Physics Name:

Lab - *Toy Truck Efficiency*

Problem: To design an experiment to determine the output horsepower of a toy truck.

Discussion: The *efficiency* of a machine is defined as the ratio of the output work to the input work, that is how much work (energy) you get out compared to how much energy (work) you put in. If the machine is a motor the efficiency can be found by measuring the electrical energy supplied to the motor and the mechanical work done by the motor, then the efficiency is just:

$$eff = W_{mech}/E$$

Prediction: The truck motor will be about ________ % efficient.

Materials:

- toy truck (electric motor)
- pulley
- meter stick
- stop watch
- multimeter
- string
- hanging masses
- battery holder
- jumper wires
- switch

Procedure:

1.) Remove the battery from the truck and devise a way to attach the battery (or a DC power supply) and a switch to the truck externally.
2.) While the truck is running practice using an ammeter and a voltmeter to measure the voltage and amperage supplied to the truck.
3.) Attach a hanging mass to the end of a string, drape it over the pulley, and tie it to the truck.
4.) Turn the switch on and time how long it takes to raise the hanging mass a certain height, at the same time record the average current and voltage on your meters. Record the readings from the meters, the mass, the height, and the time.
5.) Repeat step four for various hanging masses. Make a table to organize your data.

Analysis: *energy supplied to the truck*

In an electrical system the energy supplied--the work done to move the charges--can be determined by multiplying the voltage by the amount of charge moved: $E = V \cdot q$

However, it is not always easy to measure the amount of charge moving through a circuit. Why? So, recalling the fact that current is equal to the amount of charge passing a given point in a given time we have the relationship: $i = q/t$
==> $q = i \cdot t$
Combining the two relationships above we have:

$$E = V \cdot q = V \cdot i \cdot t$$

work done by the truck

Now, to determine the work done by the truck in lifting the weight, remember that the work done is equal to the change in potential energy (Why?). Hence,

$$W_{lift} = \Delta PE = mgh - mgh_0 = mgh$$

Finally the efficiency is the ratio of work out to work (energy) in:

$$eff = W_{lift}/E$$

Questions: 1.) How close did you come to your prediction? Were you surprised?

2.) Where does the "lost" energy go?

3.) For what weight was the truck most efficient?

4.) What causes the charge to move in the circuit? What is actually moving?

5.) How much energy must be supplied to an electric blender if it is 32% efficient and it does 4500J of mechanical work?

Extra: How much would it cost to run the blender above for 10 minutes a day for a month if electricity costs 10¢ per Kilowatt-hour (the kiloWatt-hour is a measure of energy usage. Energy usage is found by multiplying power (W) divided by 1000 then multiplied by time of use (s).

Error Analysis: What sources of error were there in this lab? How could you improve your method?

Conclusions:

What did you learn? What did you prove or disprove? What were your results?