

Ch. 4: Forces Review

10	+	10	=	20
p. 1-2		3-4	TOTAL	
11/18		11/19		

Forces Test Tue. Format 3 problem 35 mc 70 pts

Basics of Force:

The units of Force are N, which is the same as a kg · m/s²

Show how the units cancel and what you end up with if you divide **force** by **mass**.

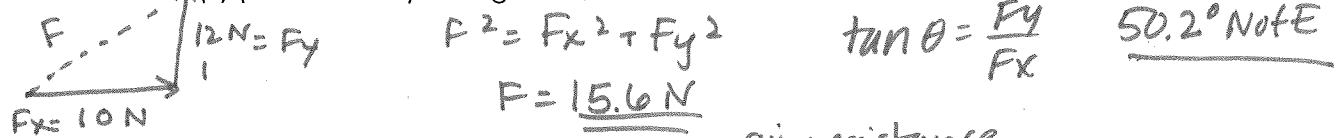
$$\frac{F}{m} = \frac{\text{kg} \cdot \text{m/s}^2}{\text{kg}} = a \text{ (m/s}^2\text{)}$$

Force is a **vector** so it has magnitude and direction.

If you are pulling a sled at an angle of 35° N of E with 25 N of force, find the force the sled feels.



You push a stack of books to the right at 10 N and your friend lifts it upwards with a force of 12 N. Find the total force (F) (the resultant) acting on the books and the ANGLE it is lifted at.



When an object is **falling**, what outside force slows it down? air resistance
 List 2 examples of friction. (friction)

air resistance; tires on road, anything sliding

Why is the force of friction **negative**? (F=ma, F ends up negative)

→ works against motion (opposes motion) → acc is negative (slowing down)

Newton's Laws of Motion:

Newton's 1st Law is the law of Inertia

What is the definition of inertia? property of matter to resist changes in motion

Newton's 2nd Law is the math equation F = m · a

Newton's 3rd Law states for every action there is an equal and opposite reaction

F = ma:

What does each **variable** in the F=ma equation stand for and what are their **units**?

force - F = m · a - acceleration (m/s²)
 (N) mass (kg)

If you divide force by acceleration, what unit do you have? kg

If you divide force by mass, what unit are you left with? m/s²

If you divide weight by acceleration, what quantity are you left with? mass

$$\frac{F}{a} = m$$

$$\frac{F}{m} = a$$

$$\frac{W}{a} = m$$

If a large truck and a small car collide with the same force, which will experience the greatest acceleration? small car

↓ m, ↑ a

In the **rollerblade lab**, we applied a constant force of 20 N and 30N to various students on rollerblades.

- a. What happened to their **speed** along the course? increased
- b. What happened to their **acceleration** along the course? (Or what should have happened if was a perfect world ☺) constant
- c. If the force is constant and mass is increased, what happens to a? ↓
- d. If the mass is constant and the force is increased, what happens to a? ↑
- e. Mass and acceleration are inversely related. (inversely or directly)
- f. Force and acceleration are directly related. (inversely or directly)
- g. A truck has a mass 10 x greater than a car. If they use the same force when accelerating, what can you say about the acceleration of the car?
acceleration of car is 10x larger $\downarrow m = \uparrow a$
- h. Constant force produces a constant velocity or acceleration

Mass vs. Weight:

- a. Explain the **difference** between mass and weight and include their **units**.

Amount of matter
(kg)

how much gravity
pulls on mass
(N)
- b. Convert 155 lbs into Newtons.

$$155 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} = 70.45 \text{ kg} (-9.8 \text{ m/s}^2) = \boxed{-690 \text{ N}}$$
- c. Which changes when you change locations, mass or weight? Weight
- d. Your weight on earth is 145 lbs. Calculate your mass and weight (N) on the moon. (gravity = -1.63 m/s²)

$$\frac{145 \text{ lb}}{2.2} = 65.9 \text{ kg} (-1.63 \text{ m/s}^2) = \boxed{-107 \text{ N}}$$

Equilibrium:

- a. If an object is at rest, are there any forces acting upon it? Explain.
Yes weight, floor ↑
- b. If you push on a wall with 50 N of force, with what force will the wall push back? Which of **Newton's laws** does this illustrate? 50 N - 3rd law
- c. What is the total force on an object in equilibrium? 0
- d. What are the 2 times when an object is in equilibrium?
- at rest
- constant velocity

G-forces:

- a. What is a g-force? how many x your weight you are experiencing
- b. What does it mean if you feel 3 g's? feel 3x your weight
- c. What does it mean if you feel .25 g's? feel 1/4 your weight

Problems:

1. If you are in a car accident where you (mass = 50 kg) and your friend (mass = 75 kg) both undergo -7050 N of force, how many g's is that for each of you? (14.4 g's, 9.6 g's)

$$g's = \left| \frac{\text{total force}}{m \cdot g} \right|$$

you: $\frac{-7050 N}{(50)(-9.8)}$

friend: $\frac{-7050 N}{(75 kg)(-9.8 m/s^2)}$

$14.4 g's$

$9.6 g's$

2. The maximum force a Target bag can withstand and not rip is -350 N. If 25 kg of Halloween candy are in the bag and are lifted from the floor with an acceleration of -3.75 m/sec², will the bag hold or break? Use $F = m(-9.8 + a)$ (-339, hold)

$$F = m(-9.8 + a)$$

$$25(-9.8 + -3.75)$$

$F = -339 N$ it will hold

3. You weigh 155 lbs at rest. You go in an elevator and on the way up find your weight to be 168 lbs and on the way back down your weight is 105 lbs.

- a. Find the **acceleration of the elevator** on the way up and how many **g-forces you experience**. (a will be negative) (-0.80 m/sec², 1.08 g's)

	lb	m	w
R -	155	70.5	-690
up -	168	76.4	-748
down -	105	47.7	-468

$$F = m(-9.8 + a)$$

$$-748 = \frac{70.5(-9.8 + a)}{70.5}$$

$$g's = \frac{-748}{(70.5)(-9.8)}$$

$1.08 g's$

$$-10.6 = -9.8 + a$$

$a = -0.80 m/s^2$

- b. Find the **acceleration of the elevator** on the way down and how many **g-forces you experience**. (3.16 m/sec², 0.68 g's)

$$F = m(-9.8 + a)$$

$$-468 N = \frac{70.5 kg(-9.8 + a)}{70.5}$$

$$g's = \frac{4.68 N}{(70.5)(-9.8)} = 0.68 g's$$

$$-6.641 = -9.8 + a$$

$a = 3.16 m/s^2$

4. A freight train has a mass of 3.3×10^7 lbs. If the train can exert a constant pulling force of 7.5×10^5 N, how long (Δt) does it take to accelerate the train from rest to 50 mph? (447 sec)

$m = 3.3 \times 10^7 \text{ lbs}$
 $2.2 = 1.5 \times 10^3 \text{ kg}$

$F = 7.5 \times 10^5 \text{ N}$

(1) solve a
 $\text{MAX} \rightarrow \text{VI}$
 $F = m \cdot a$
 $(1.05 m/s^2)$

(2) solve Δt
 $a = \frac{V_f - V_i}{\Delta t}$

$V_i = 0$ $V_f = 22.35 m/s^2$

5. You (155 lbs) are skating across a frozen pond in your boots. You start with a velocity of 12 m/s and come to a stop after 22 m. Calculate the force of friction that stops you. (-231 N)

$$\frac{155 \text{ lb}}{2.2} = 70.45 \text{ kg}$$

$$v_i = 12 \text{ m/s}$$

$$v_f = 0$$

$$\Delta x = 22 \text{ m}$$

① Find a

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$(a = -3.27 \text{ m/s}^2)$$

② Find F

$$F = m \cdot a$$

6. Your balloon car traveled 2.0 meters in 0.85 sec and had a mass of 14.5 grams.
a. Find the force exerted backwards by the air if $v_i = 0$. (0.08 N)

$$\Delta x = 2 \text{ m}$$

$$\Delta t = .85 \text{ sec}$$

$$m = 0.0145 \text{ kg}$$

① Find a

$$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$(a = 5.54 \text{ m/s}^2)$$

② Find F

$$F = m \cdot a$$

- b. Find the weight of your car in Newtons.

$$W = m \cdot \text{gravity}$$

- c. The force of the air leaving caused your car to move forward. This is an example of which of Newton's Laws of motion?

3rd action-reaction

7. The mass of a bottle rocket is 2.5 lbs and the force it is launched with is 27.2 N.
a. What is the acceleration of the bottle rocket as it is launched? (23.9 m/s²)

$$\frac{m = 2.5 \text{ lb}}{2.2} = 1.14 \text{ kg}$$

$$F = 27.2$$

$$F = m \cdot a$$

- b. What force will eventually slow the rocket down if it is shot straight up?

gravity, air resistance

8. You karate chop a block of wood with a velocity of 12 m/s. If the mass of your hand is 0.75 kg and it takes 0.0023 sec to stop your chop, what is the force exerted on your hand by the block of wood? (-3913 N)

$$m = 0.75 \text{ kg}$$

$$v_i = 12 \text{ m/s}$$

$$v_f = 0$$

$$\Delta t = 0.0023$$

① Find a

$$a = \frac{v_f - v_i}{\Delta t}$$

② Find F

$$F = m \cdot a$$

$$(a = -5217 \text{ m/s}^2)$$

u: F

Name _____ Hour _____

Forces Practice Quiz

What is a force? _____ Unit? _____

What **unit** will you be left with if you divide force by mass? _____

If you apply constant force, how is the a affected by m ? _____

Why is the force of friction negative? _____

What slows down a falling object? _____

What is inertia? _____

How do you find weight if you know lbs? _____

A semi and small car collide with 20,000 N of F . Which feels greater deceleration? _____

What is a g-force? _____

What is meant by 0.25 g's? _____

A heavy car weighs 3500 lbs and needs a force of 6550 N to accelerate from rest to a speed of 65 mph. Calculate the time it will take to reach that speed.

You are riding the Northern Lights (I think it is now called Ghost Zone) ride at MOA and have a scale in your chair. Your resting weight is 175 lbs. At the top your weight is 105 lbs and at the bottom you find your weight to be 245 lbs.

a. Find the **acceleration** at the bottom when you feel heavier. (it will be negative) How many **g-forces** do you feel?

b. Find your **acceleration** at the top when you feel lighter. How many **g-forces** do you feel?

A toy car (mass=25.5 g) starts at rest and travels 2.3 meters in 1.75 sec. What **force** did the car need to move that fast? What is the **weight** of the car in Newtons?

