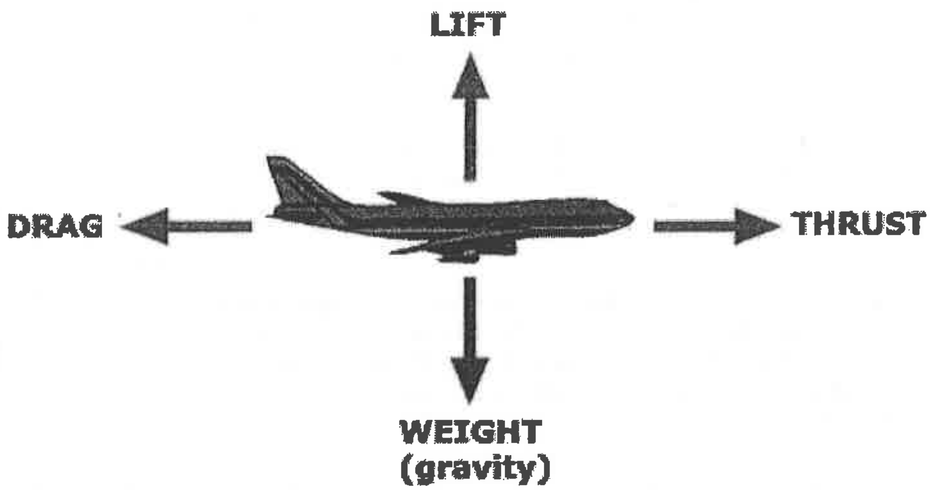
Forces Packet



Name: ______________________________

Physics Camp 2011-2012

Type of force	Label Symbol		
Gravitational force aka Weight	Fg or W	Friction	Ff or f
Normal force	FN or N	Tension	FT or T
		Applied	FApp

Normal force ↓ drawn perpendicular to the surface Always

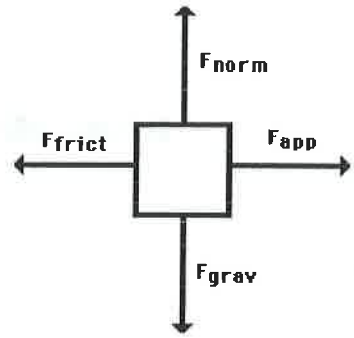
Worksheet #1 Free Body or Force diagrams...

Drawing Free-Body Diagrams

Free-body diagrams are diagrams used to show the relative magnitude and direction of all forces acting upon an object in a given situation. A free-body diagram is a special example of the vector diagrams; these diagrams will be used throughout your study of physics.

The size of the arrow in a free-body diagram is reflective of the magnitude of the force. The direction of the arrow reveals the direction in which the force acts. Each force arrow in the diagram is labeled to indicate the type of force.

It is customary in a free-body diagram to represent the object by a box or a small circle and to draw the force arrow from the center of the box or circle outward in the direction in which the force is acting. One example of a free-body diagram is shown to the right.



The free-body diagram above depicts four forces acting upon the object. Objects do not always have four forces acting upon them. There will be cases in which the number of forces depicted by a free-body diagram will be one, two, or three. There is no hard and fast rule about the number of forces which must be drawn in a free-body diagram. The only rule for drawing free-body diagrams is to depict all the forces which exist for that object in the given situation.

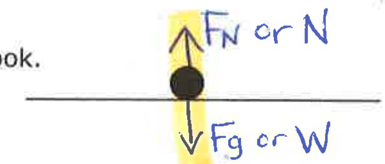
Thus, to construct free-body diagrams, it is extremely important to know the types of forces. If given a description of a physical situation, begin by using your understanding of the force types to identify which forces are present. Then determine the direction in which each force is acting. Finally, draw a box and add arrows for each existing force in the appropriate direction; label each force arrow according to its type.

Apply the method described in the reading to construct free-body diagrams for the situations described below. Use the symbols we discussed in class. Draw force vectors on the circle and label them.

The circle is a general symbol to represent ANY object!

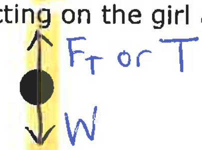
1. A book is at rest on a table top. Diagram the forces acting on the book.

↳ equal in length



2. A girl is suspended motionless from the ceiling by a rope. Diagram the forces acting on the girl as she holds onto the rope.

↳ equal in length. ↳ Tension



3. An egg is free-falling from a nest in a tree. Neglect air resistance. Diagram the forces acting on the egg as it falls.

↳ no applied force. ignore

4. An egg is falling (not freely, do not neglect air resistance) from a nest in a tree. Diagram the forces acting on the egg as it falls.

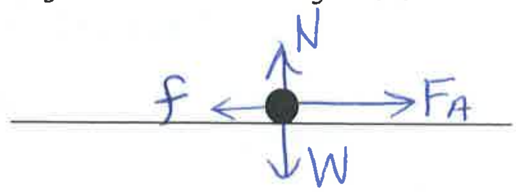
aka air friction

5. A rightward force is applied to a book in order to move it across a desk with a rightward acceleration. Consider frictional forces. Neglect air resistance. Diagram the forces acting on the book.

↳ not balanced

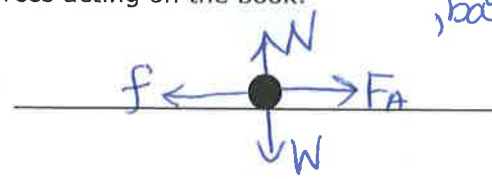
Right arrow > left arrow

friction opposes motion.



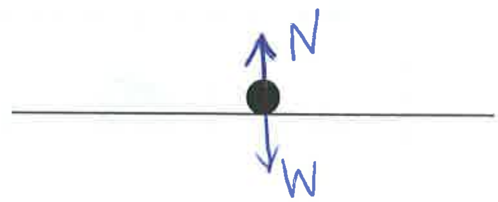
6. A rightward force is applied to a book in order to move it across a desk at constant velocity. → Equilibrium, balanced

Consider frictional forces. Neglect air resistance. Diagram the forces acting on the book.



7. A car is stopped at a stop light.

balanced



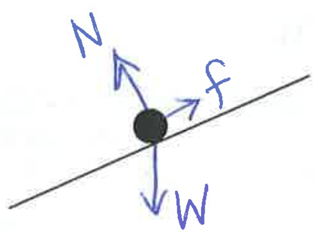
8. A skydiver is descending with a constant velocity. Consider air resistance. Diagram the forces acting upon the skydiver.

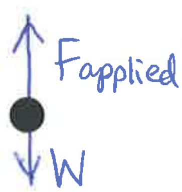
↳ Same length

9. A car is parked on a sloped street.

↳ no applied.

Normal force is PERPENDICULAR to surface ALWAYS!



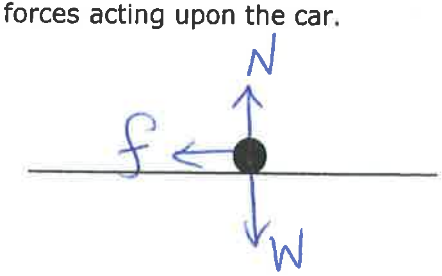


10. A hot air balloon is accelerating upward.

not balanced

11. A car is coasting to the right and slowing down. Diagram the forces acting upon the car.

↳ already in motion, no applied force.



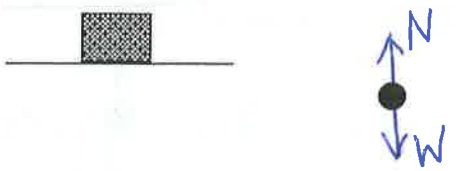
Name____________________________________

Date __________ Pd____

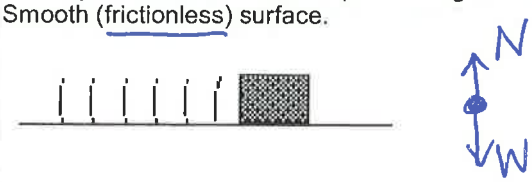
Worksheet 2, Drawing Force Diagrams

In each of the following situations, represent the object with a dot. Draw and label all the forces using standard force symbols as learned in class.

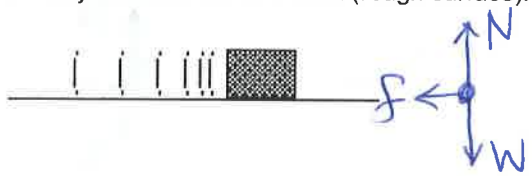
1. Object lies motionless on a surface.



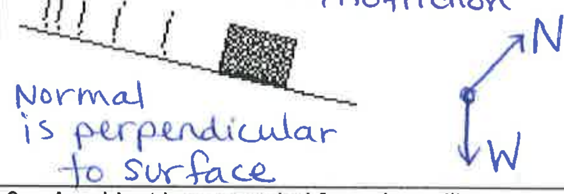
2. Object slides at constant speed along a Smooth (frictionless) surface. → no applied



3. Object slows due to friction (rough surface).



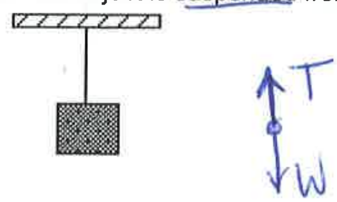
4. Object slides on a smooth incline. ↳ no friction



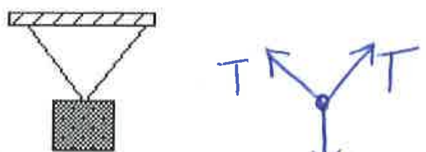
Normal is perpendicular to surface

5. Friction on an incline prevents sliding.

6. An object is suspended from the ceiling.

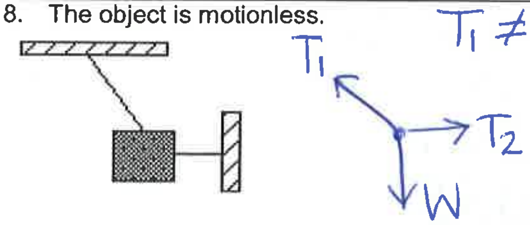


7. An object is suspended from the ceiling.

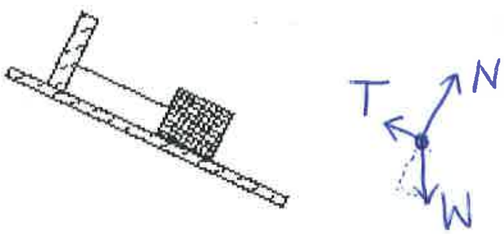


Probably T = T

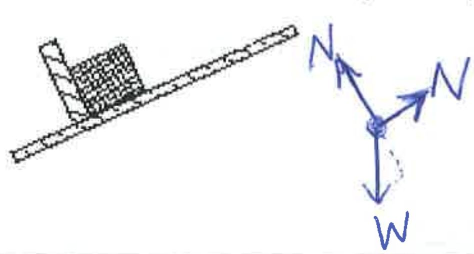
8. The object is motionless. $T_1 \neq T_2$



9. The object is motionless.

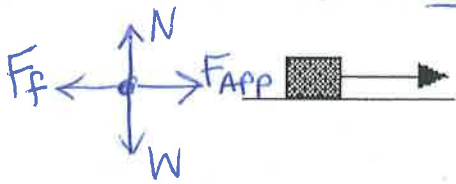


10. The object is motionless. 2 surfaces

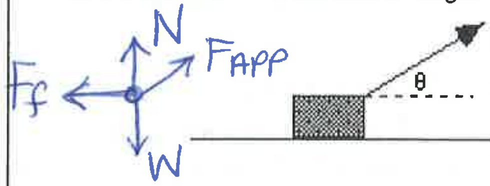


not really clear whether constant or accelerating.

11. The object is pulled by a force parallel to the surface. The surface is rough or has friction.

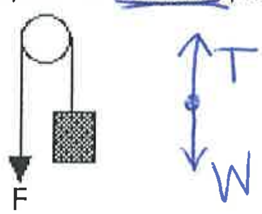


12. The object is pulled by a force at an angle to the surface. The surface is rough.

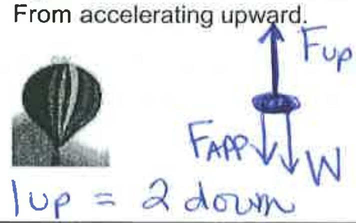


Friction is parallel to surface!

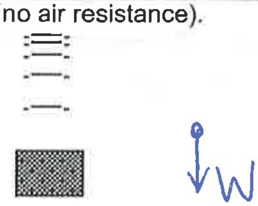
13. The object is pulled upward at constant speed.



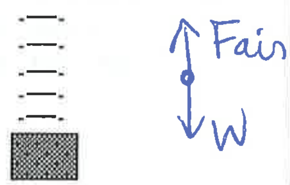
13. A hot air balloon is held down to keep it From accelerating upward.



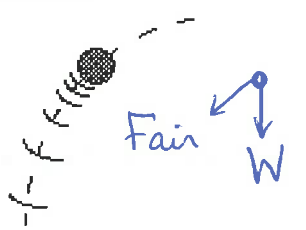
15. The object is falling (no air resistance).



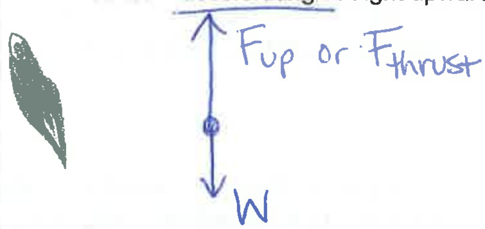
16. The object is falling at constant (terminal) velocity.



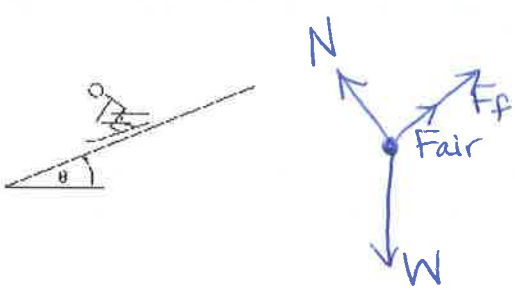
17. The ball is rising in a parabolic trajectory. Do not neglect air resistance



18. A rocket is accelerating straight upward.

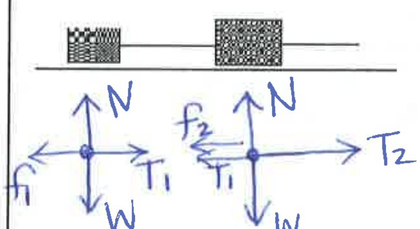


19. A skier is accelerating down a slope. There is friction and air resistance.



20.A big block of mass M is attached via a string to a smaller block of mass m. A student attaches a string to block M and pulls everything to the right along the rough surface. Both blocks travel at constant velocity.

Do force diagrams for each block separately.



CALCULATING FORCE WORKSHEET

Calculate the force in the following problems by using the equation:

Force = mass x acceleration   F = m x a

Be sure to(1) ALWAYS write the equation, (2)plug in the numbers and units, and (3) give the answer with the correct units.

1. A man hits a golf ball (0.2 kg) which accelerates at a rate of 20 m/s^2. What amount of force acted on the ball?

2. You give a shopping cart a shove down the isle. The cart is full of groceries and has a mass of 18 kg. The cart accelerates at a rate of 3 m/s^2. How much force did you exert on the cart?

3. The wind pushes a paper cup along the sand at a beach. The cup has a mass of 25 grams (= ? kg) and accelerates at a rate of 5 m/s^2. How much force (in Newtons) is the wind exerting on the cup?

4. You push a friend sitting on a swing. She has a mass of 50 kg and accelerates at a rate of 4 m/s^2. Find the force you exerted.

5. How much force would it take to push another, larger friend who has a mass of 70 kg to accelerate at the same rate of 4 m/s^2?

6. A worker drops his hammer off the roof of a house. The hammer has a mass of 9 kg, and gravity accelerates it at the usual 9.8 m/s^2. How much force does the earth apply to the hammer?

7. A car whose mass is 1000 kg is traveling at a constant speed of 10 m/s. Neglecting any friction, how much force will the engine have to supply to keep going the same speed? (tricky question) (think INERTIA) (look at the units)

   $\Sigma F = 0$

g = acceleration of gravity, ~10 m/s²

$\Sigma F = ma$

Net Force & Friction Problems

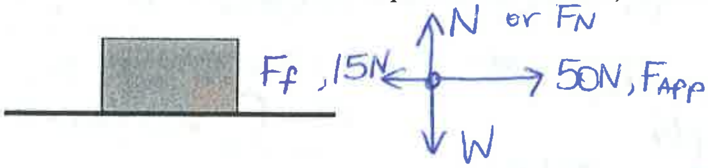
$F_f = \mu F_N$ ★ Sept

↳ coefficient of friction.

Name: ______________________ Date: ____________ (SI unit)

Draw a free body diagram (force diagram for every different problem).

1. A force of 50 Newtons is used to drag a 10 kg box across a horizontal table. If a frictional force of 15 Newtons is present on the box, calculate the unbalanced (net) force on the box. (Resultant)



$\Sigma F = 50 - 15 = 35\text{ N} = \Sigma F$

2. Calculate the acceleration of the object in problem 1.

$\Sigma F = ma \qquad 35 = 10a \qquad a = 3.5\text{ m/s}^2$

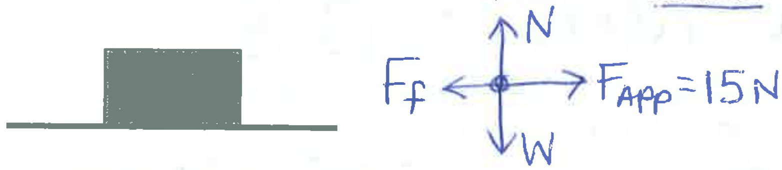
3. Calculate the force of gravity acting on the box in problem 1.

$F_g = W = mg = 10(10) = 100\text{ N}$ also $= F_N$

4. Calculate the coefficient of friction in problem 1.

★ September $F_f = \mu F_N \qquad 15 = \mu(100) \qquad \mu = .15$ no unit!

5. A horizontal force of 15 Newtons pulls a 5 kg block along a horizontal surface. If the force produces an acceleration of 2 m/s^2, what is the net force acting on the object?



$\Sigma F = ma = 5(2)$

$\Sigma F = 10\text{ N}$

* means that $F_{App} - F_f = 10\text{N}$

6. Calculate the frictional force in problem 5.

$15 - F_f = 10 \qquad F_f = 5\text{N}$

7. Calculate the weight of the block in problem 5.

$W = mg = 5(10) = 50\text{N}$

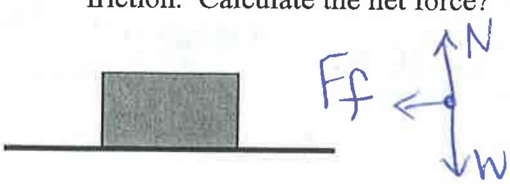
$F_N = F_g$ or $N = W$

8. Calculate the coefficient of friction in problem 7.

★ $F_f = \mu F_N \qquad 5 = \mu(50) \qquad \mu = .1$ no unit

9. A 2 kg mass moving along a horizontal surface at 10 m/s (velocity) is acted upon by a 5 N force of friction. Calculate the net force?

↳ already moving, no applied force.



$\Sigma F = F_f$ only $\therefore \Sigma F = 5\text{N}$

10. Calculate the acceleration in problem 9.

$\Sigma F = ma$

$5 = 2a$

$a = 2.5\text{ m/s}^2$

Net Force & Friction Problems

11. Calculate the weight of the mass in problem 9?

$W = mg = 2(10) = 20\ N$

12. Calculate the coefficient of friction in problem 9?

$F_f = \mu F_N \quad F_N = W \quad F_f = 5 = \mu(20) \quad \mu = .25$

13. A force of 40 Newtons applied horizontally is required to push a 20 kg box at constant velocity across the floor. Find the acceleration of the box.

$a = 0$ constant speed.

14. Calculate the net force in problem 13.

$\Sigma F = ma \quad \Sigma F = 0, a = 0$

15. Calculate the weight of the box in problem 13.

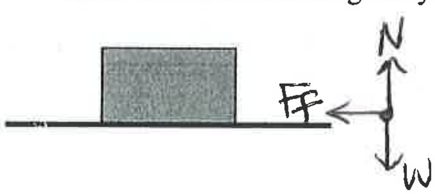
$W = mg = 20(10) = 200\ N$

16. Calculate the coefficient of friction between the box and the floor in problem 13.

friction is 40N also b/c constant speed.

$F_f = \mu F_N \quad 40 = \mu(200) = .2 = \mu$

17. A 80 kg person slides along the ground. Assuming the coefficient of kinetic friction is 0.30. Find the force of gravity acting on the person.



$W = mg = 80(10) = 800\ N$

18. Calculate the frictional force acting on the person in problem 17.

$F_f = \mu N \quad N = W$

$= .3(800) = 240\ N$

19. Find the net force acting on the person in problem 17.

ΣF is $F_f \quad \Sigma F = -240N$

negative b/c will slow down

20. Find the acceleration rate of the person in problem 17.

$\Sigma F = ma$

$-240 = 80a$

$a = -3\ m/s^2$