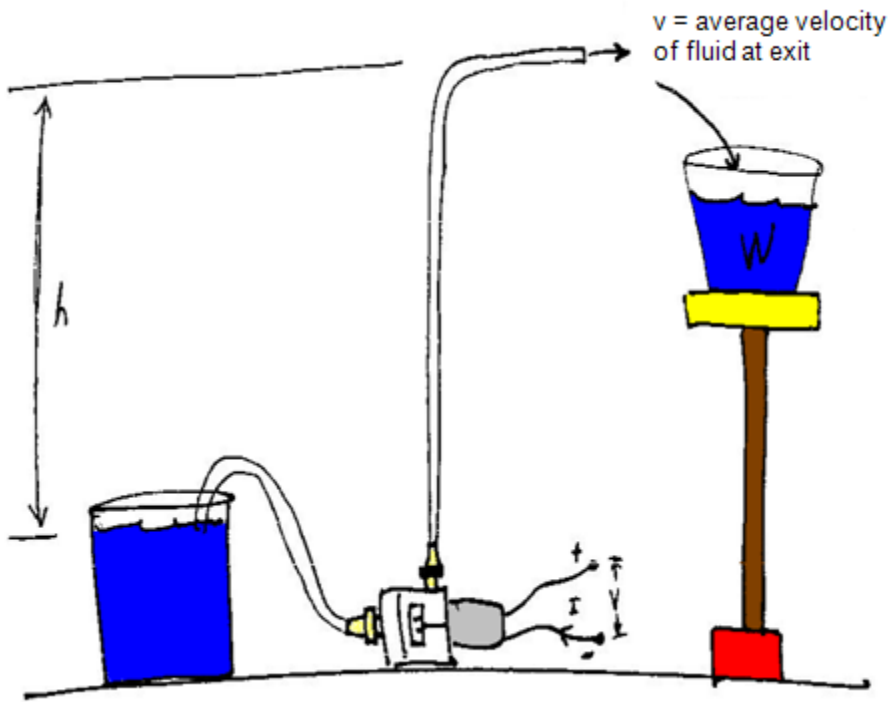


# Pump Efficiency / Energy Usage

ENGINEERS frequently are involved with devices that convert energy from one form to another. There are numerous examples. In the past, engineers harnessed the energy of water to turn the water wheel and grind grain. Today the energy stored in hydrocarbon fuels is released by combustion and can be used to move a vehicle or generate electricity.

**Efficiency** is a measure of performance for energy conversion. If the energy source is free, there is little motivation to improve Eff. The opposite is true when the energy costs the user \$.

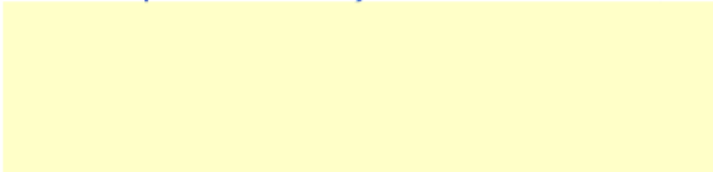
A PUMP SYSTEM (Electric Motor + Fluid Pump) is an Energy Conversion device. The Motor receives **input** ENERGY (or POWER) and outputs **output**



$W$  = weight of water collected over time  $t$

The pump has increased the K.E. and P.E. of the water.

Efficiency is usually identified with the symbol  $\eta$  the Greek letter eta



- $m$  - mass of fluid
- $v$  - velocity (avg) of fluid
- $W$  - weight of fluid
- $V$  - Voltage
- $I$  - current
- $t$  - time
- $h$  - Elevation of exit tube

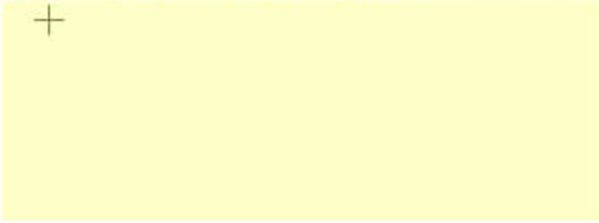
So for a pump system the efficiency of the energy conversion is



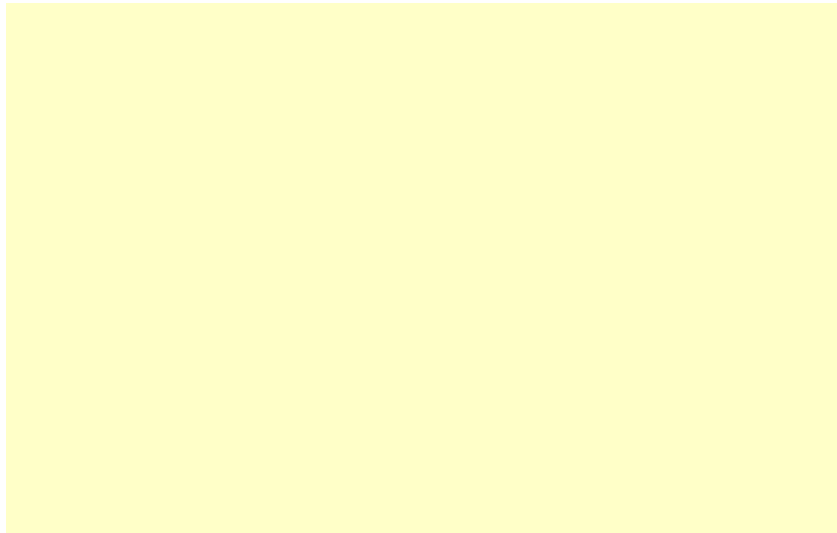
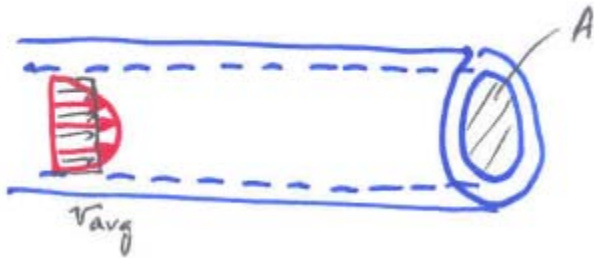
What will we measure?



How do we find  $m$ ?



How do we find  $v$ ?



**NOTE:** The volume of water pumped per unit time is the flow rate  $Q$  (1 liter = 0.001 m<sup>3</sup>):

$$\text{flow rate} = Q = v \cdot A = \frac{\text{volume pumped}}{\text{time}} = \frac{\text{liters}}{\text{min}}$$

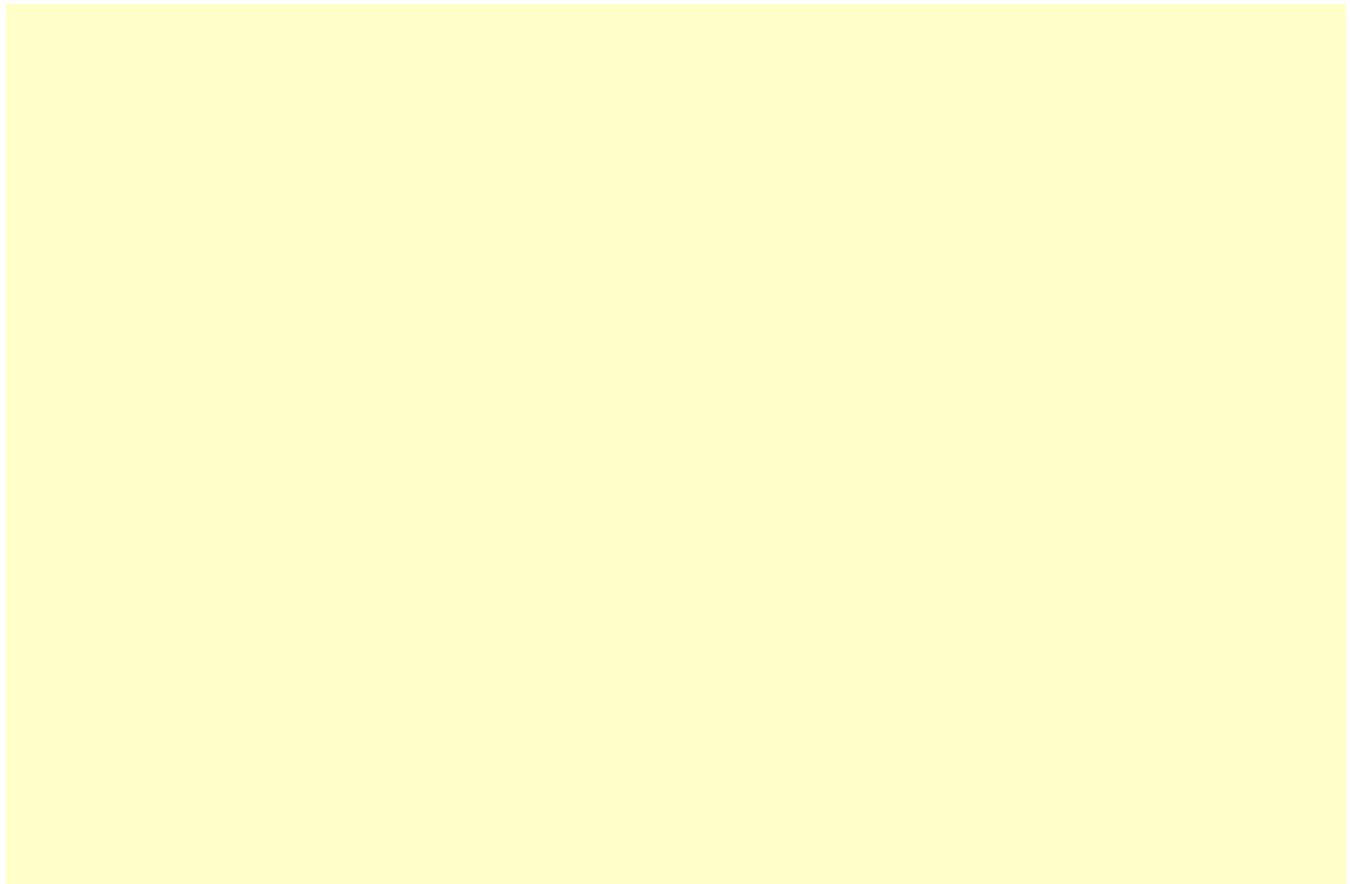
## Work the Following Example by Hand

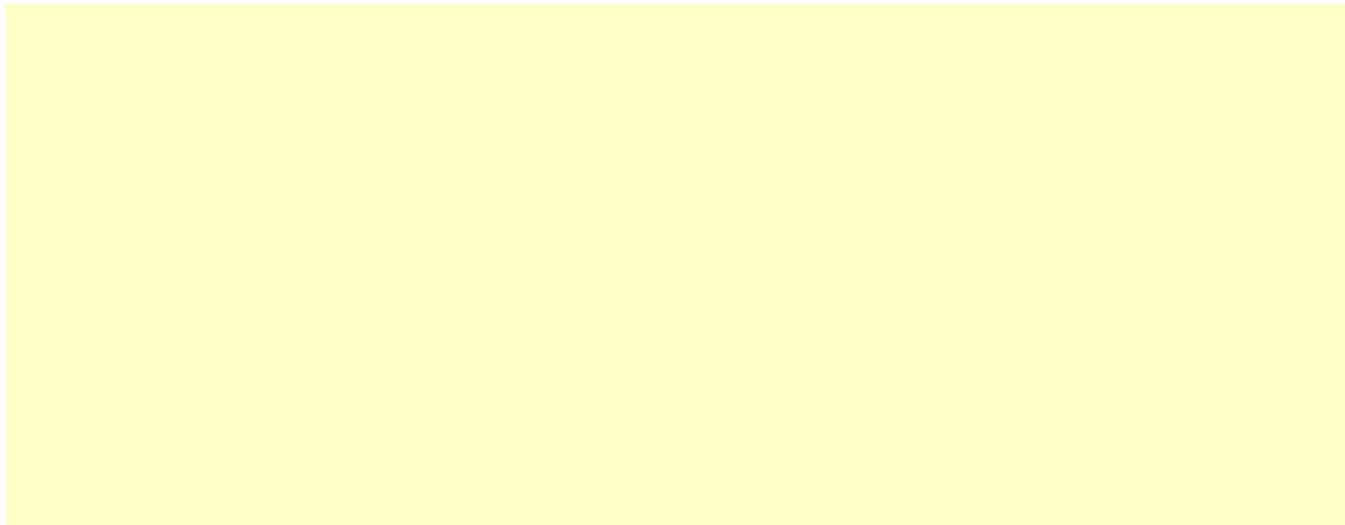
A pump is connected to an electric motor. The motor is supplied with 1 A of current from a 12 VDC source. The apparatus is run steadily for 30 seconds, and the following measurements are recorded:

Mass of Fluid Collected:	500 grams
Diameter of Exit Tube:	3/16 inch
Density of Water:	1000 kg/m <sup>3</sup>
Height of fluid exit above reservoir:	30 inches

Include ALL units in calculations. It would be very helpful to convert any US Customary units to SI units before beginning the solution to avoid complexity.

---





Mathcad Solution:

