Name: KEY

Forces Homework #1

Free-Body Diagrams (FBDs) are diagrams that show the direction of ***every*** force acting on an object.

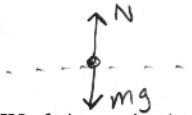
Steps to Follow:

1) Visualize the situation with a sketch
2) Draw a dot to represent the object's center of mass
3) Draw arrows to represent forces in appropriate directions
   a) Anything that touches an object exerts a force (contact forces)
      i) Surfaces exert a perpendicular force called the Normal Force (F_n)
      ii) If there is friction, frictional forces will be parallel to the surface and in the opposite direction of the objects motion or the applied force (F_f)
   b) Some forces are exerted without contact (field forces) like gravitational force (F_g)
   c) If you know one force is bigger than another then draw that force as a longer arrow
   d) **Never draw Velocity as a force!!!**
4) Define a coordinate system to identify + and – directions and your x and y components
5) If solving for a value, write out Newton's Second Law $\sum F_x = ma_x$ or $\sum F_y = ma_y$
6) Do the Math!

1. Draw a FBD of a box in free fall. (neglect air resistance)

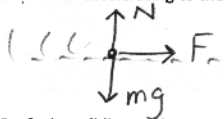
$\Sigma F = mg$

2. Draw a FBD of a box at rest on a horizontal surface.



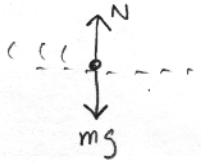
$\Sigma F = \emptyset$

3. Draw a FBD of a box accelerating to the right on a horizontal frictionless surface.



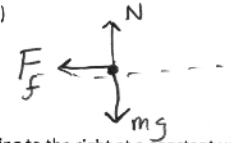
$\Sigma F = F$

4. Draw a FBD of a box sliding to the right with a constant velocity on a frictionless horizontal surface.



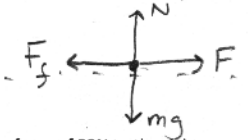
$\Sigma F = \emptyset$

5. Draw a FBD of a box sliding to the right on a horizontal surface with friction. (Remember: unless specifically stated, no force is pushing it to the right. The box must be moving to the right initially due to its inertia)



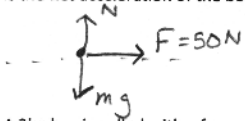
$\Sigma F = F_f$

6. Draw a FBD of a box sliding to the right at a constant velocity on a horizontal surface with friction.



$\Sigma F = \emptyset$

7. A 2kg box is pulled with a force of 50N to the right across a horizontal frictionless surface. What is the net acceleration of the box?

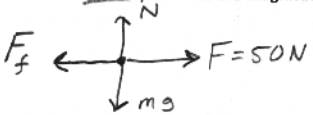


$\Sigma F = ma$

$F = ma$

$a = \frac{F}{m} = \frac{50N}{2kg} = 25 m/s^2$

8. A 2kg box is pulled with a force of 50N to the right across a horizontal surface at a constant velocity. What is the magnitude of the frictional force acting on the box?



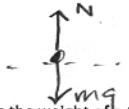
$\Sigma F = \emptyset$

$F - F_f = \emptyset$

$F = F_f$

$F_f = 50N$

9. A 2kg box is at rest on a horizontal surface. What is the normal force acting on the box?



$\Sigma F = \emptyset$

$N - mg = \emptyset$

$N = mg$

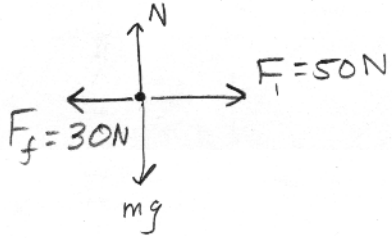
$N = 20N$

10. What is the weight of a 10kg box on Earth? (Remember weight is also known as the force of gravity acting on an object)

$F_g = W = mg$

$100N$

11. A 10kg box is pulled to the right with a force of 50N across a horizontal surface with friction. The magnitude of friction experienced by the box is 30N. What is the net acceleration of the box?



$\Sigma F_x = ma$

$F_1 - F_f = ma$

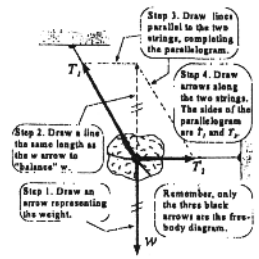
$a = \frac{F_1 - F_f}{m} = \frac{50N - 30N}{10kg}$

$a = 2 m/s^2$

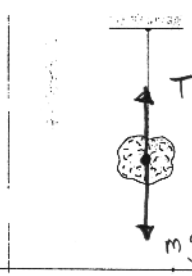
Free-Body Exercises: Linear Motion

In each case the rock is acted on by one or more forces. All drawings are in a vertical plane, and friction is negligible except where noted. Draw accurate free-body diagrams showing all forces acting on the rock. LM-1 is done as an example, using the "parallelogram" method. For convenience, you may draw all forces acting at the center of mass, even though friction and normal reaction force act at the point of contact with the surface. Please use a ruler, and do it in pencil so you can correct mistakes. Label forces using the following symbols: w = weight of rock, T = tension, n = normal reaction force, f = friction.

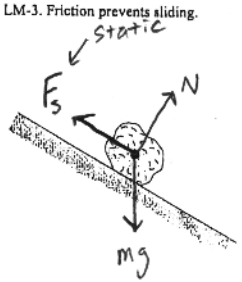
LM-1. Equilibrium (Example)



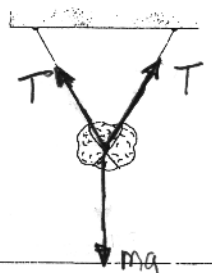
LM-2. Equilibrium



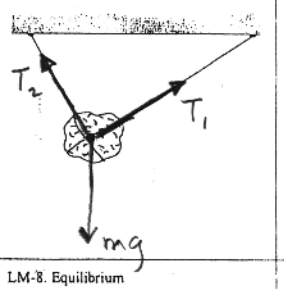
LM-3. Friction prevents sliding.



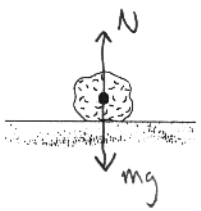
LM-4. Equilibrium



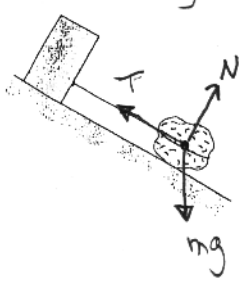
LM-5. Equilibrium



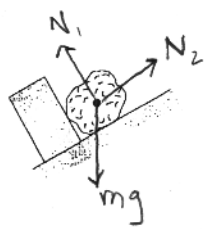
LM-6. Equilibrium



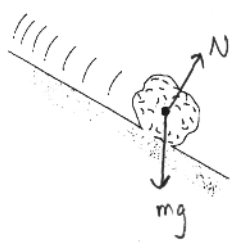
LM-7. Equilibrium



LM-8. Equilibrium

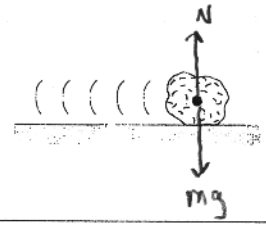


LM-9. Rock is sliding on a frictionless incline.



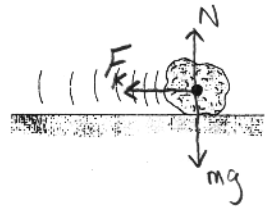
LM-10. Rock is falling. No friction.

LM-11. Rock is sliding at constant speed on a frictionless surface.

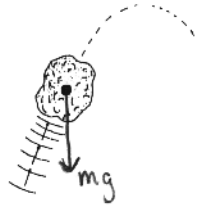


LM-12. Rock is falling at constant (terminal) velocity.

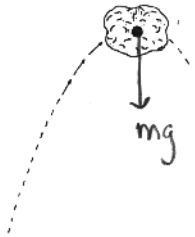
LM-13. Rock is decelerating because of kinetic friction.



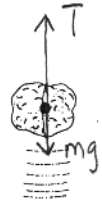
LM-14. Rock is rising in a parabolic trajectory.



LM-15. Rock is at the top of a parabolic trajectory.

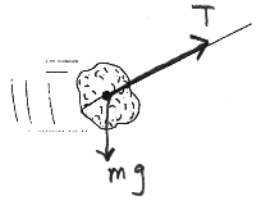


LM-16. Rock is tied to a rope and pulled straight upward, accelerating at 9.8 m/s². No friction.



LM-17. Rock is tied to a rope and pulled so that it moves horizontally at constant velocity. (There must be friction.)

LM-18. Rock is tied to a rope and pulled so that it accelerates horizontally at 2g. No friction.



Name: KEY

9-25-14 Problems AP1

$\Delta X = V_0 \cos\theta \cdot t$

$\Delta X = V_0 \cos\theta \frac{2V_0 \sin\theta}{g}$

$\Delta X = \frac{V_0^2 \sin(2\theta)}{g}$

$\Delta y = V_0 \sin\theta t - \frac{1}{2} g t^2$

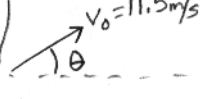
$0 = V_0 \sin\theta t - \frac{1}{2} g t^2$

$V_0 \sin\theta t = \frac{1}{2} g t^2$

$\frac{2(V_0 \sin\theta)}{g} = t$ Find time in the air

1. A rock is thrown at an angle of 35.0° to the horizontal with a speed of 11.5 m/s. How far does it travel?

$\Delta X = 12.43\,m$



$R = \frac{V_0^2 \sin(2\theta)}{g}$

2. A 450 kg mass is accelerated at 2.5 m/s^2. (a) What is the (net) force causing this acceleration? (b) If the mass of the car is doubled, what happens to the acceleration?

$\Sigma F = ma = 1,125\,N$

$\frac{1}{2}a = \frac{\Sigma F}{m \cdot 2}$ it halves

3. How much does a 34.5 kg gymnast weigh?

$F_g = mg = 345\,N$

4. A 2500 (m) kg car experiences a net 250 N force, (a) what is the acceleration acting on the car? (b) What is the car's speed at the end of 35 seconds?

a) $a = \frac{\Sigma F}{m} = \frac{250\,N}{2500\,kg} = 0.1\,m/s^2$

b) $V = V_0 + at$

$V = at = 0.1(35\,s) = 3.5\,m/s$

5. An artillery shell has a mass of 75 kg. (m) The projectile is fired from the weapon and has a velocity of 670 m/s when it leaves the barrel. The gun barrel is 2.7 m long. (a) Assuming the force and therefore the acceleration is constant while the projectile is in the barrel, what is the force that acted on the projectile? (b) If the elevation angle is 52°, what is the horizontal range of the projectile?

$V = 670\,m/s$

$V_0 = 0$

$\Delta X = 2.7\,m$

(a) $\Sigma F = ma = 6,234,722\,N$

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

$a = \frac{V^2 - V_0^2}{2\Delta X} = \frac{(670)^2}{2(2.7)} = 83,130\,m/s^2$

(b) use range equation

$R = \frac{V_0^2 \sin(2\theta)}{g}$

6. A ball is attached to a string and hangs from the ceiling. Draw a FBD of the system. Label the vectors.

7. A book sits on a table. The book has a mass of 1.25 kg. Draw a free body diagram of the thing.