Automotive Worksheet - Percentages

Review of Working With Percentages

A percent is a way of saying: "How many parts out of 100 are there?" For example, if 5 parts out of 100 were found defective, then we would say that 5% were defective.

To change a percentage to a fraction, simply place the percent number over 100 and reduce the fraction to its lowest terms. For instance, 5% can be written as $\frac{5}{100}$, which can be reduced by dividing a 5 out of the numerator and denominator, leaving $\frac{1}{20}$.

To change a percentage to a decimal, move the decimal point *two places to the left*. The decimal point for the percentage is usually not shown, but it is really there. In other words, we usually don't bother including the decimal place for a percentage like 40% (We don't write 40.%) But you can pretend it is there and count over two places to the left. For instance,

Move the decimal place over two spaces to the left.

That leaves .75, usually written with a zero out front so as to make it easier to see the decimal point: 0.75

Also 32% = 0.32 and 2% is 0.02, 0.3% is 0.003 and 150% is 1.5.

To write a decimal as a percent, you do the opposite: move the decimal place two spaces to the *right*:

0.44 = 44% and 0.06 = 6%.

If there aren't 100 parts, you can still use percents. All you have to do is to change the numbers to a fraction or a decimal then reduce it to its lowest terms.

Example 1: Say that 5 out of 20 oil changes take longer than 15 minutes. You can then say that

$= \frac{5}{20}$ ths of the oil changes take longer than 15 minutes. That can be reduced by dividing a 5 out of the top and bottom of the fraction leaving: $\frac{1}{4}$. So $\frac{1}{4}$ is the same as $\frac{5}{20}$. $\frac{1}{4}$ is also the same thing as 0.25, which is 25%. So 25% of the oil changes take longer than 15 minutes. You could also have multiplied the top and bottom of $\frac{5}{20}$ by 5. That would give you $\frac{5}{20} \mathbf{X} \frac{5}{5} = \frac{25}{100}$ = 0.25 or 25%. There are often several ways to do a problem and it often doesn't matter which way you use.

Percentages are often used when dealing with money. For instance, calculating sales tax, discounts, interest on loans, and pay deductions. These may involve finding what percent one number is of another.

Example 2: 4 is what percent of 16?

To solve this, change the numbers to a fraction or a decimal, reduce them to the lowest terms and write the result as a percentage:

$\frac{4}{16} = \frac{1}{4}$. And $\frac{1}{4}$ is the same as 0.25. To write this as a percentage, move the decimal two places over to the *right*. So 0.25 is 25%. So 4 is 25% of 16.

Example 3: What is the percentage discount on a starter motor if $10 is knocked off the regular price of $50?

To solve this, change the numbers to a fraction or a decimal, reduce them to the lowest terms and write the result as a percentage:

$\frac{10}{50} = \frac{1}{5}$. Then write this fraction as a decimal (you can divide 5 into 1 on your calculator): $\frac{1}{5} = \mathbf{0.20}$. Then write that number as a percent by moving the decimal place two spaces to the *right*: 0.20 = 20%. So by knocking $10 off the price of the starter, the customer saves 20%.

Example 4: An employee in your shop is given a 10% raise after working for 6 months and his pay before taxes went up $30 a week. What was his pay before taxes before the raise?

Basically, we are told that 10% of his earlier pay equals his $30 raise. We want to find his old pay amount. We can write this as an equation, but we must convert the % into a decimal first:

10% = 0.10 (Move the decimal over to the left two places.)

Then we can write an equation that states 10 percent *of* his old pay equals his $30 raise (the word *of* in that statement is a clue you have to multiply):

$\mathbf{(0.10)x(old\ pay) = \$30}$. This can be solved for his old pay by dividing both sides of the equation by 0.10:

$\frac{(0.10)}{(0.10)}\mathbf{x(old\ pay)} = \frac{\$30}{0.10}$. That leaves us with $\mathbf{old\ pay} = \frac{\$30}{0.10} = \mathbf{\$300}$. So he was making $300 per week, and now is making $330.

Example 5: A garage does 420 jobs in a month with a comeback rate of 5.0% (customers returning the vehicle because the repair was faulty). How many jobs does the garage have to do over again?

Here we just need to find what 5.0% *of* 422 is. First write the percentage as a decimal:

5.0% = 0.05. Then notice the word *of* again. That means multiply: (0.05)x(422 jobs) = 21 jobs. So 21 jobs had to be redone.

Sometimes you may want to know the percentage increase or decrease of something. To find the percentage increase or decrease,

$$\mathbf{\%\ increase\ or\ decrease} = \frac{\mathbf{amount\ of\ increase\ or\ decrease}}{\mathbf{original\ amount}}$$

Example 6: A salesman at the Dealership notices that sales of truck bedliners increased from 4 in April to 11 in May. What is the percentage of increase in the sales of bedliners?

We first need to find the amount of the increase (the numerator in the formula). To get that, simply subtract the numbers (11 – 4 = 7). That is, 7 more units were sold in May than in April. Using the formula, % increase is therefore = $\frac{\textbf{amount of increase}}{\textbf{original amount}} = \frac{7}{4}$. This needs to be written as a decimal and then converted into a percentage to get the % increase. So divide 4 into 7 to get 1.75, and then move the decimal two places over to the *right* to convert this number into a percent: 1.75 = 175%. So there was a 175% increase in sales of bedliners from April to May.

Another use of percentages could come when figuring out the % of ethylene glycol (antifreeze) to use in a cooling system of a car or truck. The percentage amount of ethylene glycol in a cooling system is given by the following equation:

$$\textbf{\% ethylene glycol} = \frac{\textbf{gallons of ethylene glycol used}}{\textbf{total capacity of cooling system in gallons}}$$

Use this chart to find out what the lowest safe temperature it can be before the coolant freezes.

% Ethylene Glycol	Protection to
20	+16 ^{o}F
25	+10 ^{o}F
30	+4 ^{o}F
33 1/3	0 ^{o}F
40	-12 ^{o}F
50	-34 ^{o}F
60	-62 ^{o}F

Example 7: 1.5 gallons of antifreeze and 4 gallons of water are used to refill the cooling system of a truck that has just been completely drained of coolant. What percent of the solution is antifreeze? About what temperature is this truck protected to?

$$\textbf{\% ethylene glycol} = \frac{\textbf{gallons of ethylene glycol used}}{\textbf{capacity of cooling system in gallons}} = \frac{1.5}{1.5+4} = \frac{1.5}{5.5} =$$

=0.273 = 27.3%. So 27.3% of the coolant is antifreeze and the truck should be protected to about +7 ^{o}F.

Another Formula: Ohms Law

To diagnose problems in a vehicle's electrical system, it helps to know the basic relationship between three fundamental electrical properties. These three properties are

- *Current* I. Current is the flow of electrical charges though the circuit. It is measured in amps, A. Current is sometimes called amperage.
- *Voltage* V (sometimes written as E). Voltage can be thought of as what pushes the current through the wires and circuits. If there is no voltage, then there won't be any current. Batteries supply voltage, as does a spinning alternator. The units of voltage are volts, V.

- *Resistance* R. All materials in automobiles resist the flow of current through them. That is, they limit the amount of current that can flow. More resistance = less current, less resistance = more current for a given voltage. Thick, short, metal wires have low resistance and can carry large currents. Skinny, long wires have more resistance and can't carry as much current. Most non-metals have a very large resistance (like plastic and rubber—they won't allow current to flow through them unless the voltage is huge!) Resistance is measured in Ohms, Ω.

The relationship between these three quantities is known as Ohm's Law:

Ohm's Law = V = I x R. That is, volts = amps x ohms. Use this formula when you want to know the volts given the amps and the ohms. You probably won't do that very often in your work—just about everything electrical in a car runs on a 12-volt battery (or around 14 volts when the alternator is working), except maybe some computer chips, which operate on a lower voltage. So you usually know the voltage.

But what if you want to find the current (amps) or the resistance (ohms)?

Then rearrange the equation:

$$\mathbf{I = \frac{V}{R}} \quad \textbf{or} \quad \mathbf{R = \frac{V}{I}}.$$

Example 8: The lighting system in a car that is not running draws 5.500 amps of current when the battery voltage is 11.750 volts. Find the resistance of the wires and bulbs in the lighting system to the nearest thousandth of an ohm.

Use $\mathbf{R = \frac{V}{I} = \frac{11.750\ volts}{5.500\ amps} = 2.136\ ohms}$.

Example 9: How many amps of current are flowing in an ignition circuit that has 3.30 ohms of total resistance and a battery voltage of 12.5 volts?

Use $\mathbf{I = \frac{V}{R} = \frac{12.5\ volts}{3.30\ ohms} = 3.79\ amps}$.

Homework Problems

1. A mechanic who is paid $458.00 per week gets an 6% raise. What is the mechanic's new weekly pay?

2. In one week, a dealership repaired 256 cars. If 29 of those repairs were 100% covered under the manufacturers warranty, what percentage of car owners had to pay out of their own pocket for the repair of their vehicle?

3. 9 quarts of antifreeze are used in the cooling system of a truck that holds 6 gallons. What percent of the solution is antifreeze? What percent of the solution is water? What is the lowest air

temperature this truck should operate in (estimate it from the chart found earlier in this document)? 4 quarts = 1 gallon.

4. Engineers find that a diesel engine develops 78 brake horsepower (bhp). By adding a turbocharger, they find the horsepower increases to 98 bhp. What is the percent increase in the horsepower?

5. A tune-up specialist finds that his business increases 11.5% after advertising on the radio. If he did 61 tune-ups a week before the radio campaign, how many is he doing now in a week?

6. If 11 out of 43 cars you service in a week took less than 30 minutes to repair, what percentage of cars took *longer* than 30 minutes to repair?

7. On sale, a remanufactured engine is offered at a 15% discount. The regular price of the engine is $1250. What is the savings by buying it on sale?

8. An oil company offers a $3 rebate on the purchase of a case of motor oil. A case contains 24 quarts. Each quart normally sells for $1.49. If the buyer of the case sends for the rebate, what is the percent of discount he gets by buying by the case instead of 24 individual quarts (without the rebate)?

9. While starting the motor of a truck, a current of 210 amps flows briefly from the battery to the starter motor. With a 12-volt battery, what is the resistance of the starter motor and battery cables?

10. The blower motor in a car heater has a resistance of 9.5 ohms. What current does it draw from the 12-volt battery?