Drive It Green

What's in a Label? Worksheet

Name: Answer Key

Instructions:

1. Research your vehicles using www.fueleconomy.gov and the "Find a Car" tool. Fill in the labels below. Be sure to include:
   - Fuel economy, including combined city/hwy, city , and highway mpg.
   - Gallons per 100 miles.
   - Fuel savings over 5 years.
   - The type of fuel used.
   - Annual fuel cost.
   - Fuel economy and greenhouse gas rating.
   - Smog rating.
2. Then answer the questions on the following pages.

Vehicle 1 (Car make, model, and year) Mazda, CX-5, 2020

EPA DOT **Fuel Economy and Environment** Gasoline

Fuel Economy

26 MPG

combined city/hwy | 24 city | 30 highway

3.3 gallons per 100 miles

You **save** SPEND

$250

in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost

$1,500

Fuel Economy & Greenhouse Gas Rating (tailpipe only)

1 — 5 — 10 Best

This vehicle emits ___ grams CO_2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions. Learn more at fueleconomy.gov.

Smog Rating (tailpipe only)

1 — 7 — 10 Best

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 32 MPG and costs $12,000 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $3.70 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

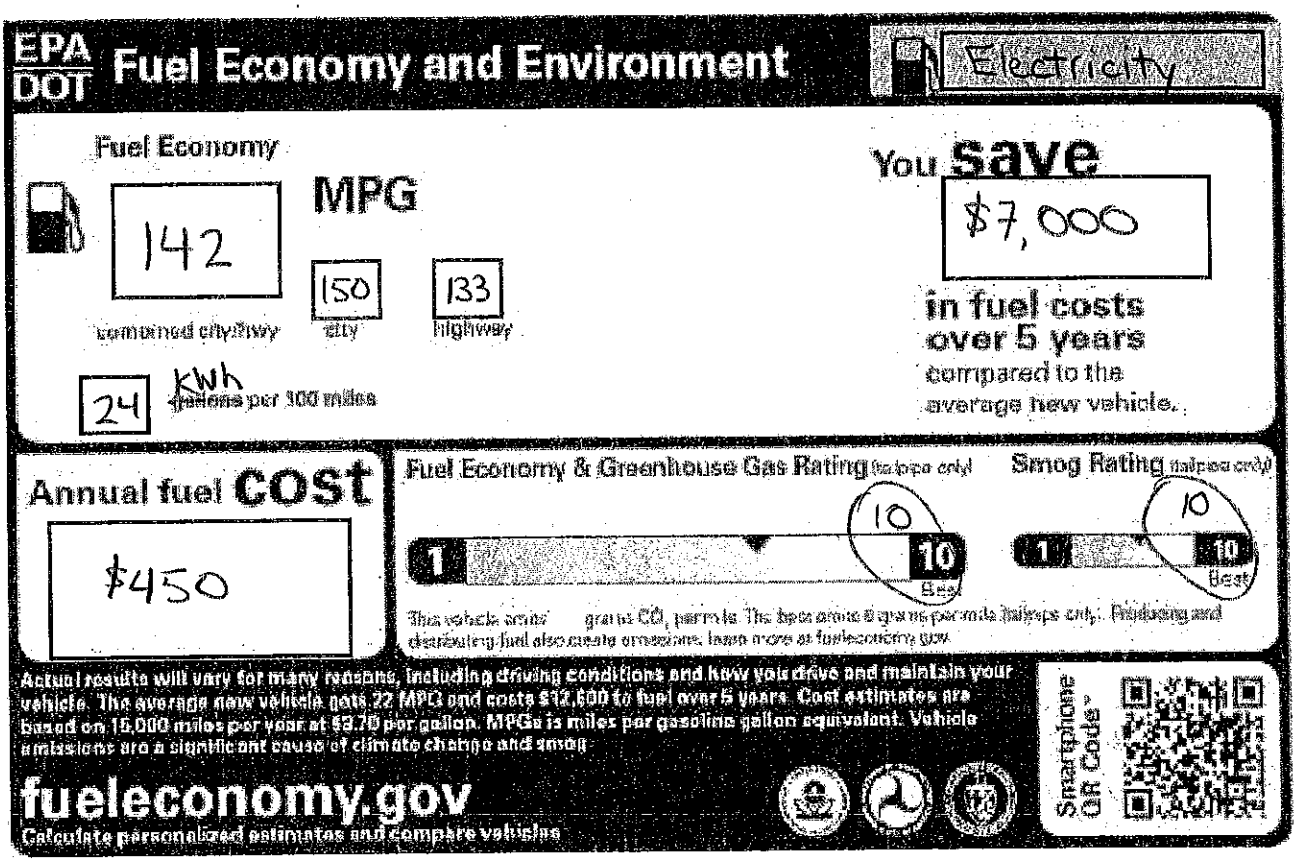
fueleconomy.gov

Calculate personalized estimates and compare vehicles

Smartphone OR Code

EPA

Vehicle 2 (Car make, model, and year) Tesla, Model 3, 2021



Questions:

1. What vehicle did you choose? Be sure to include the make, model, and year. Why did you choose this vehicle?

Vehicle 1	I chose the Mazda CX-5 from 2020 because it is the car my family uses.
Vehicle 2	I chose the Tesla Model 3 from 2021 because it is electric.

2. What type of fuel does your vehicle use? (from labels on previous pages)

Vehicle 1	gasoline
Vehicle 2	electricity

3. What was your vehicle's greenhouse gas rating? What does this rating mean?

Vehicle 1	5
Vehicle 2	10
Meaning of greenhouse gas rating:	This is a score from 1 to 10 (10 is best) based on how much carbon dioxide (or greenhouse gas) a car puts into the air.

4. How might fuel economy affect the greenhouse gas rating?

More fuel efficient vehicles would have less greenhouse gases and would be expected to have better (or higher) greenhouse gas ratings.

5. Does your vehicle cost more or less money in fuel than the average new vehicle? Why do you think it costs more/less?

Vehicle 1 The Mazda CX-5 costs more than the average new vehicle because it is less fuel efficient.
Vehicle 2 The Tesla Model 3 costs less than the average new vehicle because it is more fuel efficient.

6. Would you recommend this vehicle to someone who was interested in a fuel efficient and environmental friendly vehicle? Why or why not?

Vehicle 1 I would not recommend the Mazda CX-5 because it is not fuel efficient and has a lower greenhouse gas rating.
Vehicle 2 I would recommend the Tesla Model 3 because it is electric and extremely fuel efficient and has a high greenhouse gas rating.

7. What are ways you or your family can reduce greenhouse gas emissions from the existing car your family has? Use information you found from your second choice vehicle to help you answer this question.

We are looking for student answers to include:

- better fuel economy or fuel efficiency
- lower greenhouse gas emissions or higher greenhouse gas rating
- electric vehicles are an environmentally friendly choice

Basics of Design

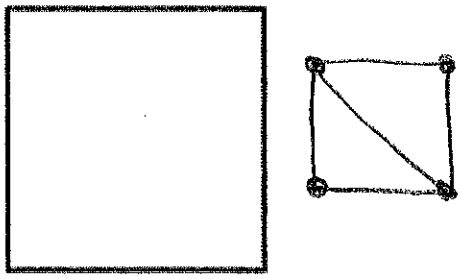
Name: Answer Key Date: _____

For the following exercises use the following:

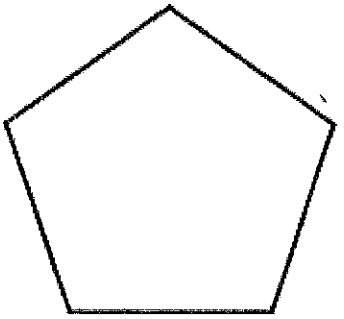
Steel Balls Magnetic Rods

Strength of Shapes

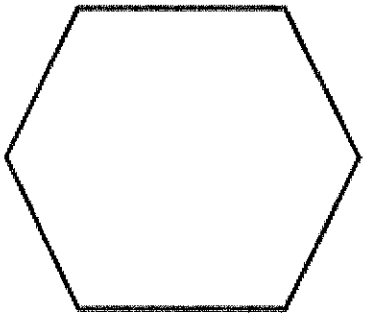
Using the steel balls and rods build the following shapes. First, name the shapes on the lines provided below each one. Next, test the strength of each shape by pressing inward on any single steel ball. If the ball moves easily, find a way to make the shape stronger by adding one or more additional rods or balls and then draw your final product next to the original.



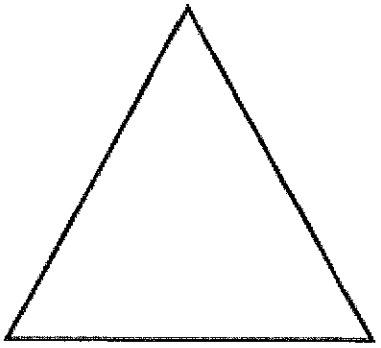
square



pentagon



hexagon



triangle

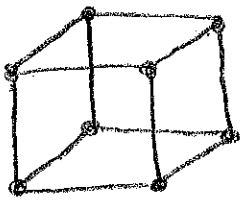
strong

After building all of these shapes, which one do you think is the strongest? triangle

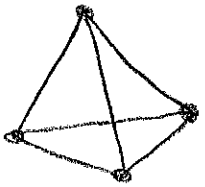
3-D Shapes

Now take some time to build the following three dimensional shapes and draw them below their name:

Cube



Pyramid (tetrahedron)



Which one of these two 3-dimensional shapes is the strongest? pyramid

Once you have built the two shapes above and have established which is the strongest try to build a structure that can hold the weight of a book. Draw a picture of your model below:

This should include many triangles.

Battery Power

Name: Answer Key

Battery Power Worksheet

Predictions:

Do you think the size of the battery has an effect on its voltage? What about the shape?

Battery Type	Labeled Voltage (V)	Measured Voltage (V)
AAA	1.5 V	1.57 V (varies a little)
AA	1.5 V	1.57 V
C	1.5 V	1.57 V
D	1.5 V	1.57 V
9V	9 V	9.1 V

1. On AAA, AA, C, and D batteries, where are the poles located? The poles are located on opposite ends (or sides) of the battery.
2. On 9V batteries, where are the poles located? The poles are located on top (or on same side)
3. What happens when the multi-meter connects to both poles? It shows a reading of voltage.
4. What happened when the probes of the multi-meter were placed on the opposite poles? It shows a negative number.
5. Which battery had the highest voltage? The 9V battery did.
6. The battery with the largest size measured how many volts? The D battery had 1.57 V.
7. The battery with the smallest size measured how many volts? The AAA battery had 1.57 V.

Aerodynamics

NAME Answer Key

START YOUR ENGINES

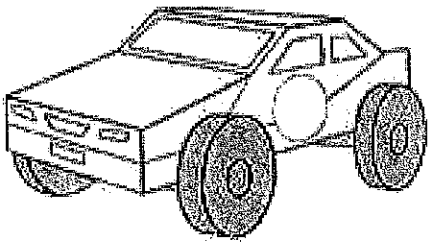
What limits how fast a race car can go?

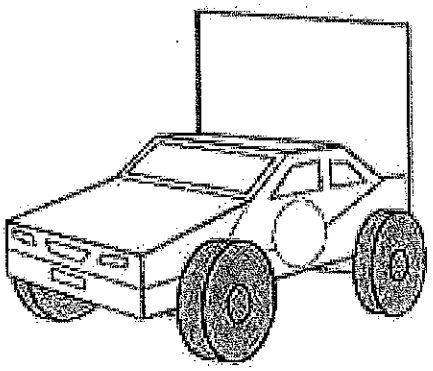
One factor is drag—a slowing force created when air pushes against an object. Try this activity to test how drag affects motion.

GATHER
YOUR MATERIALS
Completed car, ruler, tape, index card, card stock

PROCEDURE

1. Fold up both edges of a sheet of card stock. Lift one end of the card stock onto a stack of books to form a ramp.
2. Place your car at the top of your ramp so that it rolls forward. Measure the distance it travels. Repeat for a second test run. Record both results.
3. Tape an index card to the back of your car so that it sticks up above the car's roof. Repeat Step 2 again for two more test runs. Record the results of both runs.





DISTANCE TRAVELED
RACE CAR WITHOUT INDEX CARD

Test Run 1	Test Run 2

DISTANCE TRAVELED
RACE CAR WITH INDEX CARD

Test Run 1	Test Run 2

CONCLUSIONS

Answer these questions on a separate sheet of paper.

1. Which car went farther? Explain why you think this happened. The car w/out the index card went farther because it had less drag and was more aerodynamic.
2. How did adding the index card affect the car's drag? The index card increased the car's drag.
3. How might you design your EV Challenge car to minimize drag? This answer should include something about improving the car's aerodynamics or streamlining the car's shape.

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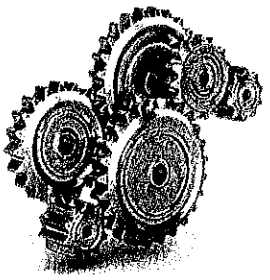
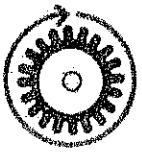
Intro to Gears
Answer Key



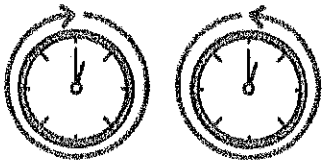
Gear Ratio Worksheet

1. Definitions that describe gears and gear motion:

Revolution – A revolution is one complete rotation of the gear

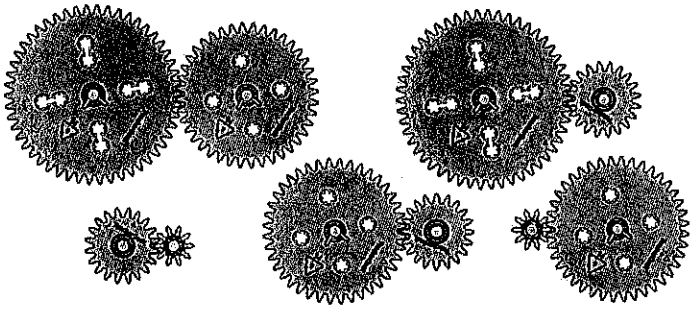


Rotation direction – Can be clockwise (CW) or counterclockwise (CCW)



Clockwise (CW) Counterclockwise (CCW)

Gear ratio – A ratio is a comparison of two values. A gear ratio compares the number of teeth of the gears which are meshed together. This ratio is a mathematical way to describe your gear set up to others. Gear ratios can be set up either for torque (turning force) or for speed.



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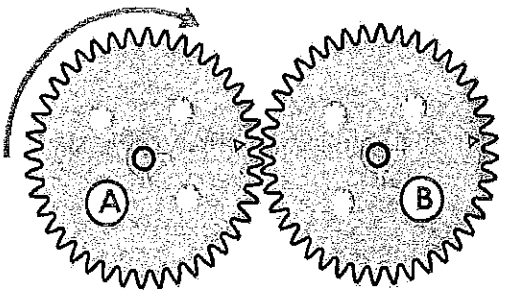
2. Using your gear set-up, place two 40-tooth gears meshed together on the base plate. Using the dowel, spin Gear A clockwise for one revolution. Complete the table below with your observations.

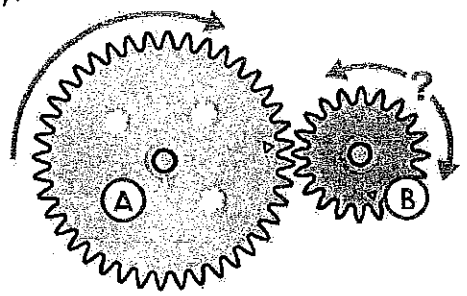


Gear	# Gear teeth	Direction of rotation (CW or CCW)	# Revolutions
A (driver)	40	CW	1
B (driven)	40	CCW	1

Gear Ratio = Driven Gear Teeth/Driver Gear Teeth

Gear Ratio = $\frac{40}{40}$ or $\frac{1}{1}$

3. Swap Gear B out and replace with a 20-tooth gear. Spin Gear A clockwise for one revolution. What happens differently?



Gear	# Gear teeth	Direction of rotation (CW or CCW)	# Revolutions
A (driver)	40	CW	1
B (driven)	20	CCW	2

Gear Ratio = Driven Gear Teeth/Driver Gear Teeth

Gear Ratio = $\frac{20}{40}$ or $\frac{1}{2}$

How did changing the size of Gear B affect the gear ratio? It reduced it from 1/1 to 1/2.

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4. Keep the same gear set up but spin Gear A counter clockwise for one revolution. What changed?

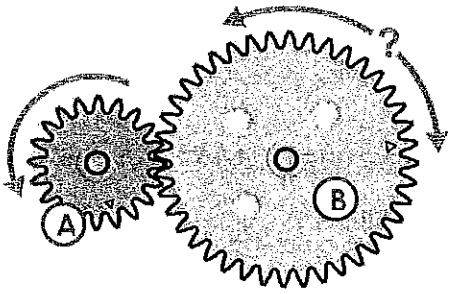
Gear	# Gear teeth	Direction of rotation (CW or CCW)	# Revolutions
A (driver)	40	CCW	1
B (driven)	20	CW	2

Gear Ratio = Driven Gear Teeth/Driver Gear Teeth

Gear Ratio = $\frac{20}{40}$ or $\frac{1}{2}$

Did the change in direction of rotation change the gear ratio? No

5. Switch your gear set-up so that Gear A is a 20-tooth gear and Gear B is a 40-tooth gear. Spin Gear A clockwise for one revolution. Record your observations.



Gear	# Gear teeth	Direction of rotation (CW or CCW)	# Revolutions
A (driver)	20	CW	2
B (driven)	40	CCW	1

Gear Ratio = Driven Gear Teeth/Driver Gear Teeth

Gear Ratio = $\frac{40}{20}$ or $\frac{2}{1}$

How did switching the driver and driven gears' sizes affect the gear ratio? It flipped the numbers or inverted the gear ratio from 1/2 to 2/1.

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6. Try some other gear set-ups, spin for one revolution in the direction of your choice and record below:

   a. Gear A has 10-teeth and Gear B has 50-teeth

Gear	# Gear teeth	Direction of rotation (CW or CCW)	# Revolutions
A (driver)	10	CW or CCW	5
B (driven)	50	CCW or CW	1

Gear Ratio = Driven Gear Teeth/Driver Gear Teeth

Gear Ratio = $\frac{50}{10}$ or $\frac{5}{1}$

   b. Gear A has 50-teeth and Gear B has 20-teeth

Gear	# Gear teeth	Direction of rotation (CW or CCW)	# Revolutions
A (driver)	50	CW or CCW	2
B (driven)	20	CCW or CW	5

Gear Ratio = Driven Gear Teeth/Driver Gear Teeth

Gear Ratio = $\frac{20}{50}$ or $\frac{2}{5}$

   c. Gear A has 10-teeth and Gear B has 40-teeth

Gear	# Gear teeth	Direction of rotation (CW or CCW)	# Revolutions
A (driver)	10	CW or CCW	4
B (driven)	40	CCW or CW	1

Gear Ratio = Driven Gear Teeth/Driver Gear Teeth

Gear Ratio = $\frac{40}{10}$ or $\frac{4}{1}$

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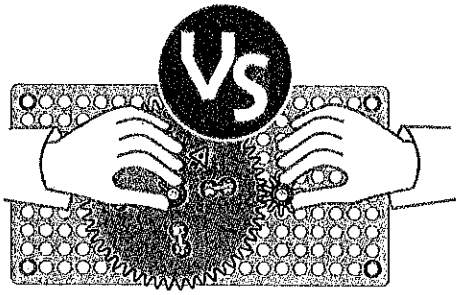
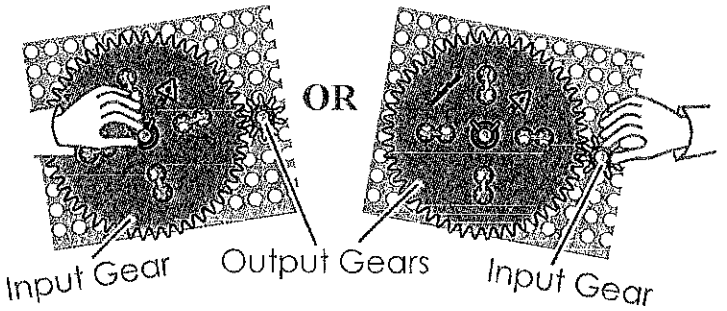
Mechanical Advantage

Now that you have tried different gear set-ups with different gear ratios, it is time to apply what you have learned. How are different gear set-ups useful?

Gears can be set-up in order to increase torque (turning force) or speed, but not both at the same time. This is called mechanical advantage. Try placing a 50-tooth gear meshed with a 10-tooth gear on your base plate. Have a twisting contest with a partner.



Which gear increases force on the other gear? When the 10 (or smaller) tooth gear is turned, the force on the second (driven) gear is greater.



Spin each gear and observe which way increases speed. When the 50 (or larger) tooth gear is turned, the speed of the second (driven) gear is greater.

Intro to Gears Remote
Answer Key

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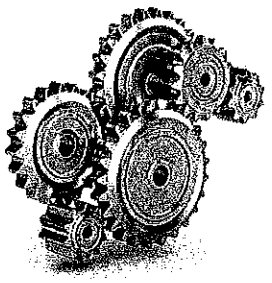

Gear Ratio Worksheet (Remote Version)

Using the online gear simulator at https://geargenerator.com, simulate different gear ratios and decide if the ratio is for high speed or high torque. Record in the table the number of times you rotated Gear A (driver gear) and how many times Gear B (drive gear) rotated.

To use Geargenerator.com, start by removing the complex gear set up on the landing page by clicking on "Remove" under "Gears" on the top left panel until you have gear #0 (driver) and gear #1(driven) only. Then, modify the gears in the simulator to create the gear ratios given and decide whether they are designed for high torque or high speed. Do this by highlighting the gear on the side panel under "Gears:" and then increasing or decreasing the number of teeth (N) under "Gear Properties".

Gear #	Gear Ratio			Torque or Speed
	A (Driver)	:	B (Driven)	
1	1	:	1	Both
2	1	:	2	Torque
3	1	:	2.5	Torque
4	4	:	1	Speed
5	4	:	3	Speed
6	3	:	1	Speed
7	2	:	1	Speed
8	4	:	5	Torque