Honors Physics Friction Review Worksheet. Name: McDevitt-Key Pd.

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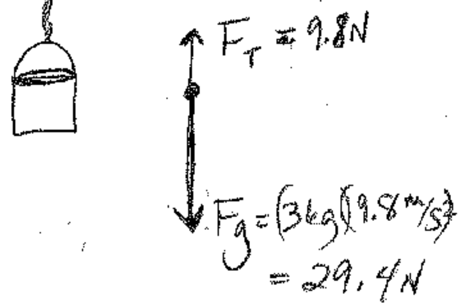
1. As a 3.0-kg bucket is being lowered into a 10-m-deep well, starting from the top, the tension in the rope is 9.8 N. The acceleration of the bucket will be:

F_T = Force of Tension

(a.) 6.5 m/s² downward.
b. 9.8 m/s² downward.
c. zero.
d. 3.3 m/s² upward.
e. 6.5 m/s² upward.



$\Sigma \vec{F} = m \cdot \vec{a}$

$\vec{F}_T + \vec{F}_g = m \cdot \vec{a}$

$9.8N + (-29.4N) = (3kg)\vec{a}$

$-19.6N = (3kg)(\vec{a})$

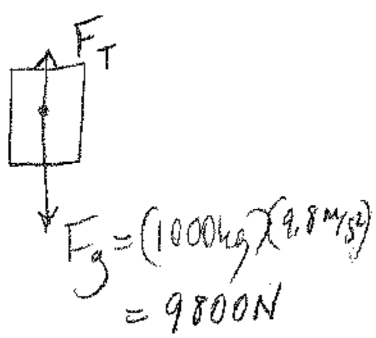
$\vec{a} = \frac{-19.6N}{3kg}$

$\vec{a} = -6.53\ m/s^2$ (down)

2. Find the tension in an elevator cable if the 1 000-kg elevator is descending with an acceleration of 1.8 m/s², downward.

$\vec{a} = 1.8\ m/s^2$ down, $\vec{v}$ is down (result is elevator speeds up as it moves down)

a. 5 700 N
(b.) 8 000 N
c. 9 800 N
d. 11 600 N



$\Sigma \vec{F} = m \cdot \vec{a}$

$\vec{F}_T + \vec{F}_g = m \cdot \vec{a}$

$\vec{F}_T + (-9800N) = (1000kg)(-1.8\ m/s^2)$

$\vec{F}_T = 9800N - 1800N$

$\vec{F}_T = 8000N$

3. A block of mass 5.00 kg rests on a horizontal surface where the coefficient of kinetic friction between the two is 0.200. A string attached to the block is pulled horizontally, resulting in a 2.00-m/s² acceleration by the block. Find the tension in the string. (g = 9.80 m/s²)

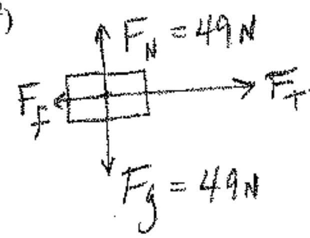
a. 0.200 N
b. 9.80 N
(c.) 19.8 N
d. 10.0 N

$m = 5kg$

$\mu_k = 0.2$

$a = 2\ m/s^2$

$F_T = ?$



$F_g = m \cdot a_g = (5kg)(9.8\ m/s^2) = 49N$

$F_f = \mu F_N = (0.2)(49N) = 9.8N$

$\Sigma \vec{F} = m \cdot \vec{a}$

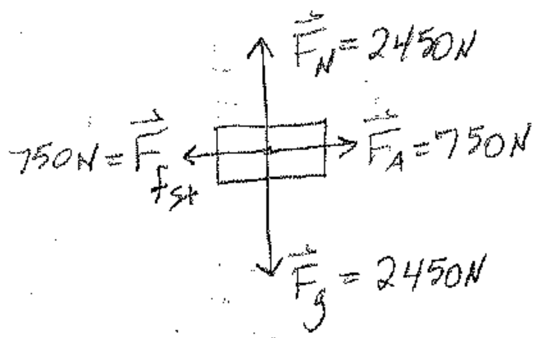
$\vec{F}_T + \vec{F}_f = m \cdot \vec{a}$

$\vec{F}_T + (-9.8N) = (5kg)(2\ m/s^2)$

$\vec{F}_T = 9.8N + 10N = 19.8N = \vec{F}_T$

4. A horizontal force of 750 N is needed to overcome the force of static friction between a level floor and a 250-kg crate. If $g = 9.8 \text{ m/s}^2$, what is the coefficient of static friction?

- a. 3.0
- b. 0.15
- c. 0.28
- (d.) 0.31



$F_g = m \cdot a_g = (250kg)(9.8 m/s^2) = 2450N$

$F_A = F_f = \mu F_N$

$750N = \mu(2450N)$

$\mu_{st} = \frac{750N}{2450N}$

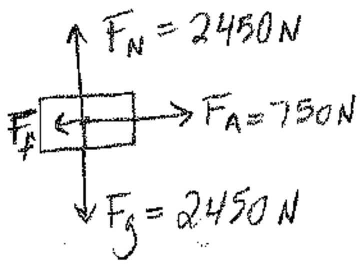
$\boxed{\mu_{static} = 0.31}$

5. A horizontal force of 750 N is needed to overcome the force of static friction between a level floor and a 250-kg crate. What is the acceleration of the crate if the 750-N force is maintained after the crate begins to move and the coefficient of kinetic friction is 0.12?

- (a.) 1.8 m/s^2
- b. 2.5 m/s^2
- c. 3.0 m/s^2
- d. 3.8 m/s^2

$\mu = 0.12$

$\vec{a} = ?$



$F_f = \mu F_N = (0.12)(2450N)$

$F_f = 294N$

$\Sigma \vec{F} = m \cdot \vec{a}$

$\vec{F}_A + \vec{F}_f = m \cdot \vec{a}$

$750N + (-294N) = (250kg)\vec{a}$

$456N = (250kg)\vec{a}$

$\vec{a} = \frac{456N}{250kg} = \boxed{1.8 m/s^2 = \vec{a}}$

Add mass = 0.25 kg

(6.) Doug hits a hockey puck, giving it an initial velocity of 6.0 m/s. If the coefficient of kinetic friction between ice and puck is 0.050, how far will the puck slide before stopping?

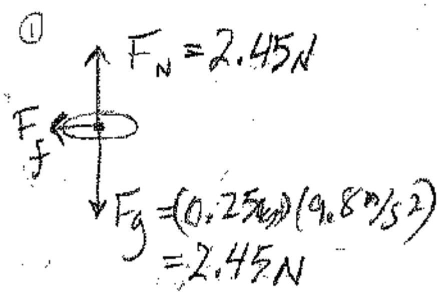
- a. 19 m
- b. 25 m
- (c.) 37 m
- d. 57 m

$V_i = 6 m/s$

$\mu_k = 0.05$

$V_f = 0$

$d = ?$

① 

② $\vec{F}_f = \mu \vec{F}_N$

$F_f = (0.05)(2.45N)$

$F_f = 0.1225N$

③ $\Sigma \vec{F} = m \cdot \vec{a}$

$\vec{F}_f = m \cdot \vec{a}$

$0.1225N = (0.25kg)\vec{a}$

$a = \frac{0.1225N}{0.25kg} = \boxed{0.49 \frac{m}{s^2}}$

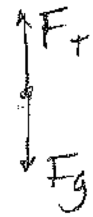
$\vec{V}_f^2 = \vec{V}_i^2 + 2\vec{a}\vec{d}$

$0 = (6 m/s)^2 + 2(0.49 m/s^2)d$

$\frac{36 m^2/s^2}{2(0.49 m/s^2)} = 36.7 \approx \boxed{37m = d}$

7. It is late and Carlos is sliding down a rope from his third floor window to meet his friend Juan. As he slides down the rope faster and faster, he becomes frightened and grabs harder on the rope, increasing the tension in the rope. As soon as the upward tension in the rope becomes equal to his weight:

a. Carlos will stop.
b. Carlos will slow down.
(c.) Carlos will continue down at a constant velocity.
d. the rope must break.



$\Sigma F = m \cdot a$

$F_T + F_g = 0$

$F_T = -F_g$

Since he's already moving, he'll continue moving but at a constant velocity.

8. As a car moves forward on a level road at constant velocity, the net force acting on the tires is:

a. greater than the normal force times the coefficient of static friction.
b. equal to the normal force times the coefficient of static friction.
c. the normal force times the coefficient of kinetic friction.
(d.) zero.

$\vec{F}_{net} = \Sigma \vec{F} = m \cdot \vec{a}$

$\boxed{\vec{F}_{net} = 0}$ since $\vec{a} = 0$

A net force causes acceleration; no net force (zero net force) means no acceleration and all forces are equal and opposite (balanced).

9. As a car skids with its wheels locked trying to stop on a road covered with ice and snow, the force of friction between the icy road and the tires will usually be: $F_f = \mu_k F_N = m \cdot a$ and $\mu_k < \mu_{st}$

a. greater than the normal force of the road times the coefficient of static friction.
b. equal to the normal force of the road times the coefficient of static friction.
(c.) less than the normal force of the road times the coefficient of static friction.
d. greater than the normal force of the road times the coefficient of kinetic friction.

← Make the mass whatever you want!

(10.) A hockey puck moving at 7.0 m/s coasts to a halt in 75 m on a smooth ice surface. What is the coefficient of friction between the ice and the puck?

a. $\mu = 0.025$
(b.) $\mu = 0.033$
c. $\mu = 0.12$
d. $\mu = 0.25$

$V_i = 7\,m/s$

$d = 75\,m$

$V_f = 0$

$\mu_k = ?$

$\vec{V}_f^2 = \vec{V}_i^2 + 2\vec{a}\vec{d}$

$0 = (7\,m/s)^2 + 2a(75\,m)$

$-49\,m^2/s^2 = 2a(75\,m)$

$\vec{a} = \frac{-49\,m^2/s^2}{2(75\,m)} = -0.327\,m/s^2$

$\Sigma F = m \cdot \vec{a}$ / $F_f = \mu F_N$

$\vec{F}_f = m \cdot \vec{a}$ $\quad F_f = \mu(m \cdot a_g)$

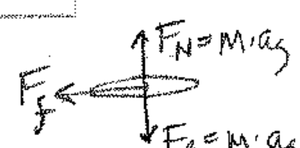
$F_f = F_f$

$m \cdot \vec{a} = \mu \cdot (m \cdot a_g)$

$\vec{a} = \mu \cdot a_g$

$\mu = \frac{\vec{a}}{a_g} = \left|\frac{-0.327\,m/s^2}{9.8\,m/s^2}\right|$

$\boxed{\mu = 0.033}$



→ see Question below

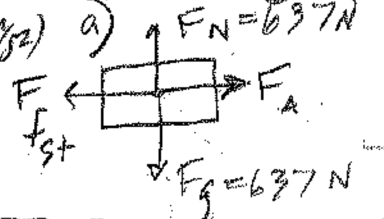
11. A 9.0-kg hanging weight is connected by a string over a pulley to a 5.0-kg block sliding on a flat table. If the coefficient of sliding friction is 0.20, find the tension in the string.

a. 19 N
b. 24 N
c. 32 N
d. 38 N

11) $F_g = (65 kg)(9.8 m/s^2)$

$F_g = 637 N$

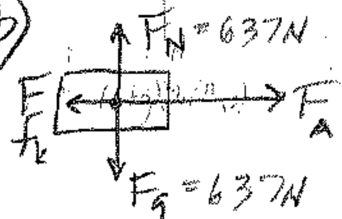
a)



a) $F_A = F_{f\,static} = \mu_{st} \cdot F_N$

$F_A = (0.55)(637 N) = \boxed{350 N = F_A}$

b)



$F_{f_k} = \mu_k \cdot F_N = (0.23)(637 N) = 146.5 N = F_{f_k}$

$\Sigma \vec{F} = m \cdot \vec{a}$

$F_A + F_f = m \cdot \vec{a}$

$F_A + (-146.5 N) = (65 kg)(1.65 m/s^2)$

$F_A = 146.5 N + 107.25 N = \boxed{254 N = F_A}$

12. A thrown stone hits a window, but doesn't break it. Instead it reverses direction and ends up on the ground below the window. In this case, we know:

a. the force of the stone on the glass > the force of the glass on the stone.
(b.) the force of the stone on the glass = the force of the glass on the stone.
c. the force of the stone on the glass < the force of the glass on the stone.
d. the stone didn't slow down as it broke the glass.

Newton's 3rd Law!

11. While helping your friend move his 65 kg dresser you apply a horizontal force of unknown value just to get the dresser to initially move. Then once moving, you notice it's easier to push the dresser and therefore push with a different force in order to accelerate the dresser at 1.65 m/s² as it slides across the floor. If the coefficient of static friction is 0.55 and the coefficient of kinetic friction is 0.23, Find the a) Force applied just to start the dresser moving and b) the force applied to accelerate it @ 1.65 m/s².