

Conceptual Questions

1. Zero acceleration does not mean that there are no forces. It does mean that there is no net force. There could be canceling forces

2. A heavier rock experiences more force, but it also has more inertia, so it does not accelerate faster. *Their weight-to-mass ratios are the same.

Concise Answer

$$2\text{kg rock} \Rightarrow W = mg = 2\text{kg}(9.8\text{m/s}^2) = 19.6\text{N of weight}$$

$$\Sigma F = ma \Rightarrow 19.6\text{N} = 2\text{kg}(a)$$

$a = 9.8\text{m/s}^2$

$$1\text{kg rock} \Rightarrow W = mg = 1\text{kg}(9.8\text{m/s}^2) = 9.8\text{N of weight}$$

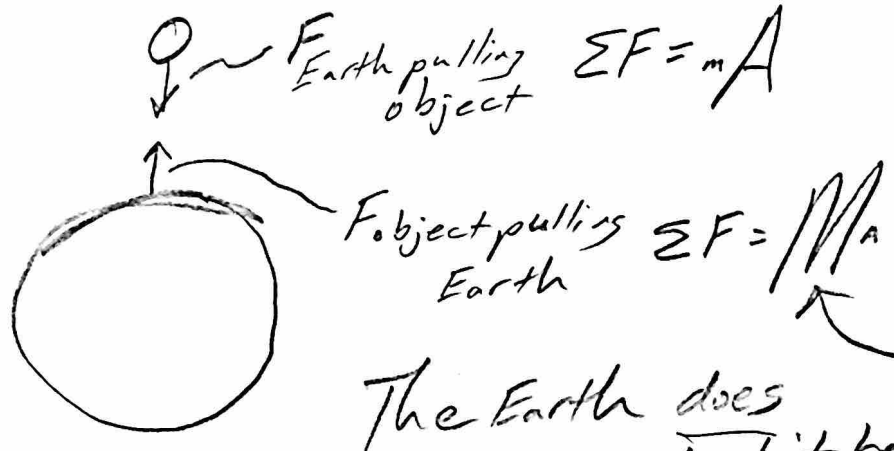
$$\Sigma F = ma \Rightarrow 9.8\text{N} = 1\text{kg}(a)$$

$a = 9.8\text{m/s}^2$

More force,
More mass (inertia),
Same Acceleration.

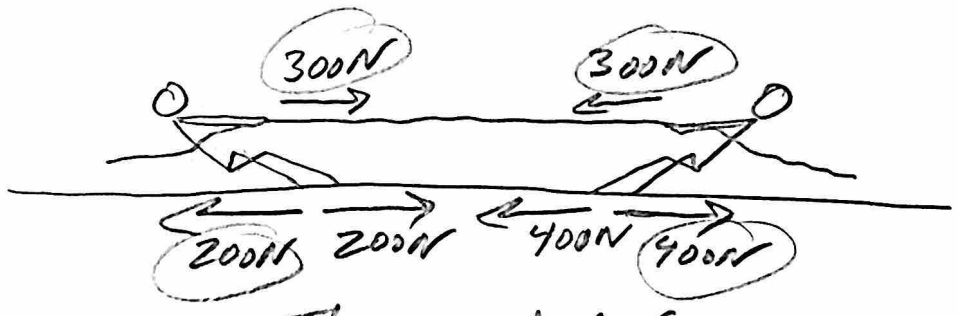
less force,
less mass (inertia),
Same acceleration

3.



The Earth does move, but it has so much mass that its acceleration is very small compared to the object's acceleration

4.



The circled forces are acting on the system of the people and rope.

The sum of those forces (Net force) is 200N to the right.

The team that pushes harder against the Earth will win.

Problems

1. $\boxed{\Sigma F = ma}$ $\Sigma F = 60 \text{ kg} (1.25 \text{ m/s}^2)$
 $\boxed{\Sigma F = 75 \text{ N}}$

2. $\boxed{\Sigma F = ma}$ $265 \text{ N} = m (2.3 \text{ m/s}^2)$
 $\boxed{m = 115 \text{ kg}}$

3. a) $W = mg_{\text{Earth}} = 76 \text{ kg} (9.8 \text{ m/s}^2) = \boxed{745 \text{ N}}$

b) $W = mg_{\text{moon}} = 76 \text{ kg} (1.7 \text{ m/s}^2) = \boxed{129 \text{ N}}$

c) $W = mg_{\text{mars}} = 76 \text{ kg} (3.7 \text{ m/s}^2) = \boxed{281 \text{ N}}$

d) $W = mg_{\text{outerspace with constant velocity}} = 76 \text{ kg} (0 \text{ m/s}^2) = \boxed{0 \text{ N}}$

4. $\boxed{\Sigma F = ma} = 1100 \text{ kg} (a)$ — we need a

$\Delta t = 8 \text{ s}$

$v_0 = 95 \text{ km/hr}$

$v = 0 \text{ m/s}$

$95 \frac{\text{km}}{\text{hr}} \left(\frac{1000 \text{ m}}{1 \text{ km}} \right) \left(\frac{1 \text{ hr}}{3600 \text{ s}} \right) = 26.4 \text{ m/s}$

$\boxed{v = v_0 + at} \Rightarrow 0 \text{ m/s} = 26.4 \text{ m/s} + a(8 \text{ s})$
 $a = -3.3 \text{ m/s}^2$

$\Sigma F = 1100 \text{ kg} (-3.3 \text{ m/s}^2) = \boxed{-3,630 \text{ N}}$

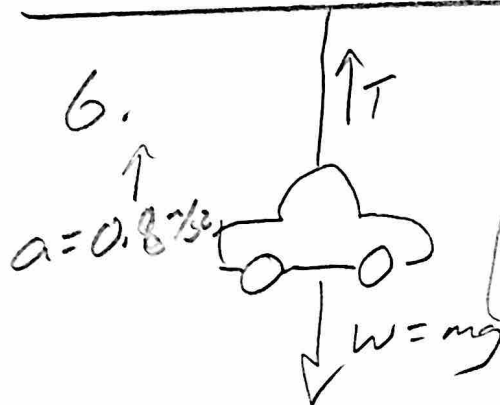
5. $\Sigma F = ma$ $\Sigma F = 0.140 \text{ kg} (a)$
 We need a

$v_0 = 35 \text{ m/s}$
 $v = 0 \text{ m/s}$
 $\Delta x = 0.11 \text{ m}$

$v^2 = v_0^2 + 2a \Delta x$
 $0 = (35 \text{ m/s})^2 + 2a(0.11 \text{ m})$

$a = 5570 \text{ m/s}^2$

$\Sigma F = 0.140 \text{ kg} (5570 \text{ m/s}^2) = 780 \text{ N}$



$\Sigma F = ma$
 $\Sigma F = T - mg$

$ma = T - mg$
 $ma + mg = T$

$m(a + g) = T$

$1200 \text{ kg} (0.8 \text{ m/s}^2 + 9.8 \text{ m/s}^2) = T$

$T = 12,720 \text{ N}$

7. The elevator can accelerate up or down



$$\Sigma F = ma$$
$$\Sigma F = T - mg$$

$$0.068g = 0.068(9.8 \text{ m/s}^2)$$
$$= 0.67 \text{ m/s}^2$$

$$ma = T - mg$$

$$ma + mg = T$$

$$m(a + g) = T$$

When the elevator is going up...

$$a = +0.67 \text{ m/s}^2 \dots$$

$$T = 4850 \text{ kg} (0.67 \text{ m/s}^2 + 9.8 \text{ m/s}^2)$$

$$T = 50,800 \text{ N}$$

Max
force

When the elevator is
descending...

$$a = -0.67 \text{ m/s}^2$$

$$T = 4850 \text{ kg} (-0.67 \text{ m/s}^2 + 9.8 \text{ m/s}^2)$$

Min
force

$$T = 44,280 \text{ N}$$

8.



$$\Sigma F = ma$$

$$\Sigma F = T - mg$$

$$T - mg = ma$$

$$T = mg + ma$$

$$T = m(g + a)$$

$$\begin{matrix} \uparrow & \uparrow \\ 75\text{kg} & 9.8\text{m/s}^2 \end{matrix}$$

$$568\text{N} = 75\text{kg}(9.8\text{m/s}^2 + a)$$

$$a = -2.23\text{m/s}^2$$

"Supporting
a mass
of 58 kg"

means
Supporting
a weight

$$W = mg = 58\text{kg}(9.8\text{m/s}^2)$$

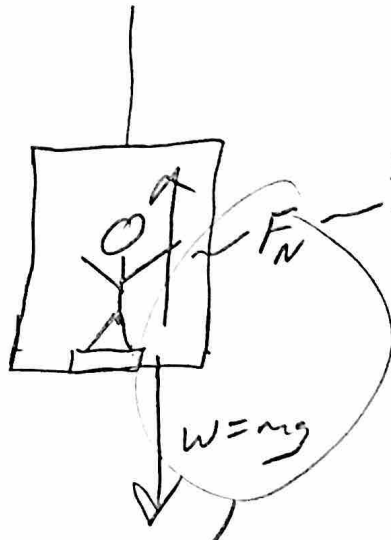
$$= 568\text{N}$$

max
tension
is
568N

If the thief
can manage to accelerate
downward at a rate of
 -2.23m/s^2 , then the
force on the rope will
only be 568N. One
way to do this is to grip the
rope lightly and slide down.

9.

$a = ?$



These are the forces acting on the person.

In this case, the "normal force" is the force of the scale pushing the person up. This is also the scale reading.

Scale reading is $0.75(mg) = F_N$

$$\Sigma F = ma$$

$$\Sigma F = F_N - mg$$

$$ma = F_N - mg$$

$$ma = 0.75mg - mg$$

$$ma = -0.25mg$$

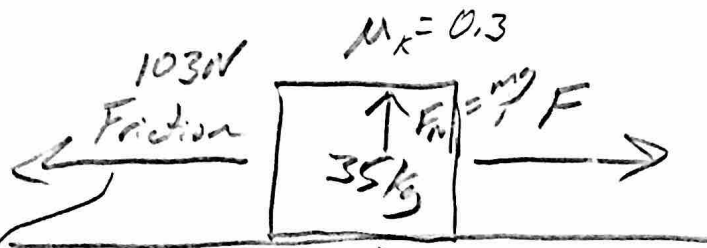
$$a = -0.25g \Rightarrow a = -0.25(9.8 \text{ m/s}^2)$$

$$a = -2.45 \text{ m/s}^2$$

Elevator is moving downward.

10.

a)



Steady speed means $a = 0$

$$\Sigma F = ma$$

If $a = 0$, then $\Sigma F = 0$,

so forces are balanced, and

$$F = F_{\text{Friction}}$$

$$F = \mu_k F_N$$

$$F_{\text{Fr}} = \mu_k mg$$

$$= 0.3(35\text{kg})(9.8\text{m/s}^2)$$

$$= 103\text{N}$$

We know

$F_N = mg$ because

box is not moving in y dimension

$$\Sigma F = ma$$

$$\Sigma F = F - F_{\text{Fr}}$$

$$ma = F - F_{\text{Fr}}$$

$$35\text{kg}(0\text{m/s}^2) = F - 103\text{N}$$

$$F = 103\text{N}$$

b)

If $\mu = 0$, then $F_{\text{Fr}} = 0$

$$\Sigma F = ma$$

$$\Sigma F = F - F_{\text{Fr}}$$

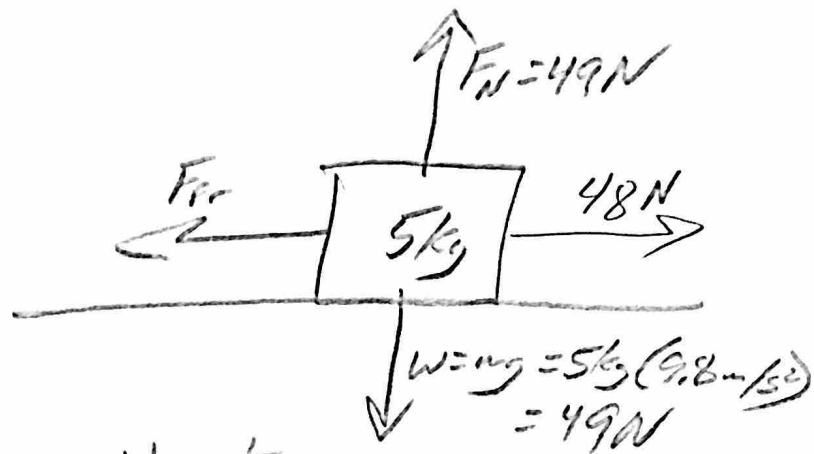
$$ma = F - F_{\text{Fr}}$$

$$35\text{kg}(0\text{m/s}^2) = F - 0$$

$$F = 0$$

11.

a)



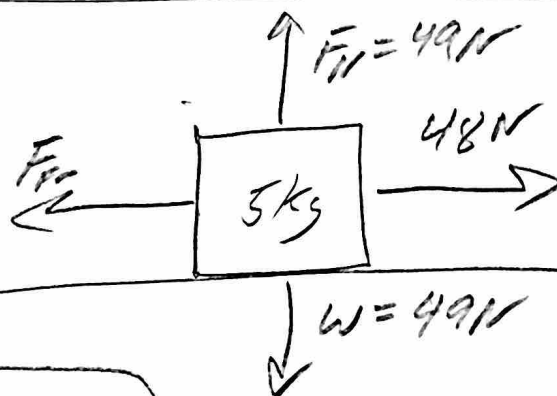
at least
 If F_A 48 N is needed
 to start moving the box, then
 F_{fr} must = 48 N

$$F_{fr} = \mu_s F_N = 48 \text{ N}$$

$$\mu_s (49 \text{ N}) = 48 \text{ N}$$

$$\boxed{\mu_s = 0.98}$$

b)



$$\boxed{\sum F = ma}$$

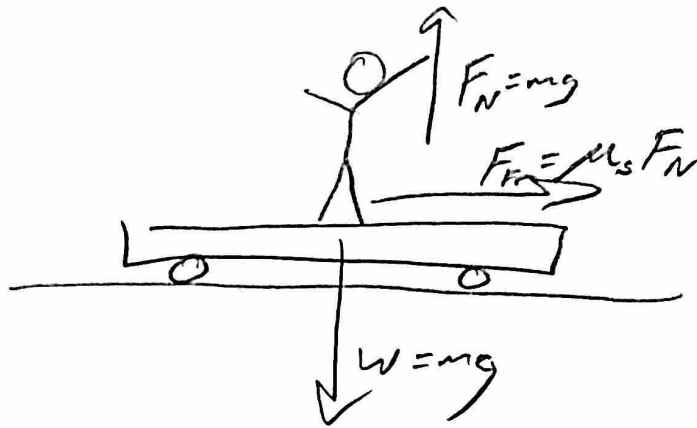
$$\boxed{\sum F = 48 \text{ N} - F_{fr}}$$

$$\Rightarrow ma = 48 \text{ N} - F_{fr}$$

$$5 \text{ kg} (0.7 \text{ m/s}^2) = 48 \text{ N} - \mu_k (49 \text{ N})$$

$$\boxed{\mu_k = 0.91}$$

12.



The only unbalanced force acting on you is Friction!

$$\Sigma F = ma$$

$$\Sigma F = F_f = \mu_s F_N = \mu_s mg$$



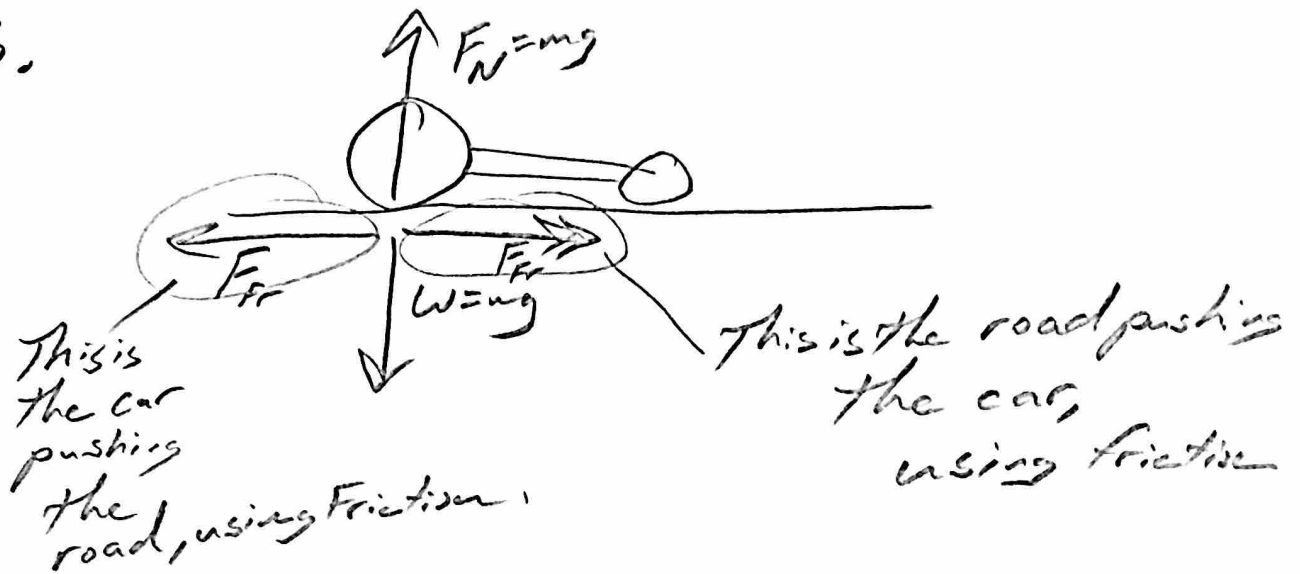
$$ma = \mu_s mg$$

$$\frac{a}{g} = \mu_s$$

$$\frac{0.2g}{g} = \mu_s$$

$$\boxed{0.2 = \mu_s}$$

13.



$$\sum F_{\text{car}} = ma$$

$$\sum F_{\text{car}} = F_{\text{fr}} = \mu_s F_N = \mu_s mg$$

$$ma = \mu_s mg$$

$$\mu_s = \frac{a}{g} \leftarrow \text{we need } a \dots$$

Using kinematics on

$$\Delta x = 1,000 \text{ m}$$

$$v_{0x} = 0 \text{ m/s}$$

$$\Delta t = 12 \text{ s}$$

$$\Delta x = v_0 t + \frac{1}{2} a t^2$$

$$1,000 \text{ m} = 0 \text{ m/s} (12 \text{ s}) + \frac{1}{2} a (12 \text{ s})^2$$

$$a = 13.9 \text{ m/s}^2$$

$$\mu_s = \frac{13.9 \text{ m/s}^2}{9.8 \text{ m/s}^2} = \boxed{1.42}$$

14. Kinematics. to find Δx

$$\Delta x = ?$$

$$V_0 = 4 \text{ m/s}$$

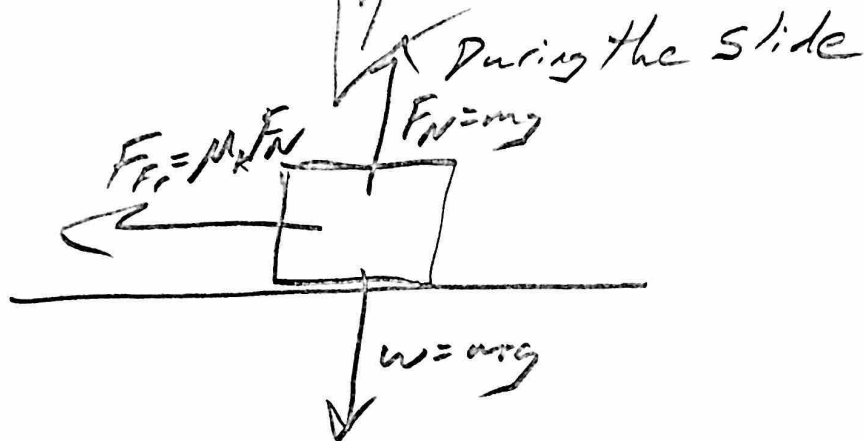
$$V = 0 \text{ m/s}$$

$$a =$$

$$t =$$

$$V^2 = V_0^2 + 2a\Delta x$$

we need a



$$\Sigma F = ma$$

$$\Sigma F = -F_f = -\mu_k F_N = -\mu_k mg$$

$$ma = -\mu_k mg$$

$$a = -(0.2)(9.8 \text{ m/s}^2) = -1.96 \text{ m/s}^2 = a$$

$$0 \text{ m/s}^2 = 4 \text{ m/s}^2 + 2(-1.96 \text{ m/s}^2) \Delta x$$

$$\Delta x = 4.08 \text{ m}$$