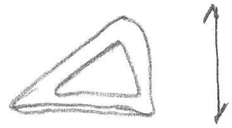
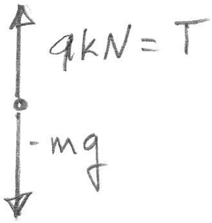
p. 286 Dr. Bob

1.



For a static system the breaking point is only due to weight.



$$T + W = T - mg = 0$$

$$T = mg$$

$$m = \frac{T}{g} = \frac{9000N}{9.8m/s^2} = 918\ kg$$

$$\boxed{m = 918kg}$$

2.

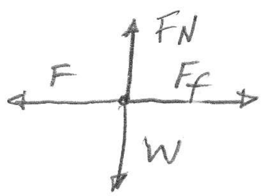
$m_1 = 629kg \quad m_2 = 8.8 \times 10^{25} kg$

$r = 2.71 \times 10^7 m + 1.50 \times 10^6 m = 2.86 \times 10^7 m$

$$F = G \frac{m_1 m_2}{r^2} = 6.67 \times 10^{-11} \frac{Nm^2}{kg^2} \frac{(629kg)(8.8 \times 10^{25} kg)}{(2.86 \times 10^7 m)^2}$$

$$\boxed{F = 4514\ N}$$

3.



$m = 230kg$
$F = 845N$
$\mu_s = 0.5$

$F_N + W = F_N - mg = 0 \quad F_N = mg$

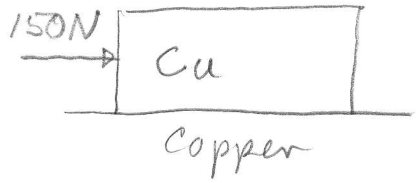
$F_N = (230kg)(9.8m/s^2) = 2254N$

$F_{f\,max} = \mu_s F_N = (0.5)(2254N) = 1127N$

$F_{f\,max} > 845N$

$\boxed{\text{He needs help to get it moving}}$

4.



$F_{f\,max} = 150N \quad \mu_s = 1.60$

$F_{f\,max} = \mu_s F_N$

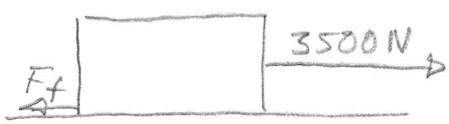
$F_N = -W = mg$

$F_{f\,max} = \mu_s m g$

$$m = \frac{F_{f\,max}}{\mu_s g} = \frac{150N}{(1.60)(9.8 m/s^2)}$$

$$\boxed{m = 9.57 \text{ kg}}$$

5.



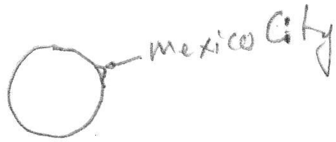
$F_{f\,max} = 3500N \quad \mu_s = 1.2$

From problem 4; $m = \dfrac{F_{f\,max}}{\mu_s g}$

$$m = \frac{3500N}{(1.20)(9.8 m/s^2)}$$

$$\boxed{m = 298 \text{ kg}}$$

6.



Avg. $r_{earth} = 6{,}371$ km $= 6.371 \times 10^6$ m

M.C. height $= 2200$ m $= 2.2 \times 10^3$ m

$$F_g = G\frac{m_1 m_2}{r^2} \qquad \frac{F_{avg}}{F_{M.C.}} = \frac{G m_1 m_2}{r_{avg}^2}\left(\frac{G m_1 m_2}{r_{MC}^2}\right)^{-1} = \frac{r_{MC}^2}{r_{avg}^2}$$

$$\frac{F_{avg}}{F_{MC}} = \frac{(6.371 \times 10^6 m)^2}{((6.371 + 0.0022) \times 10^6 m)^2} = \frac{(6.371)^2}{(6.3732)^2}$$

$$\frac{F_{avg}}{F_{MC}} = 0.9993$$

Not a big enough difference
-0.07% lower.

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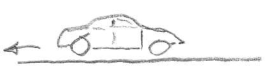
7. When the brakes are rolling, they are not sliding on the pavement. The friction force will be greatest for static friction - when not sliding.

Once the tires start to slide, the friction force will reduce, because the coeffiction of kinetic friction is lower than that of static friction (1.2 vs 0.8 for rubber on asphalt).

So the fastest way to stop with the largest stopping force is to brake only as hard as as possible without the tires sliding.

8.



$$m = 1250\ kg$$

$$F_N = mg = (1250kg)(9.8 m/s^2)$$

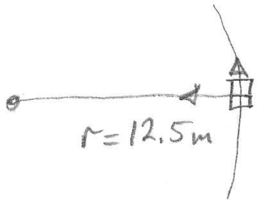
$$F_N = 12,250\ N$$

$$F_f = \mu F_N = \mu(12,250N)$$

	Asphalt μ	Asphalt F_f (N)	Concrete μ	Concrete F_f (N)
a) Wet	0.6	7350	0.7	8575
b) Dry	1.2	14,700	1.0	12,250
c) Dry sliding	0.8	9,800	0.7	8575

Asphalt is superior for stopping except for wet surfaces.

9.



The normal force provides the centripetal force for circular motion

$F_N = 1.2 \times 10^5\ N$

$$V = 250\,km/h \left(\frac{1h}{3600\,s}\right)\left(\frac{1000\,m}{1\,km}\right) = 69.4\,m/s$$

$$F_c = F_N \qquad \frac{mv^2}{r} = F_N$$

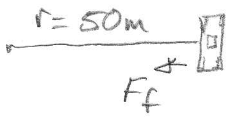
$$m = \frac{F_N\, r}{v^2} = \frac{(1.2\times10^5\,N)(12.5\,m)}{(69.4\,m/s)^2}$$

$$\boxed{m = 311\,kg}$$

Units $\frac{(kg \cdot m/s^2)(m)}{m^2/s^2} = kg$ ✓

10.

m = 1250kg



The friction force is what allows the car to turn. It is the centripetal force.

Prob. 4

$F_N = mg$

$\mu_s = 0.6 \quad F_{f\,max} = ?$

$$F_{f\,max} = \mu_s F_N = \mu_s m g$$

$$F_{f\,max} = (0.6)(1250\,kg)(9.8\,m/s^2)$$

$$F_{f\,max} = 7350\,N$$

Now find max velocity

$$F_c = F_{f\,max}$$

$$\frac{mv^2}{r} = F_{f\,max}$$

$$V^2 = \frac{(r)(F_{f\,max})}{m} \qquad V = \sqrt{\frac{(r)(F_{f\,max})}{m}}$$

$$V = \sqrt{\frac{(50\,m)(7350\,N)}{1250\,kg}}$$

$$\boxed{V = 17.1\,m/s}$$

Units:

$$\sqrt{\frac{m\,(kg\,m/s^2)}{kg}} = \sqrt{m^2/s^2} = m/s \checkmark$$

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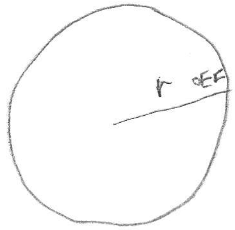
11.

$r = 175 m$



The centripetal acceleration for circular motion is

$$a_c = \frac{v^2}{r}$$

This must equal $g = 9.8 m/s^2$

$$a_c = g$$

$$\frac{v^2}{r} = g$$

$$V = \sqrt{g \cdot r} = \sqrt{(9.8 m/s^2)(175 m)}$$

$$\boxed{V = 41.4 m/s}$$

Extra

circumference $C = 2\pi r = 2\pi(175 m)$

period $T = t = \frac{d}{V} = \frac{2\pi(175 m)}{41.4 m/s} = 26.55 s$

The space station would need to make 1 complete rotation every, $T = 26.6 s$