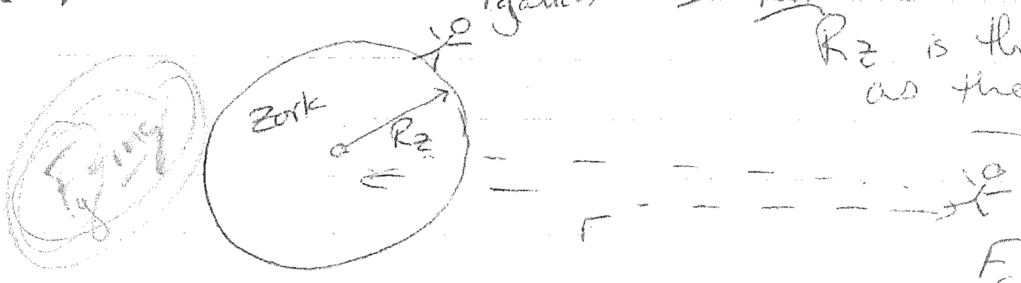
$$\therefore \boxed{g' = \frac{2}{9}g}$$

25.

$$F_g = \frac{G m_1 m_2}{r^2} = \frac{(6.67\times10^{-11})(2.5\times10^3)(20)}{(5)^2}$$

$$\boxed{F_g = 1.3\times10^{-7} N}$$

26.



* note: assume that R_Z is the same as the radius of Mars.

(a) $g = \frac{F_g}{m} = \frac{4.45 \times 10^3 N}{765 kg}$

$\boxed{g = 5.82 \cancel{N}/kg}$

(b) $F_g = \frac{G M_{alien} M_{Zork}}{r^2}$

~~on surface~~, $\therefore$ $M_{Zork} = \frac{F_g r^2}{G M_{alien}}$ ← constant

Surface — at r

$\frac{F_g R_Z^2}{\cancel{G} M_{alien}} = \frac{F_{g(at\ r)} r^2}{\cancel{G} M_{alien}}$

$\therefore F_{g(at\ r)} = \frac{F_{g(at\ surface)} R_Z^2}{r^2}$

$= \frac{(4.45 \times 10^3 N)(3.38 \times 10^6 m)^2}{(3.0 \times 10^5 \times 10^3 m)^2}$

$\boxed{F_g = 0.565 N}$