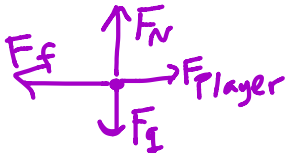
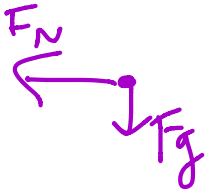
Worksheet 3.2

1. For each image below, draw the free body diagram for the specified item.
   a. For the player on the right:



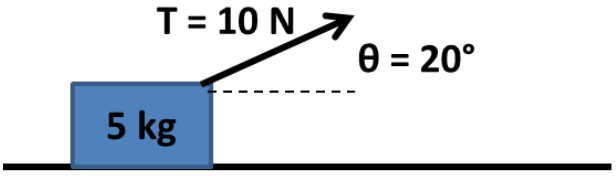
   b. For the basketball:

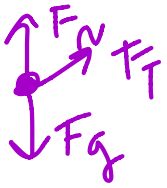


c. For the volleyball:

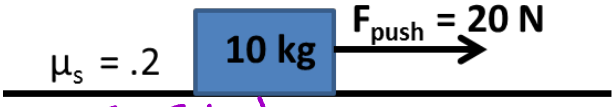
d. For the pole vaulter:

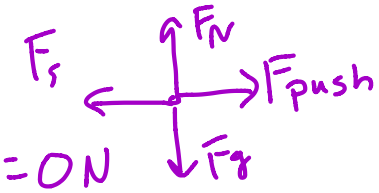
2. For each of the following diagrams, draw a FBD and calculate the net force.





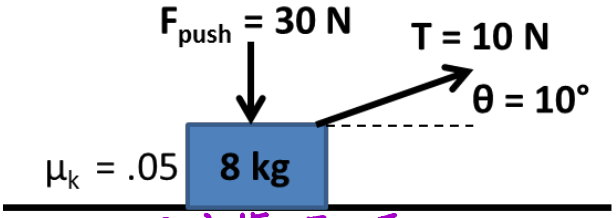
$F_N + F_{Ty} = F_g$ $F_{Net} = 10\cos 20 = 9.4\,N \rightarrow$

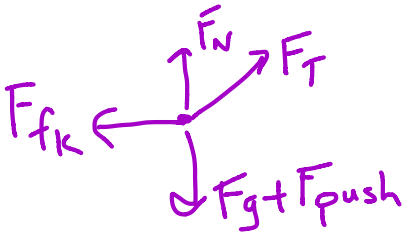




$F_{fs} = F_N(\mu s)$
$= 100\,N(.2) = 20\,N$

$F_{fs} = F_{push}$
$F_N = F_g$
$F_{Net} = 0\,N$



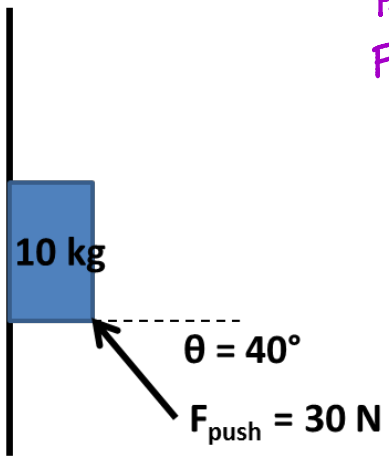


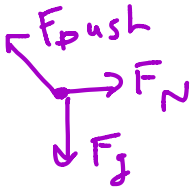
$F_{push} + F_g = F_N + F_{Ty}$
$30 + 80 = F_N + 10\sin 10$
$F_N = 108.3\,N\uparrow$

$F_{fk} = (.05)(108.3)$
$= 5.4\,N\leftarrow$

$F_{Tx} = 10\cos 10 = 9.8\,N \rightarrow$

$F_{Net} = 9.8 \rightarrow - 5.4 \leftarrow = 4.4\,N \rightarrow$





$F_{push\,in\,x} = 30\cos 40 = 22.98\,N$
$F_{push\,in\,y} = 30\sin 40 = 19.3\,N$
$F_g = 100\,N$

$F_x = F_N$
So F_{Net} is vertical $F_{Net} = 100\,N\downarrow + 19.3\,N\uparrow = 80.7\,N\downarrow$

2. If an object is moving at constant velocity or at rest, what is the minimum number of forces acting on it (other than zero)? Explain.

2, b/c they must balance so that $F_{Net}=0$. A single force would result in a non-zero F_{Net}.

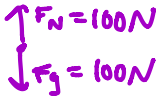
3. For a boy who weighs 500 N on Earth (g = 10 m/s2), what are his mass and weight on the moon (where g = 1.6 m/s2)?

$F_g = 500N = m(10 m/s^2)$ $m = 50kg$ mass is the same on the moon

$F_{g_{moon}} = (50kg)(1.6 m/s^2) = 80N$

4. A stone with a mass of 10 kg is sitting on the ground, not moving.

a. Draw a free body diagram (FBD) for the stone.



b. What is the weight of the stone?

$F_g = 100N$

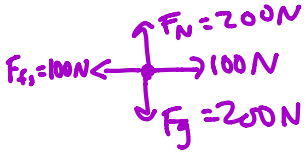
c. What is the normal force acting on the stone?

$F_N = 100N$

d. Is the normal force on an object always equal to the object's weight? Explain.

No, the Normal force can change if there are other forces pushing or pulling the object in the same direction

8. When a 20 kg (mass) is pulled with a force of 100 N to the right, it just starts to move (i.e. the maximum value of static friction is overcome with a force of 100 N). What is the value of the coefficient of static friction, μ_S?



$F_{fs} = 100N = F_N(\mu_s)$

$100N = 200N(\mu_s)$

$\mu_s = .5$

9. A different box, this time 5 kg in mass, is being pulled with a force of 20 N and is sliding with an acceleration of 2 m/s^2. Find the coefficient of kinetic friction, μ_K.

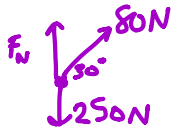
$F_{Net} = 20N - F_{fs} = ma$

$20N - 50N(\mu_s) = (5kg)(2m/s^2)$

$\mu_s = .2$

10. A heavy box (mass 25 kg) is dragged along the floor by a kid at a 30° angle measured with respect to the ground with a force of 80 N. This is the maximum force the kid can apply.

a. Draw the free body diagram.



$F_y = 80\sin 30 = 40N$

$F_x = 80\cos 30 = 69.3\,N$

b. What is the normal force F_N?

$F_N + F_y = F_g$ $\quad F_N + 40N = 250N$ $\quad F_N = 210N$

c. Would the normal force decrease or increase if the angle of pull increases? Explain.

decrease, b/c F_y would increase

d. Assuming no friction, what is the acceleration of the box?

$F_{Net} = F_x = 69.3N = (25kg)a$

$a = 2.77\,m/s^2$

e. Assuming it begins at rest, what is its speed after ten seconds?

$V = 2.77(10s) + 0 = 27.7\,m/s$