Honors Physics: Section 4.1 - Force and Motion

Force

What is force?

a push or pull exerted on an object

Variable: F

Units: Newton (N) $\Rightarrow 1N = \frac{1\,kg \cdot m}{s^2}$

Contact vs. Field Forces

forces that touch the object

forces that cannot touch the object

Free Body Diagrams (FBD)

- a visual representation (vector diagram) of all of the forces exerted on an object.

↳ one FBD per object

↳ forces are represented with arrows in direction force is exerted

↳ label all of your arrows (vectors)

Practice Problems:

1. A flowerpot fall freely from a windowsill.

system

contact forces

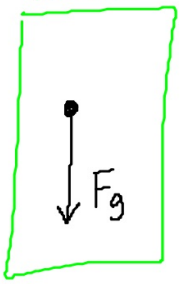
air resistance (ignore)

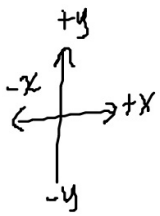
field forces

gravity (F_g)

F_g

answer





2. A skydiver falls downward through the air at constant velocity. (the air exerts an upward force on the person)

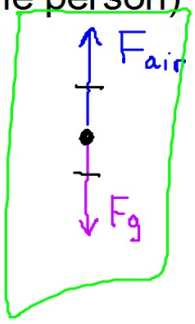
contact forces

air resistance (F_{air})

field forces

gravity (F_g)

F_{air} F_g

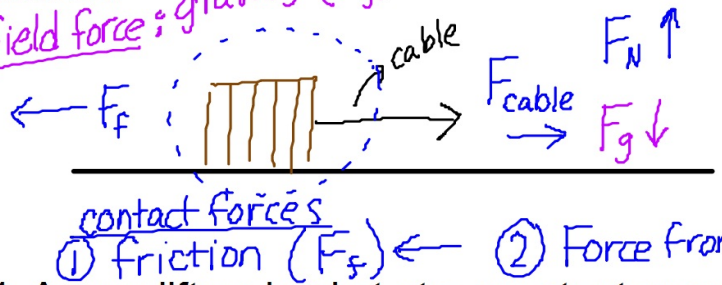


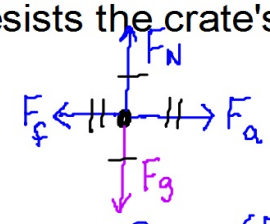
the magnitudes of F_{air} and F_g are the same (const. velocity)

Practice Problems

3. A cable pulls a crate at a constant speed across a horizontal surface. The surface provides a force that resists the crate's motion.

field force: gravity (F_g)



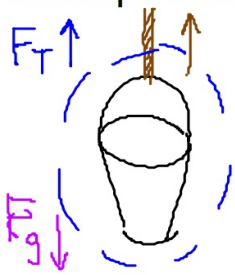


contact forces

① friction (F_f) ← ② Force from cable (applied force) F_a

③ normal force (F_N)

4. A rope lifts a bucket at a constant speed.



contact forces

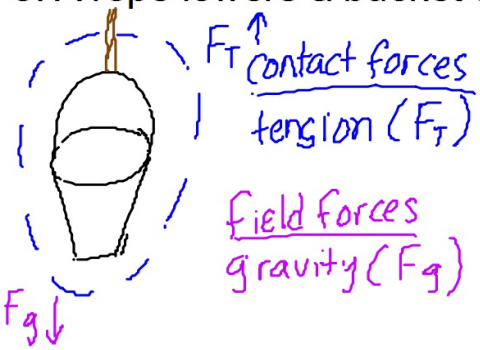
① tension (F_T)

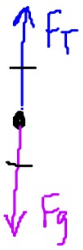
field forces

gravity (F_g)

Practice Problems

5. A rope lowers a bucket at a constant speed.





Net Force

the vector sum of all the forces acting on an object

- $F_{net} = \sum F$

  * $\sum \Rightarrow$ sigma $\Rightarrow$ "the sum of"

Newton's Second Law

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

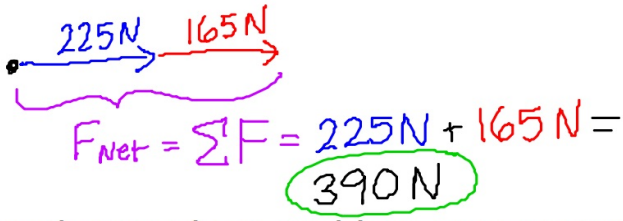
$F_{net} \Rightarrow$ N (newtons)

$m \Rightarrow$ Kg (kilograms)

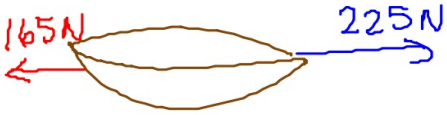
$a \Rightarrow m/s^2$

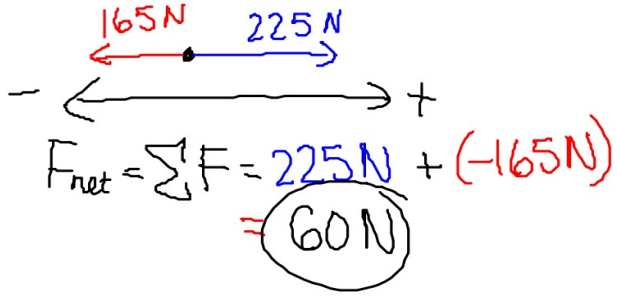
Practice Problems

6. Two horizontal forces, 225 N and 165 N, are exerted on a canoe. If these forces are applied in the directions, find the net horizontal force on the canoe.



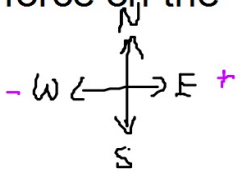
7. If the same to forces as the previous problem are exerted on the canoe in opposite directions, what is the het horizontal force on the canoe?





Practice Problems

8. Three confused sleight dogs are trying to pull a sled across the Alaskan snow. Alutia pulls east with a force of 35 N, Seward also pulls east but with a force of 42 N, and Kodlak pulls west with a force of 53 N. What is the net force on the sled?



$F_{net} = \sum F = F_A + F_S + F_K$

$= 35 + 42 + (-53)$

$= 24N$, east

Newton's First Law

(1) Moving at a constant (velocity) speed OR (2) at rest (speed = $0\frac{m}{s}$)

UNLESS acted on by an unbalanced (external) force

$$\Sigma F = F_{net} = 0\ N$$

b/c $a = 0\ m/s^2$ @ equilibrium

Inertia

property of matter; mass

Equilibrium

$F_{net} = 0\ N$

Types of Forces

Force	Symbol	Description	Direction

Practice Problems: 4.1 Section Review (pg. 95, #9-13)

4.1 Section Review

9. Force Identify each of the following as either **a, b,** or **c:** weight, mass, inertia, the push of a hand, thrust, friction, air resistance, spring force, and acceleration.

a. a contact force

b. a field force

c. not a force

10. Inertia Can you feel the inertia of a pencil? Of a book? If you can, describe how.

11. Free-Body Diagram Draw a free-body diagram of a bag of sugar being lifted by your hand at a constant speed. Specifically identify the system. Label all forces with their agents and make the arrows the correct lengths.

12. Direction of Velocity If you push a book in the forward direction, does this mean its velocity has to be forward?

13. Free-Body Diagram Draw a free-body diagram of a water bucket being lifted by a rope at a decreasing speed. Specifically identify the system. Label all forces with their agents and make the arrows the correct lengths.

14. Critical Thinking A force of 1 N is the only force exerted on a block, and the acceleration of the block is measured. When the same force is the only force exerted on a second block, the acceleration is three times as large. What can you conclude about the masses of the two blocks?

Homework: pg. 112 (#41, 42) and pg. 113 (#59-62)

Mastering Concepts

41. A physics book is motionless on the top of a table. If you give it a hard push with your hand, it slides across the table and slowly comes to a stop. Use Newton's laws to answer the following questions. (4.1)

a. Why does the book remain motionless before the force of your hand is applied?

b. Why does the book begin to move when your hand pushes hard enough on it?

c. Under what conditions would the book remain in motion at a constant speed?

42. Cycling Why do you have to push harder on the pedals of a single-speed bicycle to start it moving than to keep it moving at a constant velocity? (4.1)

Mastering Problems

4.1 Force and Motion

59. What is the net force acting on a 1.0-kg ball in free-fall?

60. Skating Joyce and Efua are skating. Joyce pushes Efua, whose mass is 40.0-kg, with a force of 5.0 N. What is Efua's resulting acceleration?

61. A car of mass 2300 kg slows down at a rate of 3.0 m/s^2 when approaching a stop sign. What is the magnitude of the net force causing it to slow down?

62. Breaking the Wishbone After Thanksgiving, Kevin and Gamal use the turkey's wishbone to make a wish. If Kevin pulls on it with a force 0.17 N larger than the force Gamal pulls with in the opposite direction, and the wishbone has a mass of 13 g, what is the wishbone's initial acceleration?