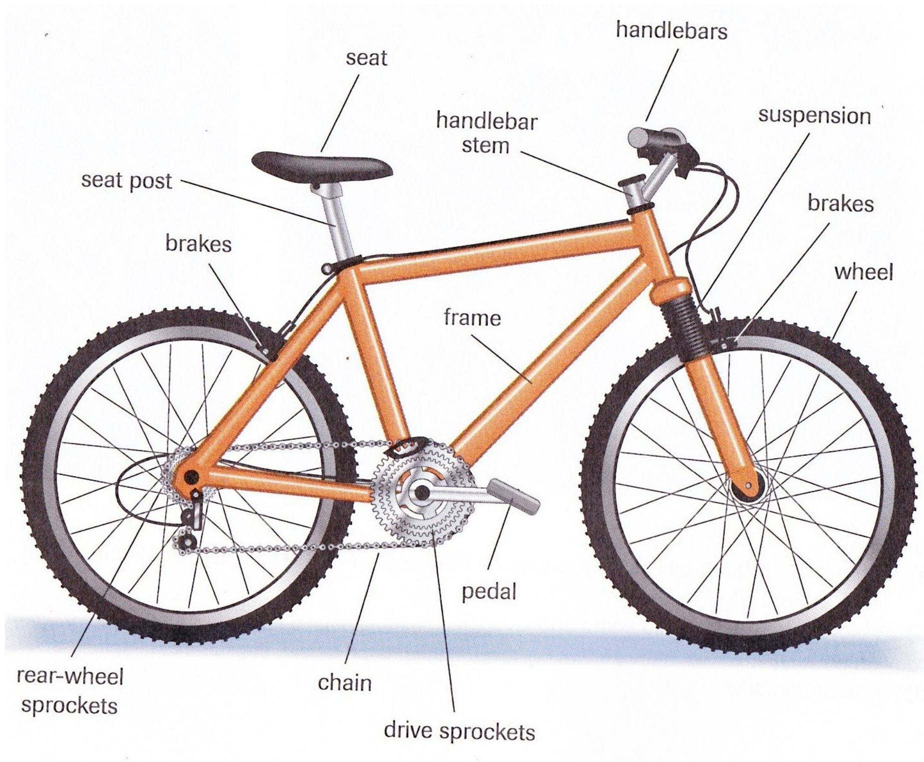
Name: ___________________________

A Compound Machine: The Bicycle

SPH4C

Purpose: The student will be able to describe how a multi-speed bicycle applies the principles of simple machines and make mathematical calculations related to the use of these machines.

Materials: multi-speed bicycle, metre stick and ruler, two spring scales, string



Part 1: Forces and Friction

What are the three parts of the bicycle to which a rider applies a force?

____

Which of these forces will produce a torque?

____

Where can you find devices designed to reduce friction (such as bearings)?

____

Where can you find devices designed to increase friction?

____

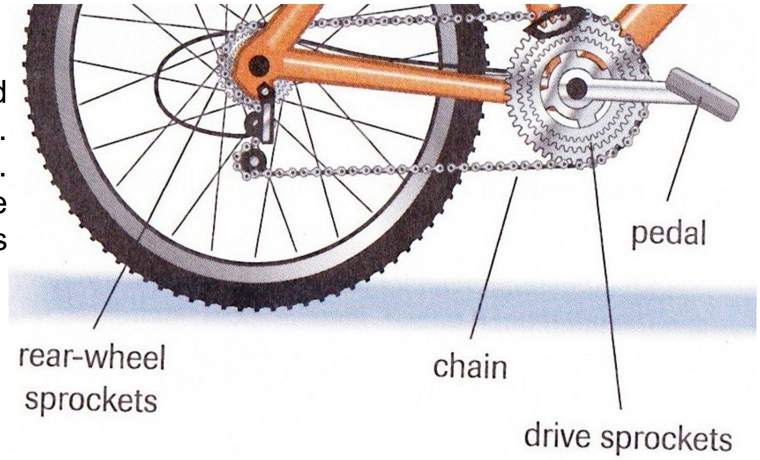
____

Part 2: Simple Machines

Find at least 4 examples of simple machines on the bicycle you are investigating (not including the gears). For each machine you find, describe its function and draw a labelled sketch of how it operates (e.g., labelling the fulcrum and/or effort distance/arm). If it is a member of the lever family, identify the class of lever.

Part: ______________________ Function: ______________________ ______________________ ______________________ Sketch:	Part: ______________________ Function: ______________________ ______________________ ______________________ Sketch:
Part: ______________________ Function: ______________________ ______________________ ______________________ Sketch:	Part: ______________________ Function: ______________________ ______________________ ______________________ Sketch:

Part 3: Gears



On the bicycle, the gears are also called sprockets and are connected by a chain. Determine the gear ratios for the bicycle. (Note that you may find it easier to take the ratios of the diameters of the gears than the ratios of the number of teeth.)

How many possible effort (driver/pedal) gears are there? _____________

List their measurements (either the number of teeth or the diameters of the gears):

____

How many possible load (driven/rear wheel) gears are there? _____________

List their measurements (either the number of teeth or the diameters of the gears):

____

What is the lowest possible gear ratio/IMA? *Remember that your gear ratio is the ratio of the number of teeth (or the diameter) of the effort gear to the number of teeth (or the diameter) of the load gear. To get the lowest possible gear ratio, you need to take the ratio of the smallest effort gear to the largest load gear.* Show your calculation here:

Under what conditions would you want to use this gear ratio? Explain.

____

____

What is the highest possible gear ratio/IMA? T*o get the highest possible gear ratio, you need to take the ratio of the largest effort gear to the smallest load gear.* Show your calculation here:

Under what conditions would you want to use this gear ratio? Explain.

____

____

Determine the AMA for the lowest gear ratio and for the highest gear ratio by tying a piece of string around the tire (as shown in the diagram at right) to measure the load force.

(You will need to hold both spring scales.)

Vary the load force and record the measurement on both spring scales when you are holding both at static equilibrium.

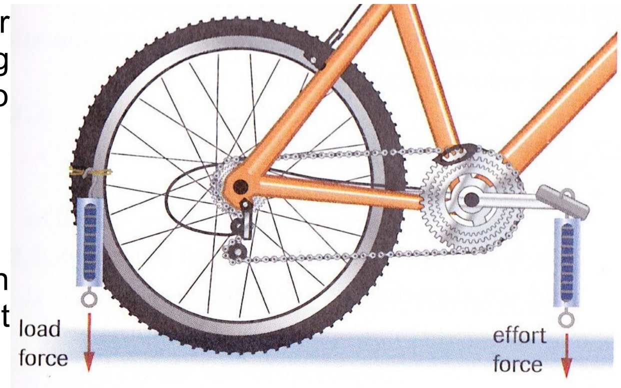


Table 1: Load force and effort force for the lowest gear ratio

Trial	Load Force F_L (N)	Effort Force F_E (N)	$AMA = \frac{F_L}{F_E}$
1			
2			
3			
4			

Calculate your average AMA for the lowest gear ratio: average AMA = ____________

Determine the percent efficiency of the lowest gear ratio:

percent efficiency = $\frac{AMA}{IMA}$ x 100% =

Could this percent efficiency change when the bicycle is in motion? Explain.

____

Table 2: Load force and effort force for the highest gear ratio

Trial	Load Force F_L (N)	Effort Force F_E (N)	$AMA = \frac{F_L}{F_E}$
1			
2			
3			
4			

Calculate your average AMA for the highest gear ratio: average AMA = ____________

Determine the percent efficiency of the highest gear ratio:

percent efficiency = $\frac{AMA}{IMA}$ x 100% =