Appendix: Instructional Worksheets Used in Experiments 1 and 2

Schwartz, D.L., Chase, C.C., Oppezzo, M.A., & Chin, D.B. (in revision). Practicing versus inventing with contrasting cases: The effects of telling first on learning and transfer. Journal of Educational Psychology.

Density (discrete): Crowded Clowns

1. Invention instructions
2. Tell-and-Practice information
3. Cases worksheet

Speed (discrete): Corn Poppers

4. Invention instructions
5. Tell-and-Practice information
6. Cases worksheet

Density (continuous): Gold Cubes

7. Invention instructions
8. Tell-and-Practice information
9. Cases worksheet

Speed (continuous): Racing Cars

10. Invention instructions
11. Tell-and-Practice information
12. Cases worksheet

1

Inventing an Index

An **index** is a number that helps people compare things.

Miles per gallon is an index of how well a car uses gas.
Batting average is an index of how well a baseball player hits.
Grades are an index of how well you are doing in school.
Star rating is an index of how efficient an electrical appliance is.

We want you to invent a procedure for computing one kind of index.

THE CROWDED CLOWNS INDEX

Companies send clowns to parties, circuses, amusement parks, sporting events, and so on.

To get the clowns to the event, each company packs the clowns into a bus. Some companies make the clowns more crowded than other companies.

The more crowded the clowns are, the grumpier they will be.

People who order clowns want to know a company's crowded clown index.

Invent a procedure for computing a crowded clown index for each company.

RULES FOR THE INDEX

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1. The same company always crowds the clowns the same amount, no matter how many clowns get ordered. So a company only gets a single crowded clown index.

2. You have to use the exact same procedure for each company to find its index.

3. A big index value should mean that the clowns are more crowded. A small index number should mean that the clowns are less crowded.

Good luck!

FINDING **DENSITY**

Density is how much stuff is packed into a space. Density can be the number of people in a room, the density of feathers in a pillow, and many other things.

Density is very important in chemistry. Density is a property of ***matter***. Gold is denser than carbon, because more matter is packed into each atom of gold compared to each atom of carbon.

When working with density, the trick is to use the simple equation:

$$D = \frac{M}{V} \quad \text{or} \quad \text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Density is a measure of the mass of a substance per unit of volume.

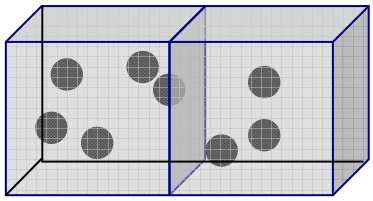
Sometimes we find the ***Mass*** by counting the number of objects.

Volume is the amount of space. Volume is harder to find, because a volume can take many shapes – a sphere, a balloon, a bottle.

To make it easier, we will tell you the volume. We will measure it in cubes.

In the example below, there are two cubes. There are 8 objects spread across the cubes.

Density is the average number of objects per unit of volume.



Density = # objects / volume

= 8 objects / 2 cubes

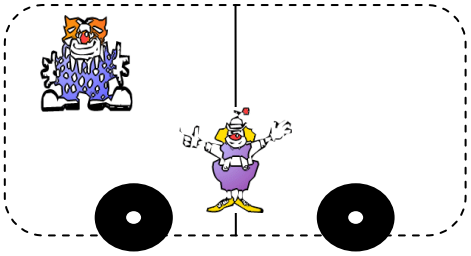
= 4 objects / cube

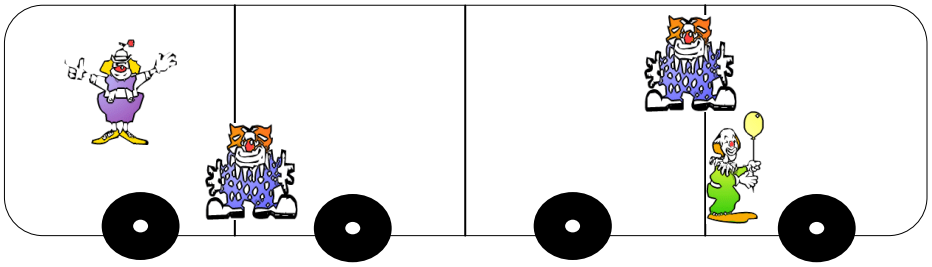
On the next page, compute the density for each company that busses clowns.

3

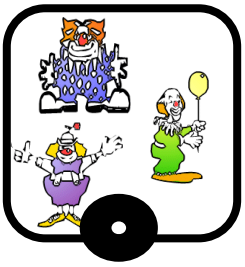
Names _____ Period _____

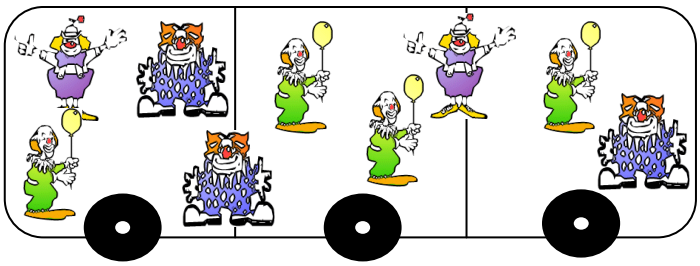
Happy Clowns = _____



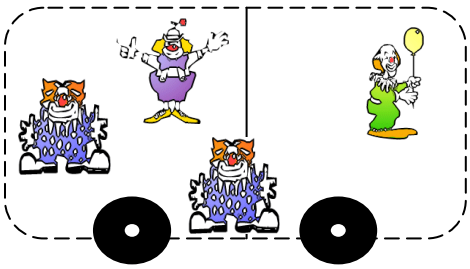


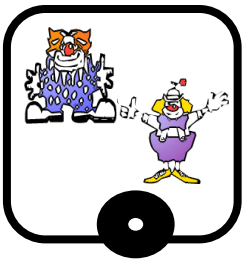
Bargain Basement Clowns = _____





Clowns ‘r’ Us = _____





4 Three companies make popcorn. They use different types of corn so the popping is fast or slow.

Create a “popping index” to let consumers know how fast each brand pops.

FINDING **SPEED**

SPEED is how quickly something happens. Speed can be how fast a car goes, how fast a player can shoot baskets, how slowly a tree grows, and many other things.

Speed is very important in physics. Speed is a property of ***a mass***. All mass has a speed. If a mass is not moving, then it has a speed of zero.

Speed is a measure of how fast a change occurs.

Sometimes ***Speed*** can be found by counting.

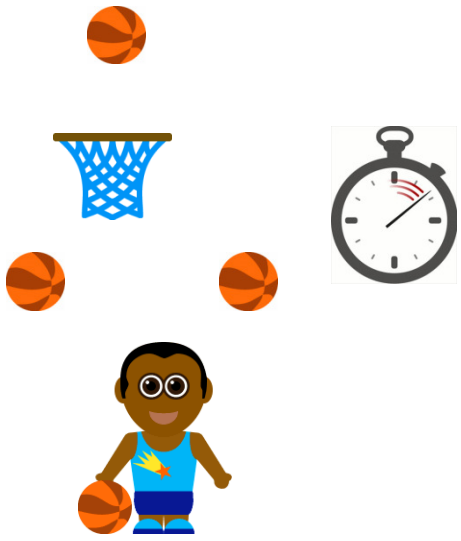
When working with speed as a count, the trick is to use the simple equation:

$$S = \frac{E}{T} \quad \text{or} \quad \text{Speed} = \frac{\text{\# of Events}}{\text{Time}}$$

# of Events is the number of events that happens in a period of time.

In the example below, the player shot free throws. Each free throw is an event.

The player shot 4 free throws in 10 seconds.



Speed = events / time

= 4 free throws / 10 seconds

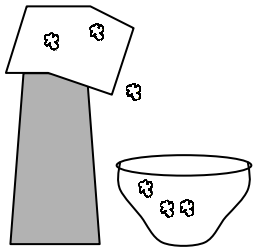
= 4/10 (free throws per 10 seconds)

On the next page, compute the speed for each popcorn popper.

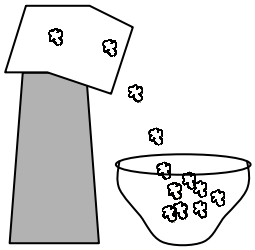
Names _____ Period _____

6

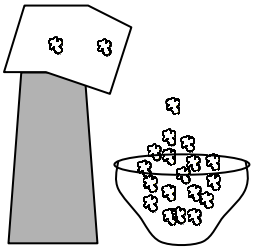
HipHop Popping Corn = _____



6 seconds

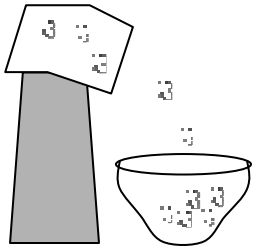


12 seconds

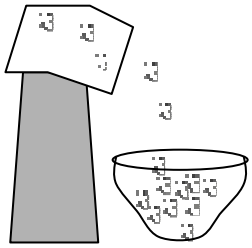


20 seconds

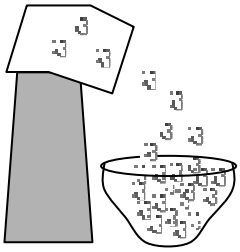
Hot Pops = _____



20 seconds

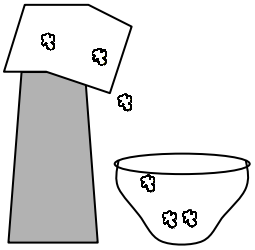


30 seconds

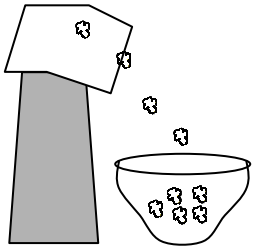


50 seconds

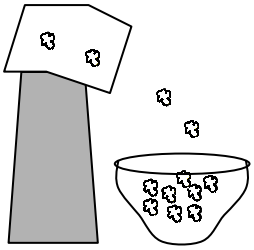
Poppomatic Popcorn = _____



8 seconds



12 seconds



16 seconds

7

Getting your money's worth.

Have you ever heard of 14 karat gold? It is not worth as much as 20 karat gold.

What is the difference?

Most gold that people buy is a mix of pure gold and cheaper metals.

14 karat gold has less gold and more cheap metal than 20 karat gold.

On the next page you have some samples of gold from different companies. Each company has its own mix of gold and cheap metal.

You have to come up with your own "gold quality" index for each company. That way, people can look at the index and know if they are buying better quality "gold" that has more "pure gold" in it.

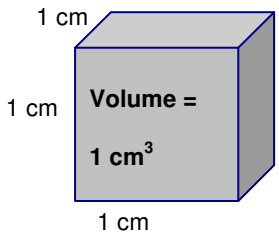
How to do this?

The trick is that gold is heavier than the cheap metal. So the more pure gold, the heavier the metal will be. Given two pieces of gold that are the same size, the better quality gold will be heavier.

To do this task you need to know two things:

Weight is measured in ***grams***.

Volume is measured in cm^3. A cm^3 means a cube that is 1 cm on each side.



2 cm^3 is a volume that equals two of the cubes.

FINDING **DENSITY**

Density is how much stuff is packed into a space. It can be density of people in a room and density of feathers in a pillow. Density is very important in chemistry. Density is a property of ***matter***. Gold is denser than carbon, because more matter is packed into each atom of gold compared to each atom of carbon.

When working with density, the trick is to use the simple equation:

$$D = \frac{M}{V} \quad \text{or} \quad \text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

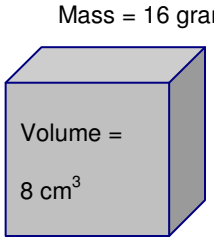
Density is a measure of the mass of a substance per unit of volume.

Mass can be found by weighing an object. It is measured in **grams**.
Mass can also be found by counting.

Volume is the amount of space. Volume is harder to find, because a volume can take many shapes – a sphere, a balloon, a bottle.

To make it easier, we will only talk about the volume of cubes. The volume of a cube is the **height** x **width** x **depth**. But, we will make it <u>even</u> easier. We will tell you the volume. Volume is always measured in centimeters cubed or **cm^3**.

Look at the example to see how to compute the density of the cube.



Density = mass / volume

= 16 grams / 8 cm^3

= 2 g / cm^3

FLOATING IN WATER?

Water always has a density of 1 g / cm^3.

An object will float in water, if the density of the object is less than the water.

The cube above has a density of 2g / cm^3. It will sink in water.

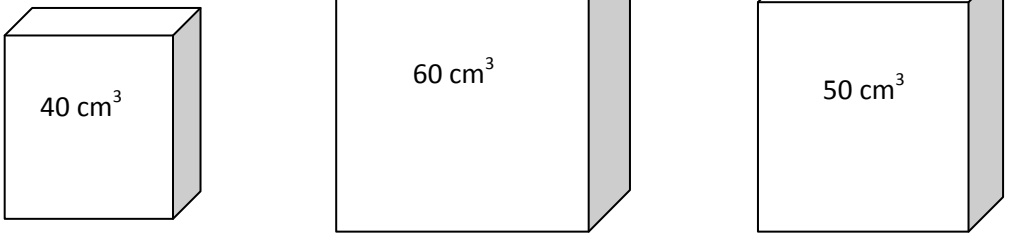
On the next page, compute the density of each object.

9

Names _____ Period _____

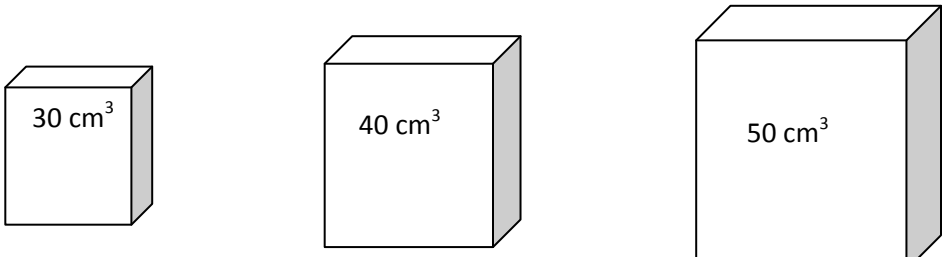
Grams is the weight. cm^3 is the volume.

Diamond Jim's ----------



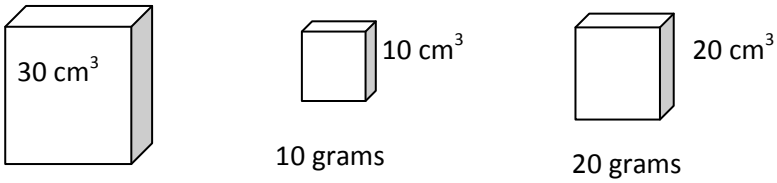
160 grams 240 grams 200 grams

Gold miner gems ----------



150 grams 200 grams 250 grams

Jewelry Jane ----------



30 grams 10 grams 20 grams

10

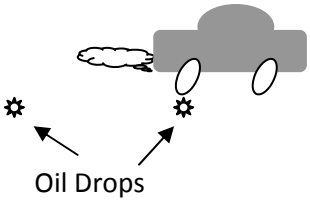
How fast is that car?

Your task is to come up with a *fastness index* for cars with dripping oil.

You will see a bunch of cars, and you need to come up with one number to stand for each car's fastness.

There is no watch or clock to tell you how long each car has been going.

However, all the cars drip oil once a second. (They are not very good cars!)
You can look at the oil drops to help figure out how long a car has been travelling.



This task is a little harder than before.

A company always makes its cars go the same fastness.

We will not tell you how many companies there are.

You have to decide which cars are from the same company. They may look different!

To review:

(1) Make a fastness index for each car.

(2) Decide how many companies there are.

(3) To show the cars that are from the same company, draw a line that connects the cars.

FIGURING OUT **SPEED**

A measurement of distance can tell you how far an object travels. A cyclist, for example, might travel 30 km. An ant might travel 2 cm. If you know the distance an object travels in a certain amount of time, you can calculate the speed of the object. Speed is a type of rate. A rate tells you the amount of something that occurs or changes in one unit of time.

The equation below shows how to calculate the speed of a moving object:

$$S = \frac{D}{T} \qquad \text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Time can be measured in seconds, minutes, hours, days, and years.
Distance can be measured in inches, feet, yards, miles, centimeters, meters, kilometers.
To compute speed, you divide the distance by the time:

144 meters

= 8 seconds

$Speed_{dog}$= distance/time

= 144 m / 8 s

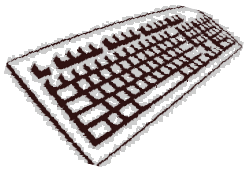
= 18 m/s

People also use the concept of speed or rate for things other than travel. For example, the world record for typing on a computer is 474 words in 3 minutes.

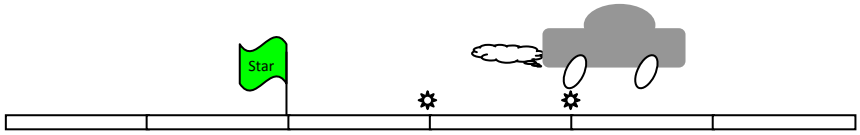
Typing speed = Number of words / time

= 474 words / 3 min

= 158 words / min



You have to compute the speeds of different cars. Each car drips oil every one second. That's how you can find it's time. In the picture below, the car has been driving for 2 seconds, because there are two drops of oil. Each little rectangle means the car has traveled 10 meters. The car has driven 20 meters. 20/2 = 10. The car's speed is 10 meters / sec.



On the next page, compute the speed of each car. Afterwards, indicate which cars went the same speed, by drawing a line between them.

Names _____ Science Period _____

12