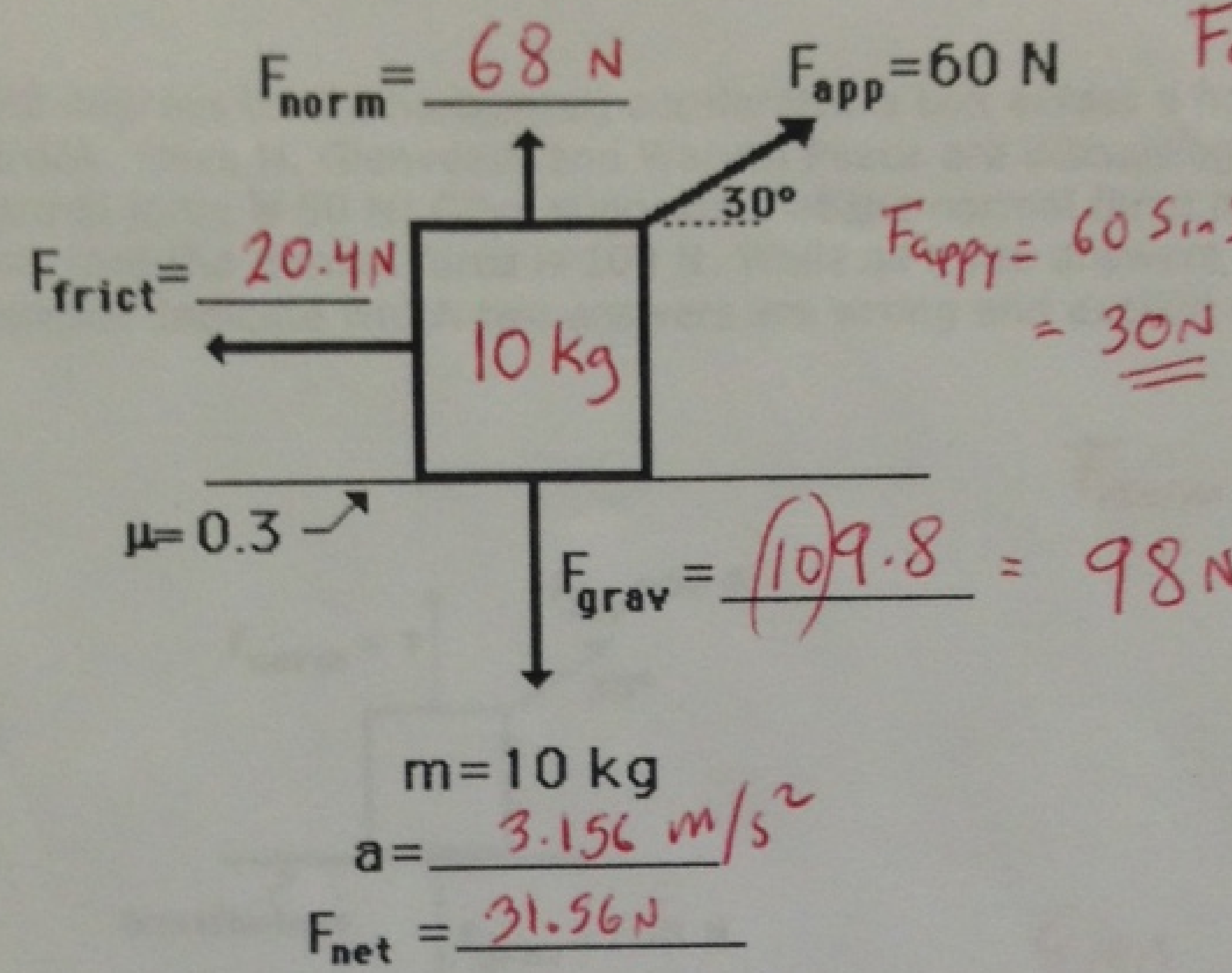
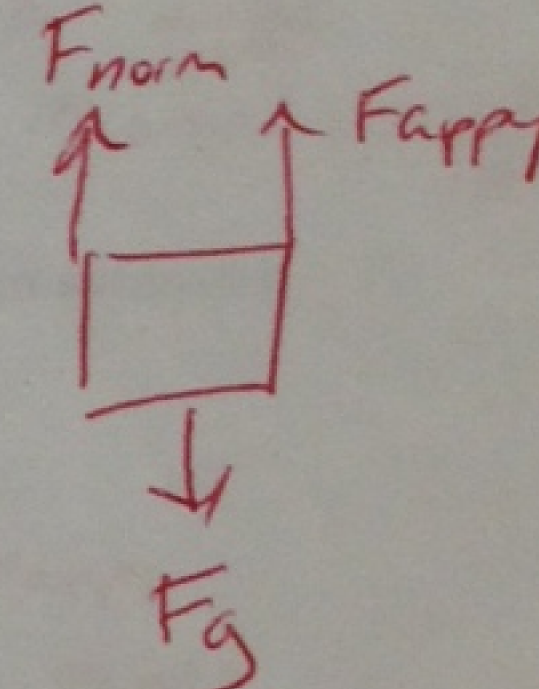
Now consider the following situation in which a force analysis must be conducted to fill in all the blanks and to determine the net force and acceleration. In a case such as this, a thorough understanding of the relationships between the various quantities must be fully understood. Make an effort to solve this problem. When finished, click the button to view the answers. (When you run into difficulties, consult the help from a previous unit.)



$F_{appx} = F_{app} \cos\theta$
$= 60 \cos 30$
$= 51.96\ N\ F_{appx}$

$F_{appy} = 60 \sin 30°$
$= 30N$



$F_{norm} = F_{gravity} - F_{appy}$
$= 98 - 30$
$= 68N$

$\mu = 0.3$

$F_{FRICTION} = 0.3(68)$
$= 20.4\ N.$

$F_{Fr} = \mu F_{Normal}$

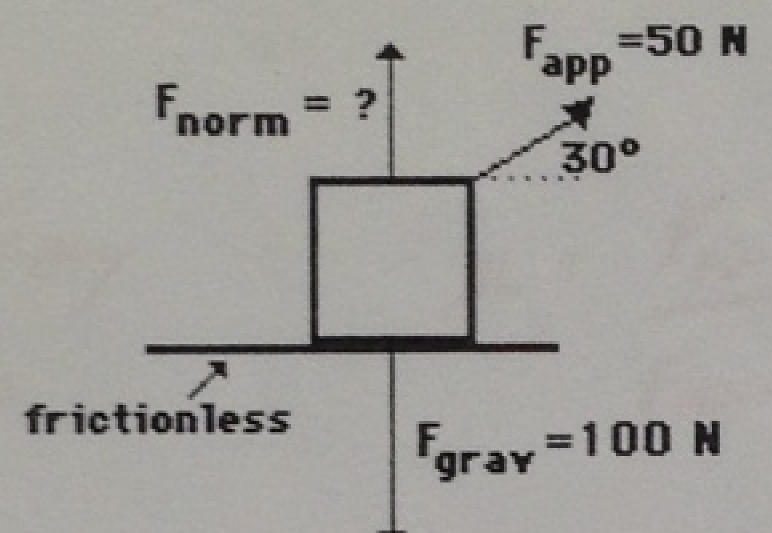
$F_{net} = F_{appx} - F_{Fr.}$
$= 51.96 - 20.4$
$= 31.56N$

$a = \frac{F_{net}}{m} = \frac{31.56}{10}$
$= 3.156\ m/s^2$

Check Your Understanding

The following problems provide plenty of practice with $F_{net} = m \bullet a$ problems involving forces at angles. Try each problem and then click the button to view the answers.

1. A 50-N applied force (30 degrees to the horizontal) accelerates a box across a horizontal sheet of ice (see diagram). Glen Brook, Olive N. Glenveau, and Warren Peace are discussing the problem. Glen suggests that the normal force is 50 N; Olive suggests that the normal force in the diagram is 75 N; and Warren suggests that the normal force is 100 N. While all three answers may seem reasonable, only one is correct. Indicate which two answers are wrong and explain why they are wrong.



$F_{norm} = F_{grav} - F_{appy}$

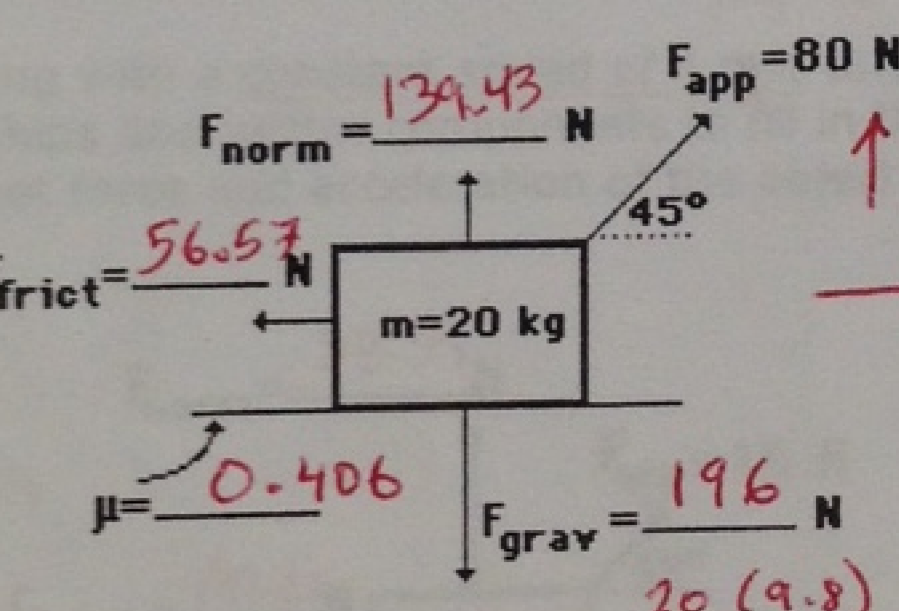
$= 100 - 50(\sin 30)$

$= 75\text{ N}$

Glen is wrong because the 50 N applied is at an angle so it would not be 100 − 50 = 50 N

Warren is wrong since $F_g \neq F_n$ in this case because of F_{appy}

2. A box is pulled at a constant speed of 0.40 m/s across a frictional surface. Perform an extensive analysis of the diagram below to determine the values for the blanks.



↑ 56.57 N F_{appy}

→ 56.57 N F_{appx}

Constant speed = a = 0

so $F_{net} = 0$

so $F_{appx} = F_{fr}$

$= 56.57\text{ N}$

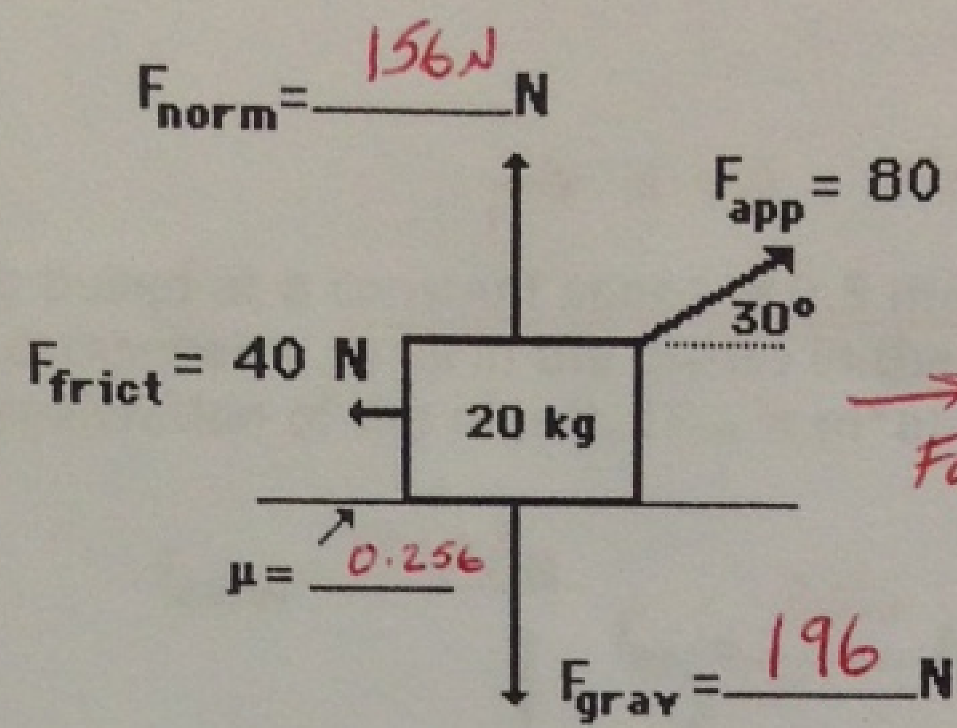
$F_{norm} = F_g - F_{appy}$

$= 139.43\text{ N}$

$\mu = \frac{F_{fr}}{F_n} = \frac{56.57}{139.43}$

$= 0.406$ (0.41)

3. Use your understanding of force relationships and vector components to fill in the blanks in the following diagram and to determine the net force and acceleration of the object. (F_{net} = m*a; F_{frict} = "mu"*F_{norm}; F_{grav} = m*g)



↑ Fappy = 40N

→ Fappx = 69.3 N

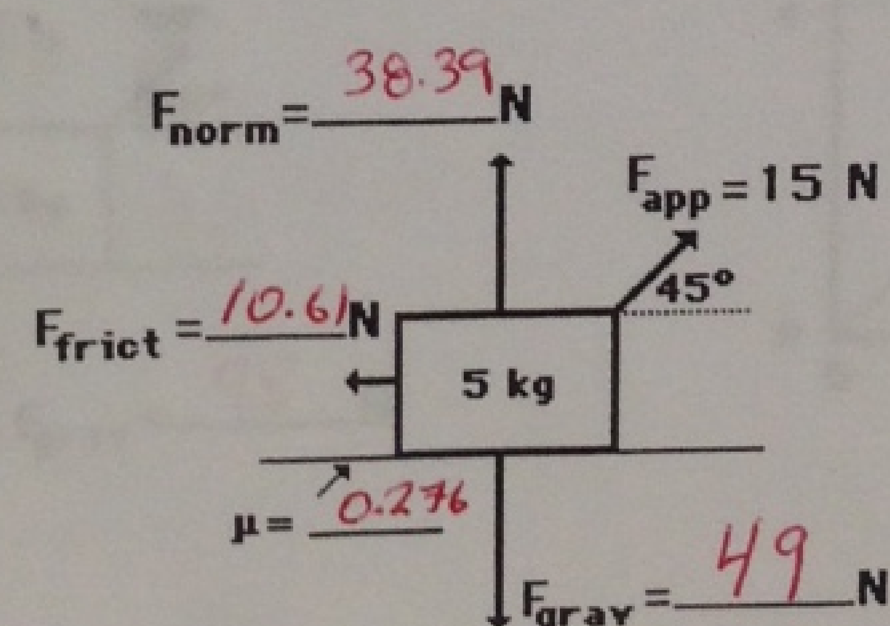
Fnorm = Fg − Fappy
= 196 − 40
= 156 N

μ = Ffr / Fnorm = 40 / 156 = 0.256

Fnet = Fappx − Ffr
= 69.3 − 40
= 29.3 N so a = 29.3 / 20 = 1.465 m/s²

→ a = 0, Fnet = 0, Fappx = Ffr.

4. The 5-kg mass below is moving with a constant speed of 4 m/s to the right. Use your understanding of force relationships and vector components to fill in the blanks in the following diagram and to determine the net force and acceleration of the object. (F_{net} = m*a; F_{frict} = "mu"*F_{norm}; F_{grav} = m*g)



Fappy = 10.61 N = Ffr.

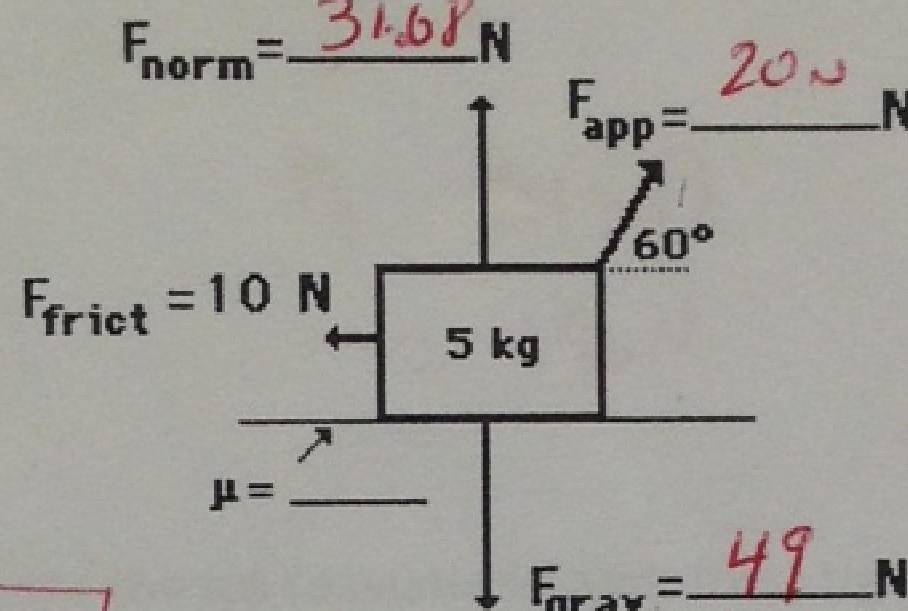
Fappx

Fnorm = Fg − Fappy
= 49 − 10.61
= 38.39 N

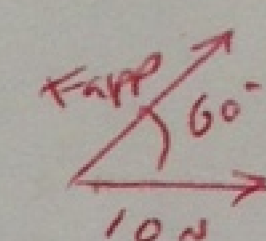
μ = Ffr / Fn = 10.61 / 38.39 = 0.276

→ a = 0 $F_{net} = 0$ $F_{app\,x} = F_{fr} = 10\,N$

5. The following object is being pulled at a constant speed of 2.5 m/s. Use your understanding of force relationships and vector components to fill in the blanks in the following diagram and to determine the net force and acceleration of the object. (F_{net} = m*a; F_{frict} = "mu"*F_{norm}; F_{grav} = m*g)



Since $F_{app\,x} = F_{fr} = 10\,N$



$\cos 60 = \frac{10}{F_{app}}$

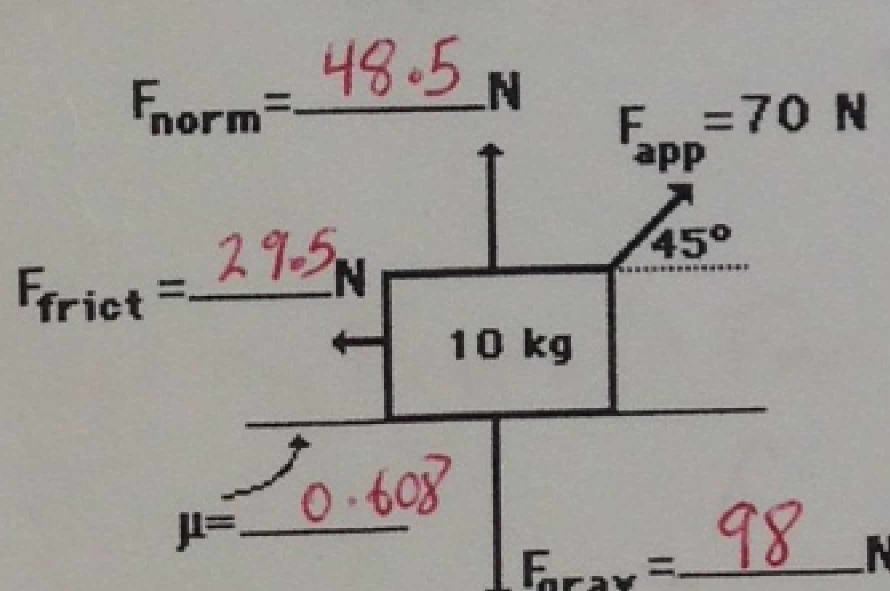
$F_{app} = 20\,N$

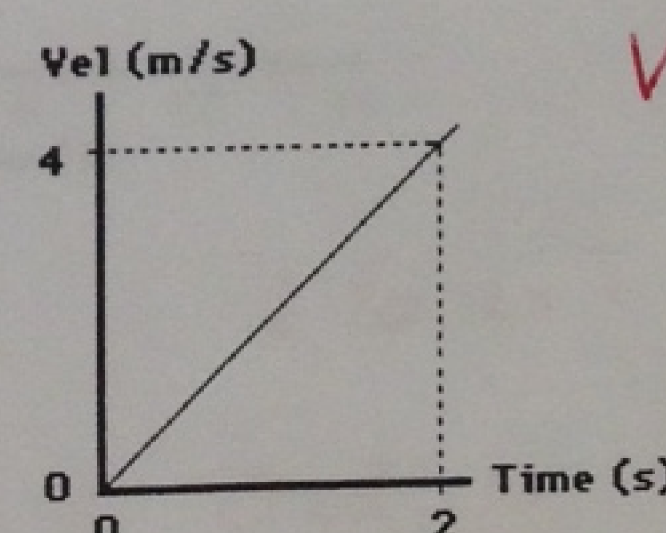
So $F_{app\,y} = 20 \sin 60 = 17.32\,N$

$F_{norm} = F_g - F_{app\,y} = 49 - 17.32 = 31.68\,N$

$\mu = \frac{F_{fr}}{F_n} = \frac{10}{31.68} = 0.316$

6. Use your understanding of force relationships and vector components to fill in the blanks in the following diagram and to determine the net force and acceleration of the object. (F_{net} = m*a; F_{frict} = "mu"*F_{norm}; F_{grav} = m*g)





V-T graph!!

a = slope

$a = \frac{4-0}{2-0} = \frac{\Delta V}{\Delta T} = 2\,m/s^2$

$F_{app\,x} = F \cos 45 = 70 \cos 45 = 49.5\,N = F_{app\,y}$

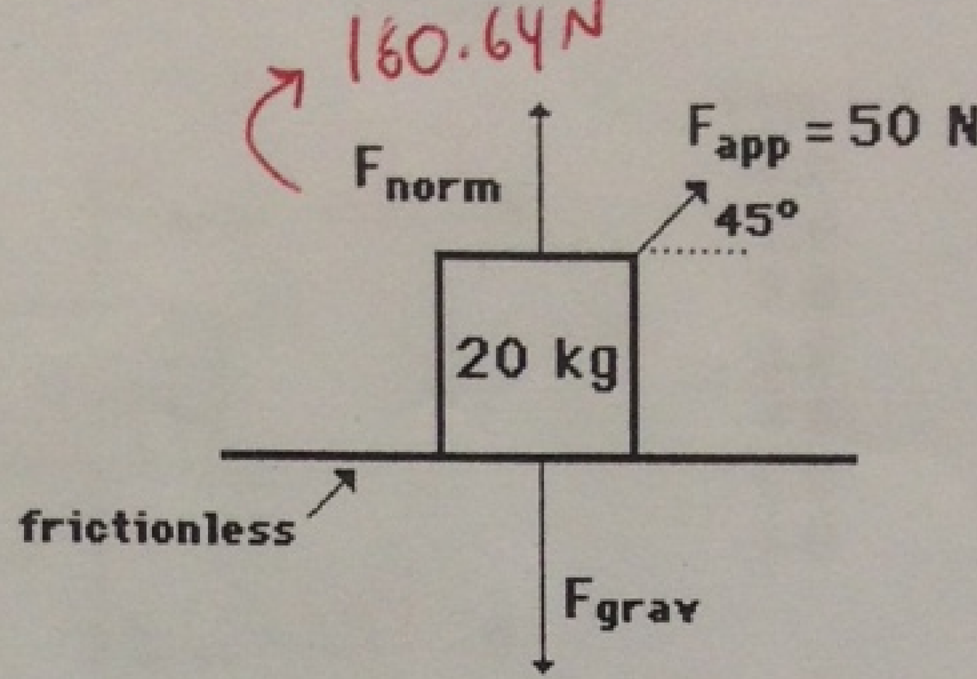
$\mu = \frac{F_{fr}}{F_n} = 0.608$

So $F_{net} = F_{app\,x} - F_{fr} = ma = 10(2) = 20\,N = F_{app\,x} - F_{fr}$

$F_{norm} = F_g - F_{app\,y}$

$F_{fr} = F_{app\,x} - 20\,N = 29.5\,N$

7. Study the diagram below and determine the acceleration of the box and its velocity after being pulled by the applied force for 2.0 seconds.



↑35.36N Fappy

→ 35.36N Fappx

Fnet = Fappx − 0 (FFR)

= 35.36 N

a = 1.768 m/s² to the right

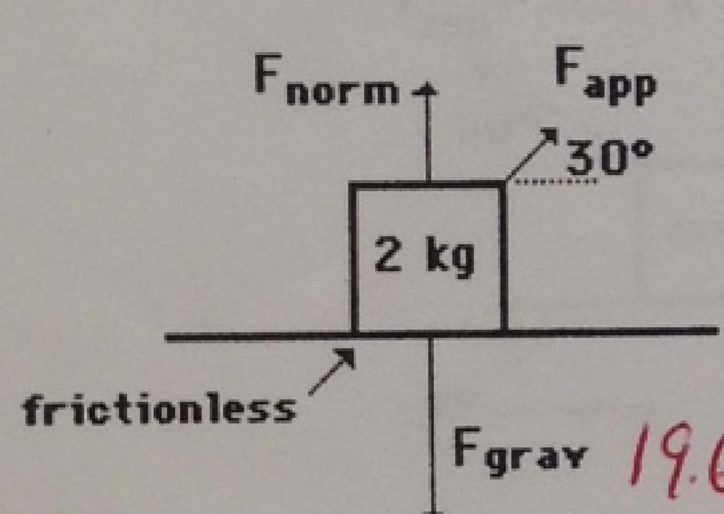
$F_g = 20(9.8)$

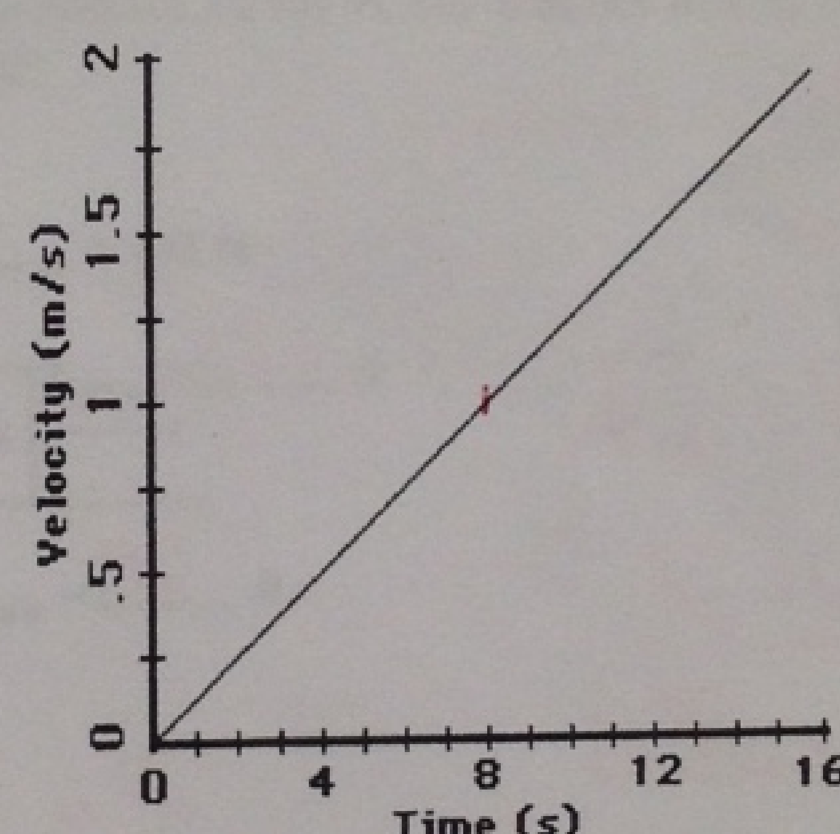
= 196N

$V_f = V_i + at$

= 3.536 m/s

8. A student pulls a 2-kg backpack across the ice (assume friction-free) by pulling at a 30-degree angle to the horizontal. The velocity-time graph for the motion is shown. Perform a careful analysis of the situation and determine the applied force.





slope = a

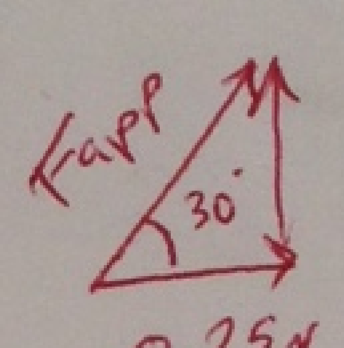
$a = \frac{\Delta V}{\Delta T} = \frac{1-0}{8-0}$

= 0.125 m/s²

Fnet = Fappx − FFr = ma = 2(0.125)

(FFr = 0)

= 0.25N = Fappx



Cos 30° = adj / hyp

hyp = adj / cos 30°

= 0.25 / 0.866

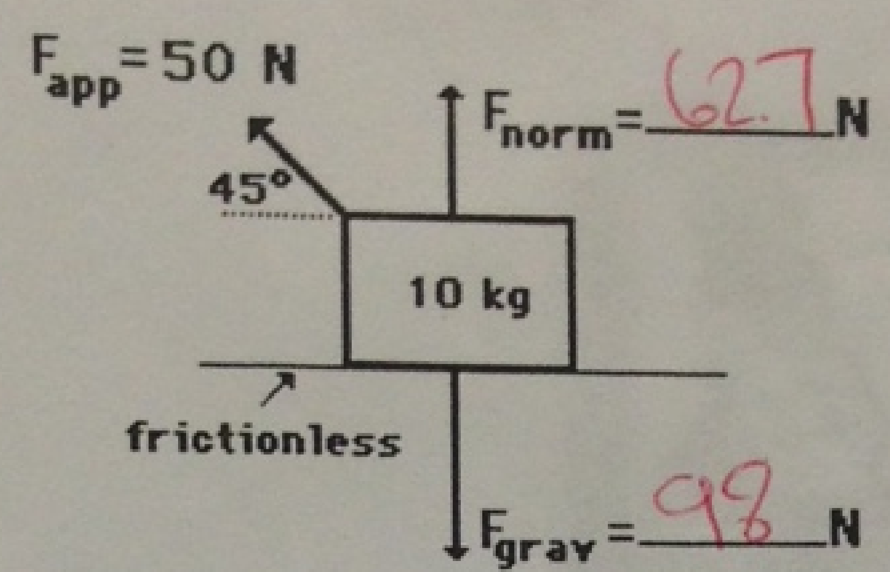
Fapp 0.289N

Fn = Fg − Fappy = 19.6 − 0.1443

Tan 30 = opp / adj

= 19.456N

9. The following object is moving to the right and encountering the following forces. Use your understanding of force relationships and vector components to fill in the blanks in the following diagram and to determine the net force and acceleration of the object. (F_{net} = m*a; F_{frict} = "mu"*F_{norm}; F_{grav} = m*g)



Time (s)	Vel (m/s)
0.0	21.0
1.0	
2.0	
3.0	
4.0	
5.0	
6.0	

F_{fr} = 0 N

F_{n} = 98 - 35.3

F_{n} = 62.7 N

F_{net} = 0

a = 0 m/s²

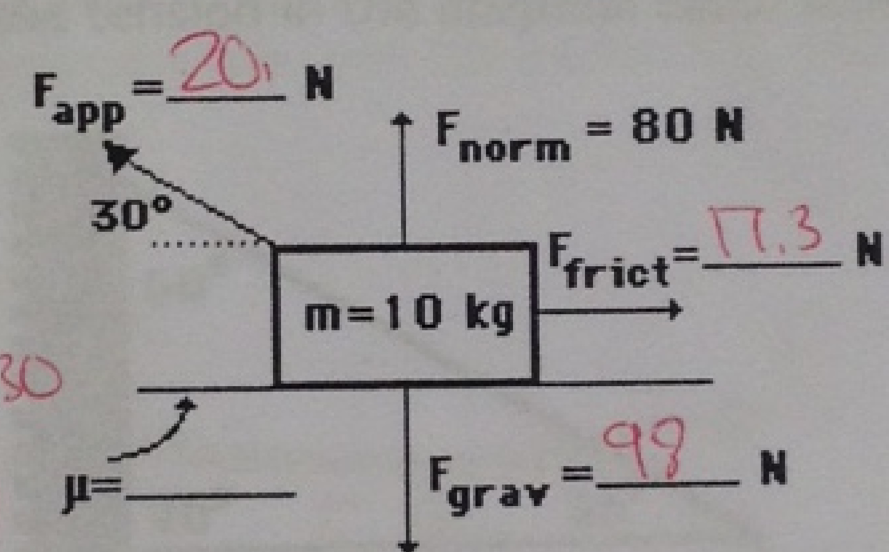
$F_{app x}$ = 50 cos 45

$F_{app x}$ = 35.3

$F_{app y}$ = 50 sin 45

$F_{app y}$ = 35.3 N

10. The 10-kg object is being pulled to the left at a constant speed of 2.5 m/s. Use your understanding of force relationships and vector components to fill in the blanks in the following diagram. (F_{net} = m*a; F_{frict} = "mu"*F_{norm}; F_{grav} = m*g)



Constant v : F_{net} = 0 N

a = 0 m/s²

$F_{app y}$ = 10 N

F_{app} = $F_{app y}$ / sin 30 = 10 / sin 30

F_{app} = 20 N

$F_{app x}$ = 20 cos 30

$F_{app x}$ = 17.3 N

F_{net} = F_{app} - F_{fr}

F_{fr} = F_{app} - F_{net}

F_{fr} = 17.3 N

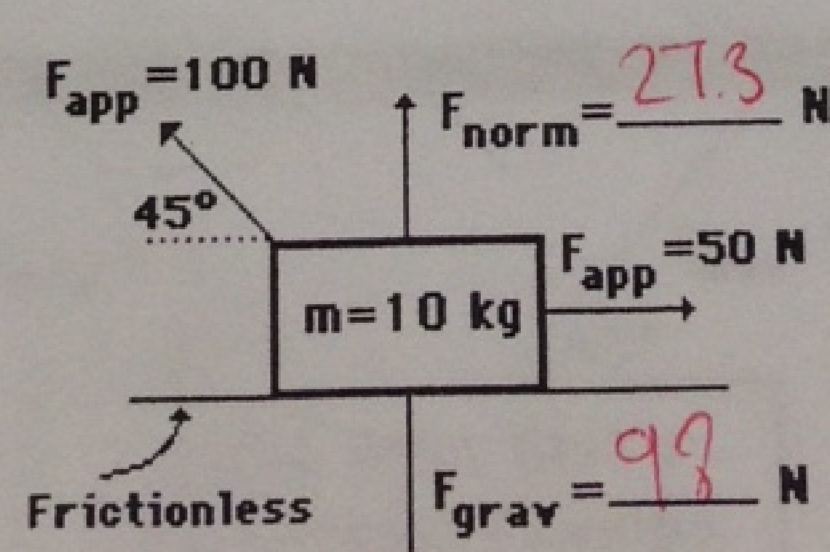
F_{fr} = μ F_{n}

μ = F_{fr} / F_{n}

μ = 17.3 / 80

μ = 0.2163

11. Use your understanding of force relationships and vector components to fill in the blanks in the following diagram and to determine the net force and acceleration of the object. (F_{net} = m*a; F_{frict} = "mu"*F_{norm}; F_{grav} = m*g)



$F_{app x}$ = 100 cos 45

$F_{app x}$ = 70.7 N

$F_{app y}$ = 100 sin 45

$F_{app y}$ = 70.7 N

F_{n} = 98 - 70.7

F_{n} = 27.3 N

F_{net} = 70.7 - 50

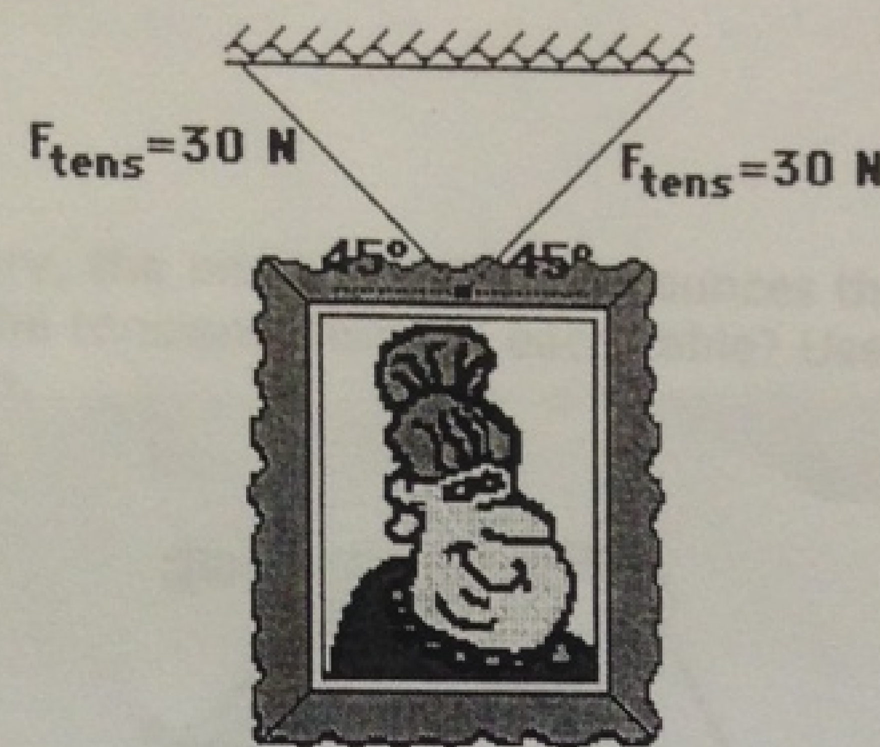
F_{net} = 20.7 N (left)

F_{net} = m·a

a = F_{net} / m = 20.7 / 10

a = 2.07 m/s²

1. The following picture is hanging on a wall. Use trigonometric functions to determine the weight of the picture.



1 side

$F_{tens\,y} = 30 \sin 45$

$= 21.213\,N$

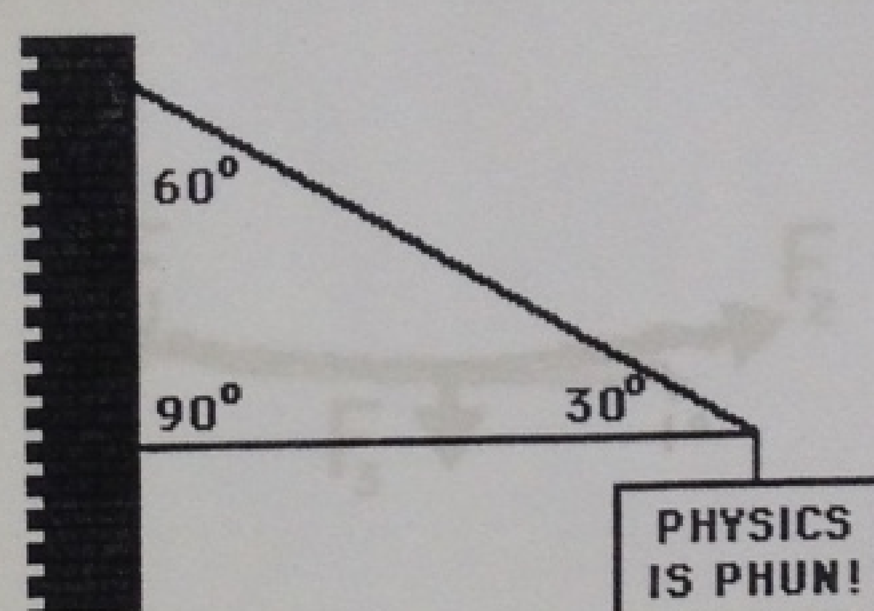
So 21.213 21.213 $= 42.426\,N$

So

$F_g = 42.426$

$m = \frac{F_g}{g} = \frac{42.426}{9.8} = 4.33\,kg$

2. The sign below hangs outside the physics classroom, advertising the most important truth to be found inside. The sign is supported by a diagonal cable and a rigid horizontal bar. If the sign has a mass of 50 kg, then determine the tension in the diagonal cable which supports its weight.



3. The following sign can be found in Glenview. The sign has a mass of 50 kg. Determine the tension in the cables.