Newton's Laws

Isaac Newton lived in the 1600's and developed three laws based on forces and how they cause objects to behave. Each law deals with Forces and acceleration and they are called Newton's First, Second and Third Laws.

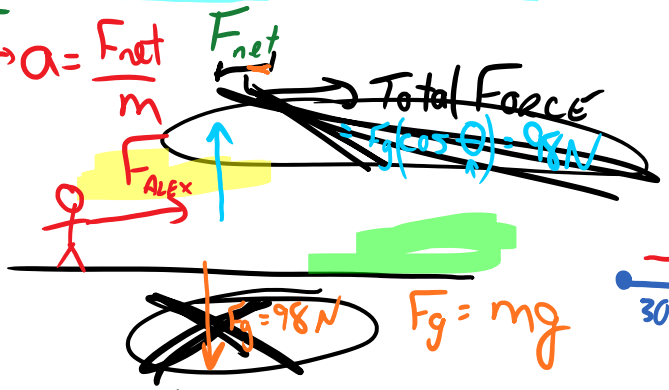
move force in one direction

NEWTON'S SECOND LAW:

An object will accelerate in the direction of an unbalanced force.
The size of the acceleration is proportioned to the size of the unbalanced force.
The size of the acceleration is INVERSELY proportioned to the mass of the object.

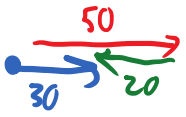
Big F, get big a

$a = \frac{F_{net}}{m}$



Big m small a

Find $F_{net} = 30N$



Find a

$a = \frac{F_{net}}{m} = \frac{3}{} = 3.0 \frac{m}{s^2}$ Right

Winning Newton's 2nd Law:

Step 1) draw a free body diagram (shows all forces acting out from an object) FBD
Step 2) Winners - losers = Fnet
Step 3) Newton's 2nd law gets accel

Dumb partner mistake: You turned off Fg

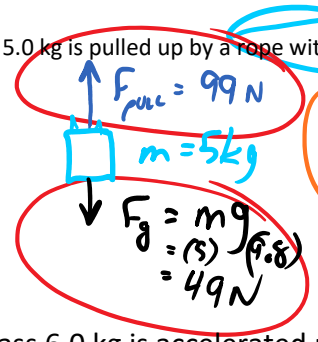
$-L = F_{net}$

$F_{net} = W_{in} - L_{oser}$ (big; 980; go other way)

$\frac{F_{net}}{m} = a$

m

A cat of mass 5.0 kg is pulled up by a rope with a force of 99 N, what is the cat's acceleration?



$F_{net} = 99 - 49 = 50N$

$a = \frac{F_{net}}{m} = \frac{50}{5} = 10 \frac{m}{s^2}$ up

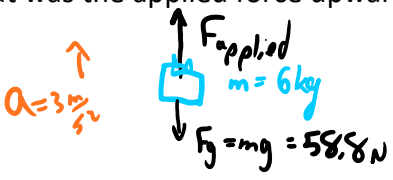
$= 220N$

$\frac{220}{100} = 2.2 \frac{m}{s^2}$

$1.0 \frac{m}{s^2}$ up

own

A cat of mass 6.0 kg is accelerated up at 3.0 m/s^2
what was the applied force upward?



$F_{net} = 3(6) = 18N$ UP

$F_{net} = F_{APPLIED} - F_g$

$18 = F_{app} - 58.8$

$18 + 58.8 = F_{app} = 76.8N$

A cat of mass 6.0 kg is accelerated DOWN at 3.0 m/s^2

A cat of mass 6.0 kg is accelerated DOWN at 3.0 m/s^2
What was the applied force upward?

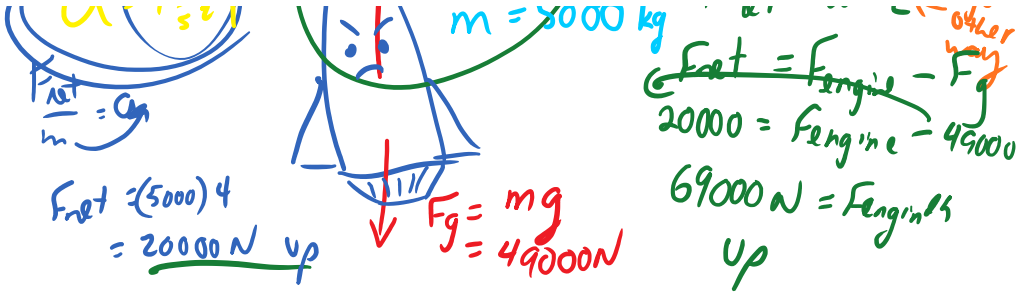
Newton's First Law (law of inertia) : An object will continue at a constant velocity until an unbalanced force acts on it. If Fnet = 0 then acceleration = 0
You will stay at a constant speed until some NEW force acts on you.
Total Force = 0 N and velocity is constant
Fnet = total force

A cat of mass 4.0 kg is pulled AT CONSTANT VELOCITY to the right with a force of 12 N
Find the coefficient of friction!!!

A cat of mass 10kg is pulled left with a force of 20 N, if the Coefficient of friction is 0.25 find the acceleration!!

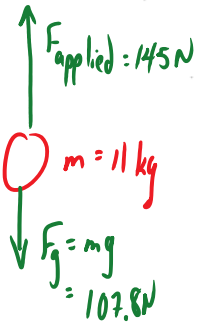
A cat of mass 10kg accelerates from rest to 5.0 m/s right in 2.0 seconds. Find the net force!!!

A rocket accelerates up at 4.0 m/s^2, if its mass was 5000 kg find the force from its engines, assume there is no air resistance.



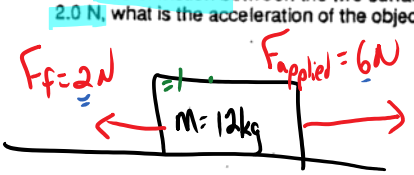
Practice Problems:

1. An 11.0 kg object is thrown vertically into the air with an applied force of 145 N. What is the initial acceleration of the object?



(3.37 m/s²)

2. A 12.0 kg object is pushed with a horizontal force of 6.0 N east across a horizontal table. If the force of friction between the two surfaces is 2.0 N, what is the acceleration of the object?



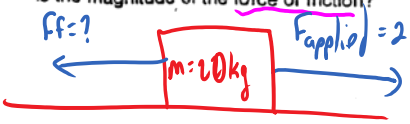
$F_{net} = 6 + -2$
$= 4N$
$\frac{F_{net}}{m} = a = \frac{4}{12} = 0.33\ \frac{m}{s^2}$

(0.33 m/s² east)

3. A 15.0 kg object is thrown vertically into the air. If the initial acceleration of the object is 8.80 m/s², what is the applied force?

(279 N)

4. A 20.0 kg object is pulled horizontally along a level floor with an applied force of 27.0 N. If this object is accelerating at a rate of 0.80 m/s², what is the magnitude of the force of friction?



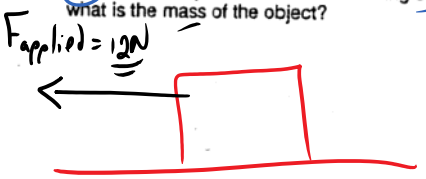
$a = .8\ \frac{m}{s^2}$

$F_{net} = F_{app} - F_f$
$16 = 27 - F_f$
$F_f = 27 - 16 = 11N$

$F_{net} = ma$
$= (1.8)(20) = 16$

(11 N)

5. An object is pulled west along a horizontal frictionless surface with a steady horizontal force of 12.0 N. If the object accelerates from rest to a velocity of 4.0 m/s while moving 5.0 m, what is the mass of the object?

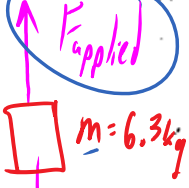


$V_o = 0$
$V_f = 4$
$d = 5$
$a =$
$V_f^2 = V_o^2 + 2ad$
$16 = 2a5$
$16 = 10a$
$a = 1.6$

$F_{net} = 12$
$F_{net} = ma$
$\frac{12}{1.6} = 7.5kg$

(7.5 kg)

6. A 6.3 kg object is thrown upward with an acceleration of 0.45 m/s². What is the magnitude of the force applied to the object?



$ma = 2.8\ N = F_{net}$
$F_{net} = F_{app} - F_g$
$2.8 = F_{app} - 61.7$
$+61.7$
$F_{app} = 64.6N$
$= 6.3(9.8) = 61.7N$

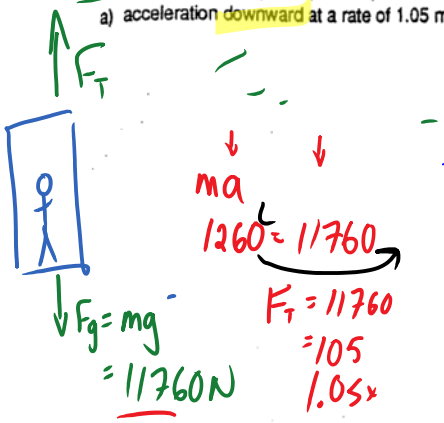
(65 N)

7. What is the tension in the cable of an

8. An object that has a mass of 36.0 kg is pushed

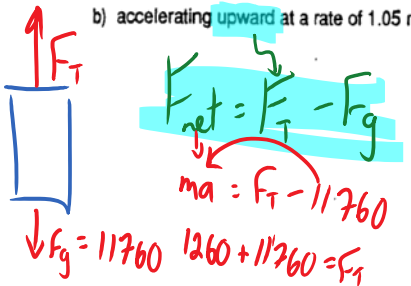
7. What is the tension in the cable of an 1.20×10^3 kg elevator that is

a) acceleration downward at a rate of 1.05 m/s^2



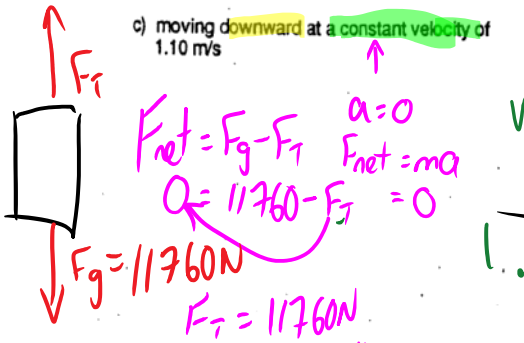
(1.05×10^4 N)

b) accelerating upward at a rate of 1.05 m/s^2



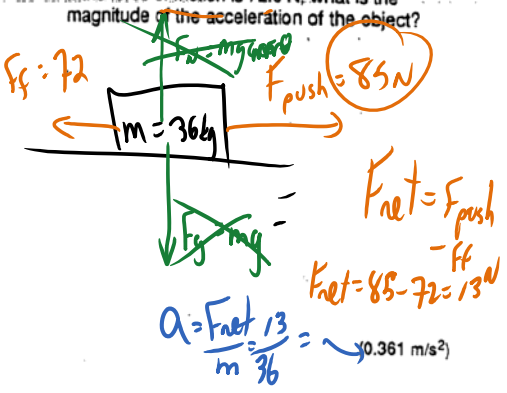
(1.31×10^4 N)

c) moving downward at a constant velocity of 1.10 m/s



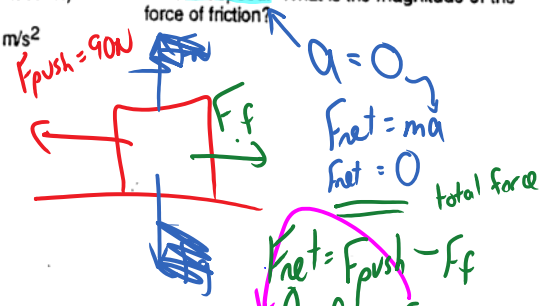
(1.18×10^4 N)

8. An object that has a mass of 36.0 kg is pushed along a horizontal surface with a force of 85.0 N. If the force of friction is 72.0 N, what is the magnitude of the acceleration of the object?



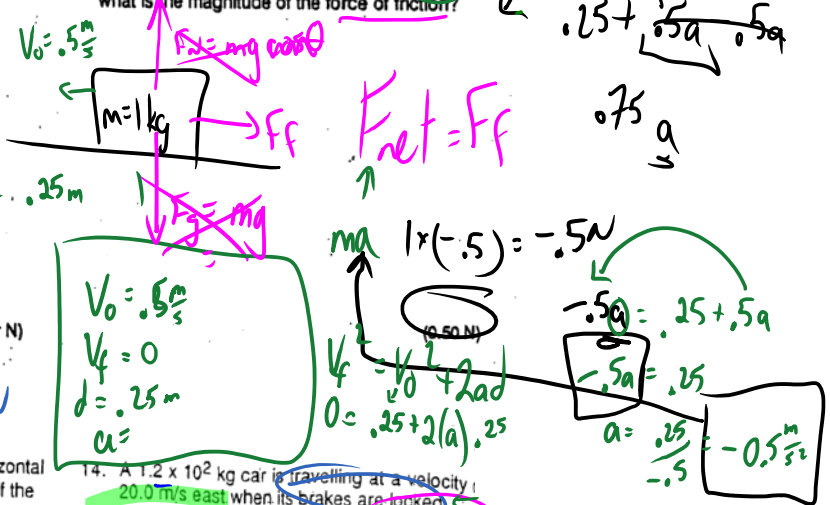
(0.361 m/s^2)

9. A horizontal force of 90.0 N is required to push a 75.0 kg object along a horizontal surface at a constant speed. What is the magnitude of the force of friction?

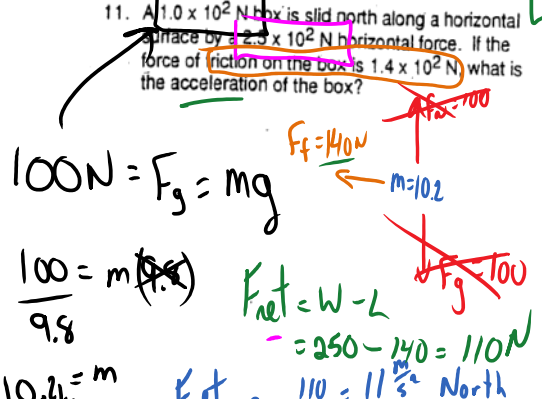


(90.0 N)

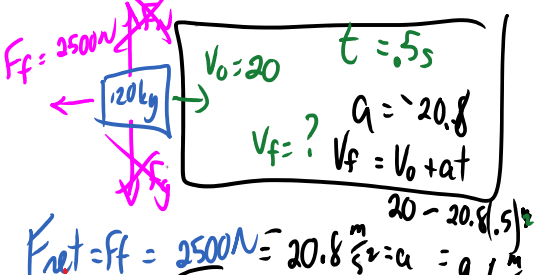
10. A 1.0 kg object is given a push along a horizontal surface. If the velocity of the object when it is released is 0.50 m/s west, and the object slides 0.25 m before coming to a stop, what is the magnitude of the force of friction?



11. A 1.0 x 10^2 N box is slid north along a horizontal surface by a 2.5 x 10^2 N horizontal force. If the force of friction on the box is 1.4 x 10^2 N, what is the acceleration of the box?



14. A 1.2 x 10^2 kg car is travelling at a velocity of 20.0 m/s east when its brakes are locked. Assuming a force of friction of 2.50 x 10^3 N, what is the velocity of the car after 0.50 s?



9.8

10.2 kg = m

$F_{net} = 250 - 140 = 110\ N$

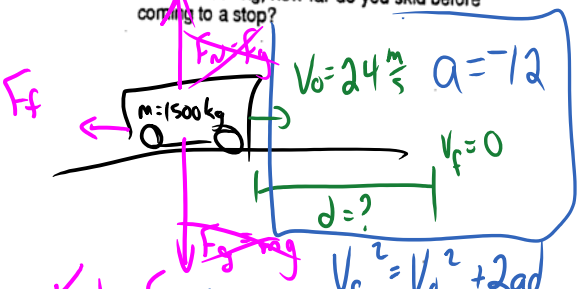
$\frac{F_{net}}{m} = a = \frac{110}{10.2} = 11\ \frac{m}{s^2}$ North

(1.1 x 10^1 m/s^2 north)

12. An 7.0 kg object rests on a horizontal frictionless surface. What is the magnitude of the horizontal force that is required to accelerate it at the rate of 2.3 m/s^2?

(16 N)

13. You are travelling in your car at a velocity of 24.0 m/s east when you slam on your brakes. The force of friction on your car tires is 1.80 x 10^4 N. If the mass of you and your car is 1.50 x 10^3 kg, how far do you skid before coming to a stop?



$F_{net} = F_f$ 18000

$ma = -18000$

$a = \frac{-18000}{1500} = -12\ \frac{m}{s^2}$

$V_f^2 = V_0^2 + 2ad$

$0 = 24^2 + (-24)(24.0\ m)\ d$

$d = 24\ m$

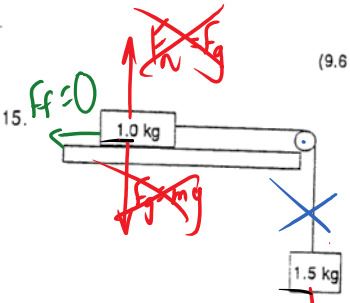
$F_{net} = F_g = 2500\ N = 20.8\ \frac{m}{s^2} = a$

$\frac{F_{net}}{m} = \frac{2500\ N}{120} = 20.8\ \frac{m}{s^2} = a$

$20 - 20.8(.5) = 9.6\ \frac{m}{s}$

(9.6 m/s east)

15.



A 1.0 kg box on a horizontal frictionless surface is accelerated by attaching a 1.5 kg mass as shown in the diagram. What is the acceleration of the box?

F_N = normal force supporting force exerted by surface at 90° to surface

$F_g = 14.7\ N$

$F_{net} = F_g = 14.7\ N$

$a = \frac{F_{net}}{m} = \frac{14.7}{2.5} = 5.88\ \frac{m}{s^2}$

$a = 9.8\ \frac{m}{s^2}$ wrong $\leftarrow \frac{14.7}{1.5}$

$a = 14.7\ \frac{m}{s^2}$

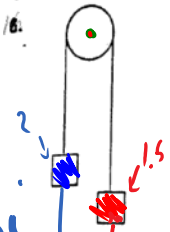
F_{net}

1 kg

(5.9 m/s^2)

$F_g = 125\ N = mg$ $\frac{125}{9.8} = 12.8\ kg$

16.



Two masses of 1.5 kg and 2.0 kg are hung on a frictionless pulley as shown in the diagram. What is the acceleration of

a) the 1.5 kg mass?

$F_g = mg = 19.6$

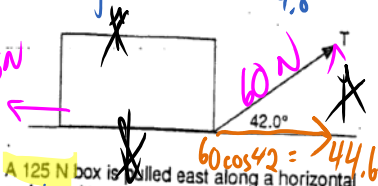
$F_g = mg = 14.7$

$F_{net} = W - T = 19.6 - 14.7 = 4.9\ N$

$\frac{F_{net}}{m} = \frac{4.9}{3.5} = +1.4\ \frac{m}{s^2}$

$-1.4\ \frac{m}{s^2}$

17.



A 125 N box is pulled east along a horizontal surface with a force of 60.0 N acting at an angle of 42.0° as shown in the diagram. If the force of friction on the box is 15.0 N, what is the acceleration?

$F_{net} = W - T$

$= 44.6 - 15 = 29.6\ N$

$F_{net} = 29.6$

$\frac{F_{net}}{m} = \frac{29.6}{12.8} = 2.31\ \frac{m}{s^2}$

$F_g = mg$ $\frac{725}{9.8} = 74\ kg$ (2.32 m/s

$F_g = mg$ $\frac{725}{9.8} = 74\,kg$ (2.32 m/s

18. A 725 N student stands on a bathroom scale while riding in an elevator. The student observes that the scale reads 775 N as the elevator begins to rise. Find the acceleration of the elevator as it begins to rise.

(1.4 m/s²)

b) the 2.0 kg mass?

$1.4 \frac{m}{s^2}$ down

$F_N = 775N$

$19.6N = (.4)(49)$ $F_n = F_g \cos\theta = 49$

$F_f = \mu F_n$ $F_{applied} = 50N$

m = 5kg

find accel

$\mu = 0.4$ $F_g = mg = 49N$

$F_{net} = W - L$

$= 50 - 19.6$

$= 30.4$

$\frac{F_{net}}{m} = \frac{30.4}{5} = 6.08 \frac{m}{s^2}$

Right