Energy, Work, and Power

I. Energy
   - kinetic and potential
   - conservation

II. Work
   - dot product
   - work-energy relations

III. Springs

IV. Power
   - machines and efficiency

	The student will be able to:	HW:
1	Define and apply the concepts of kinetic and potential energy and use the conservation of energy to explain physical phenomena. ✓	1 – 7
2	Calculate mechanical kinetic energy and gravitational potential energy (in Joules) and use conservation of energy to solve related problems. ✓	8 – 16
3	Define and calculate work and solve related problems. ✓	17 – 23
4	Relate and equate work and energy and solve related problems. ✓	24 – 31
5	Solve problems involving work and energy for a mass attached to a spring. ✓	32 – 33
6	Define and calculate power (in Watts or horsepower) and solve related problems.	34 – 41
7	Solve problems involving machines and efficiency.	42 – 45

What can the bus with more horsepower do that the other bus cannot?

80 hp

100 hp

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80 hp

100 hp

Its acceleration will be slightly better (less **pathetic**) than the bus with the lesser engine!

Its engine can do work more rapidly!

Power

Power is the rate at which work is done (or the rate of energy transfer/transformation):

$$P = \frac{W}{t}$$ or $$P = \frac{E}{t}$$

where: W = work done in amount of time t
E = energy transfer and/or transformation in time t

The WATT

The **watt** is the SI unit for measuring power. When work is done at a rate of 1 joule per second it is a power of 1 watt (or if energy is transferred/transformed 1 joule per second).

1 watt = 1 joule ÷ 1 second

$$W = J/s$$

$$W = kg\ m^2/s^3$$

On an electrical device the number of watts typically indicates the power input.

A 60 W bulb converts electric energy to heat and light energy at a rate of 60 joules per second.

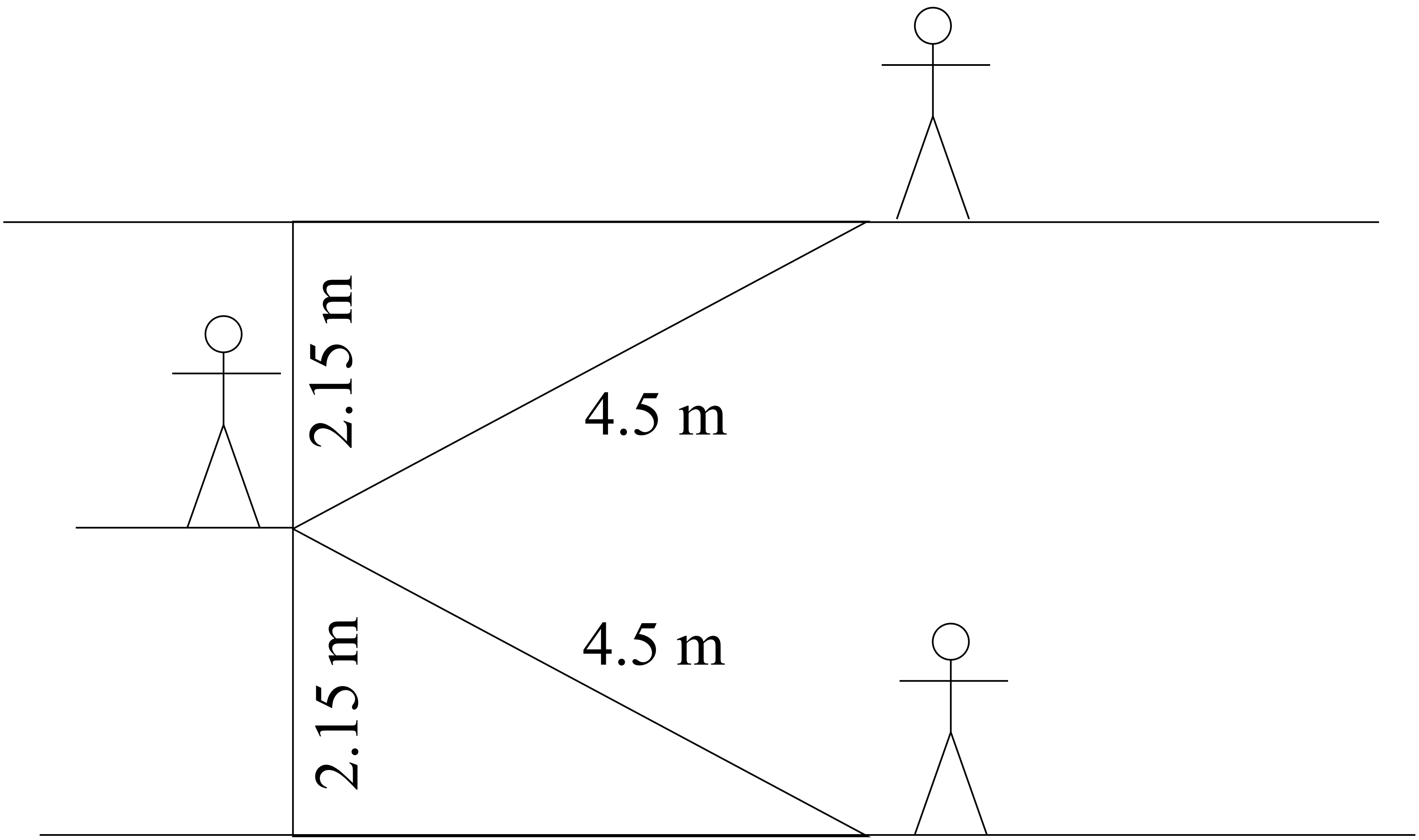

SAMSUNG
DVD/VHS DUAL DECK
MODEL NO.: DVD-V3500
AC 120V 60Hz 25 W
ORY ID/IDENTIFICATION D'USINE:"I"
LR38329
AUDIO/VIDEO EQUIPMENT
UL
LISTED
77HN
E215927


KICK DIS™
TWO HOUR CHARGER
FE-AC ADAPTOR
PLUG-IN CLASS 2 TRANSFORMER
MODEL: FE41-3009D
INPUT: AC 120V 60 HZ 9W
OUTPUT: DC 9V 300 MA
CAUTION
RISK OF ELECTRIC SHOCK
DRY LOCATION USE ONLY
– +
UL
LISTED
E102249
37X9
0504
MADE IN CHINA

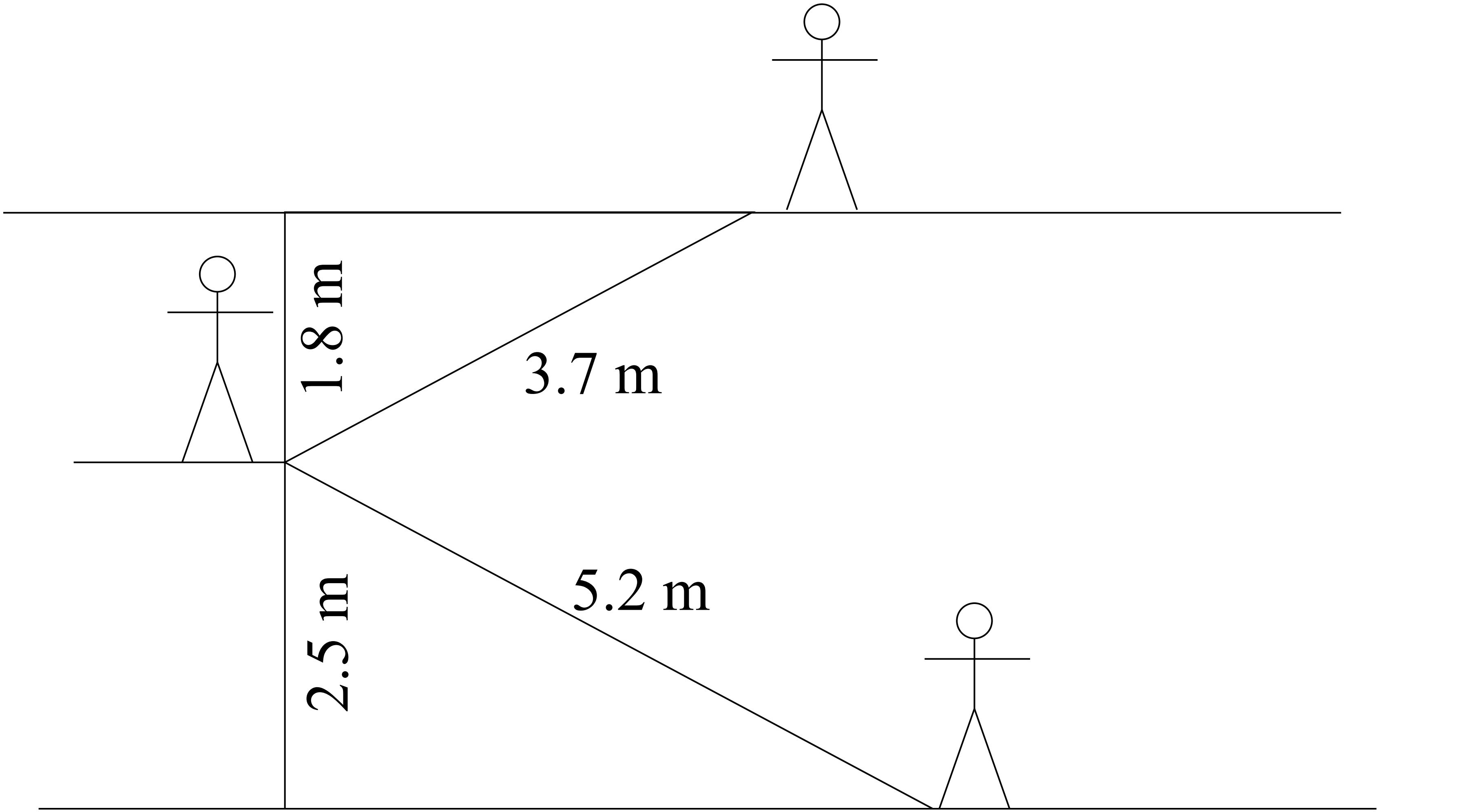
Horsepower

- Power is also measured in units of horsepower (hp) – a value James Watt originally developed to compare steam engines to horses.
- It was determined that a horse could do work at a steady rate of 33000 lb-ft/min and this was defined as 1 horsepower.
- In modern terms 1 hp $\approx$ 746 W.
- Mainly used today to quantify *mechanical output* of a machine, engine, or motor.

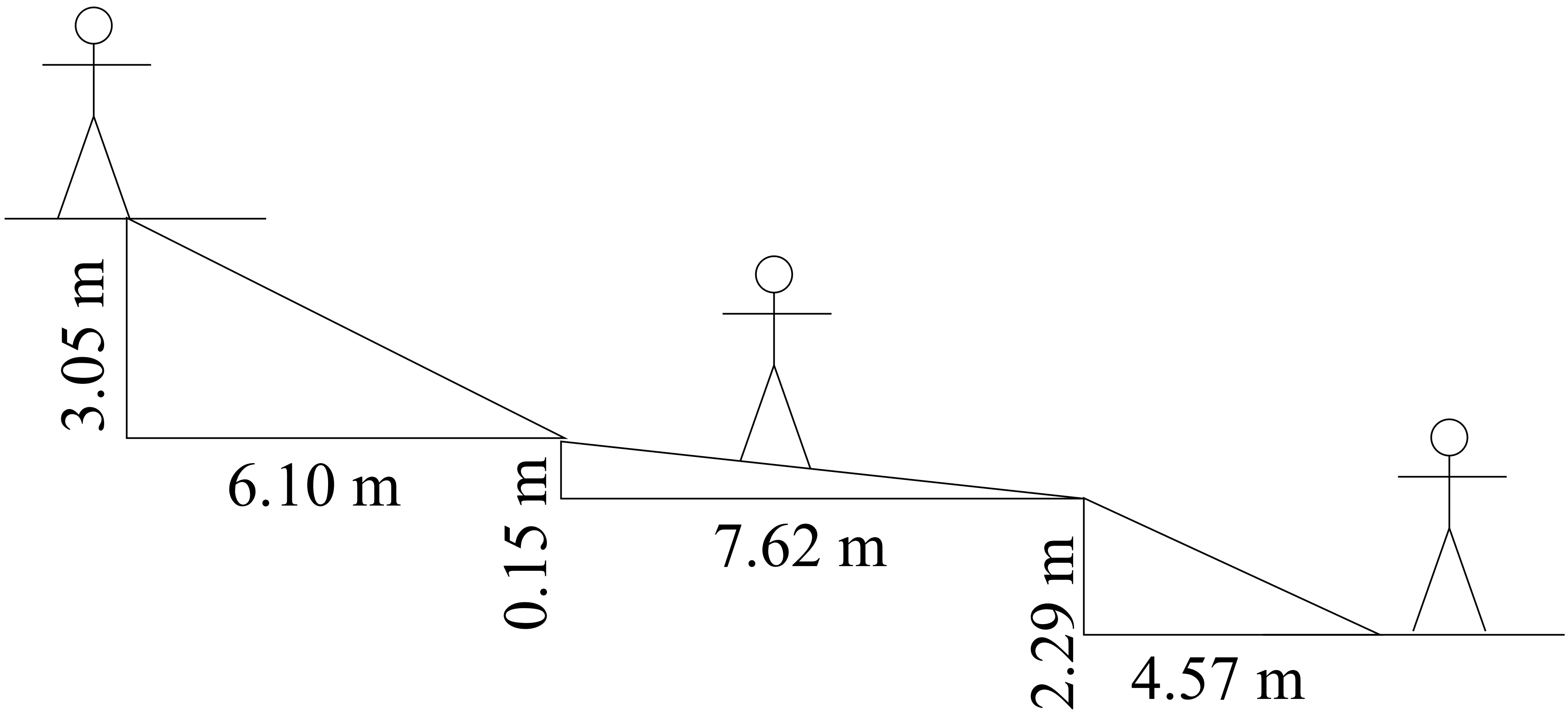
The Most Powerful Person!



The Most Powerful Person!



The Most Powerful Person!



The Timer – this person should have good reflexes and be willing to say "On your mark, set, go!" to the climber waiting at the bottom of the stairs.
Climbers – each person in the group should have the opportunity to dash (or walk) up the stairs.
Figurers – each person in your group should determine and calculate his/her own individual power. Work together to decide *how* power can be calculated using the given information and then compare results and check that each power value is correct.
The Reporter – one person in your group should go to the board and show the work and calculations and resulting power for the most powerful person in your group. "The Reporter" should have neat handwriting!

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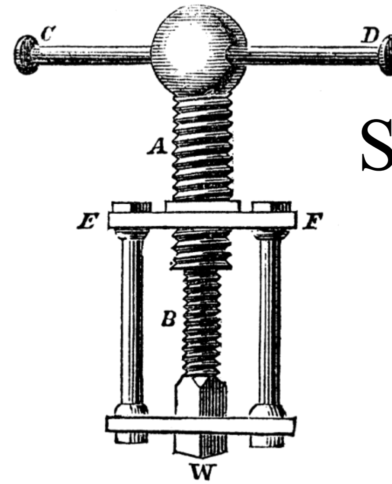
Simple Machines

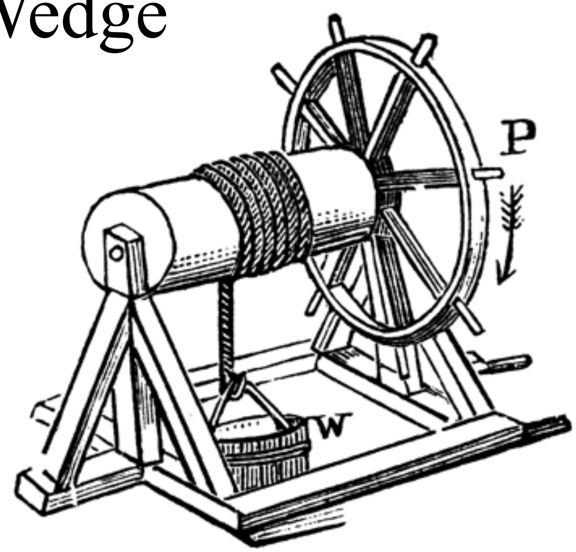
Inclined Plane

Wedge



Screw

Lever



Wheel and Axle

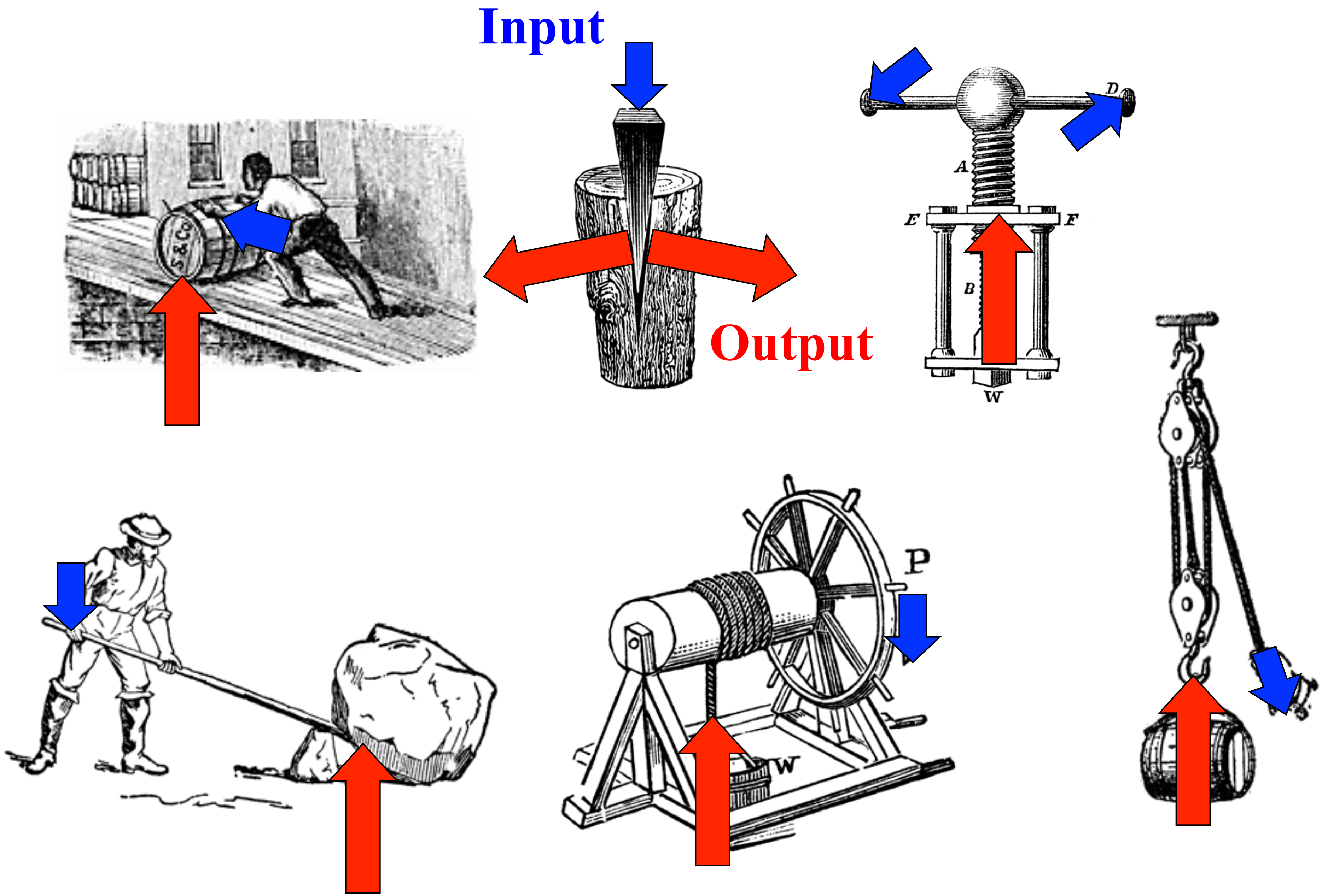
Pulley

Simple Machines

All simple machines are "force multipliers" that can make a task easier to accomplish.

Although a machine may provide an increased force it cannot violate conservation of energy.

The work (or energy) output of a machine cannot exceed the work (or energy) put into it.

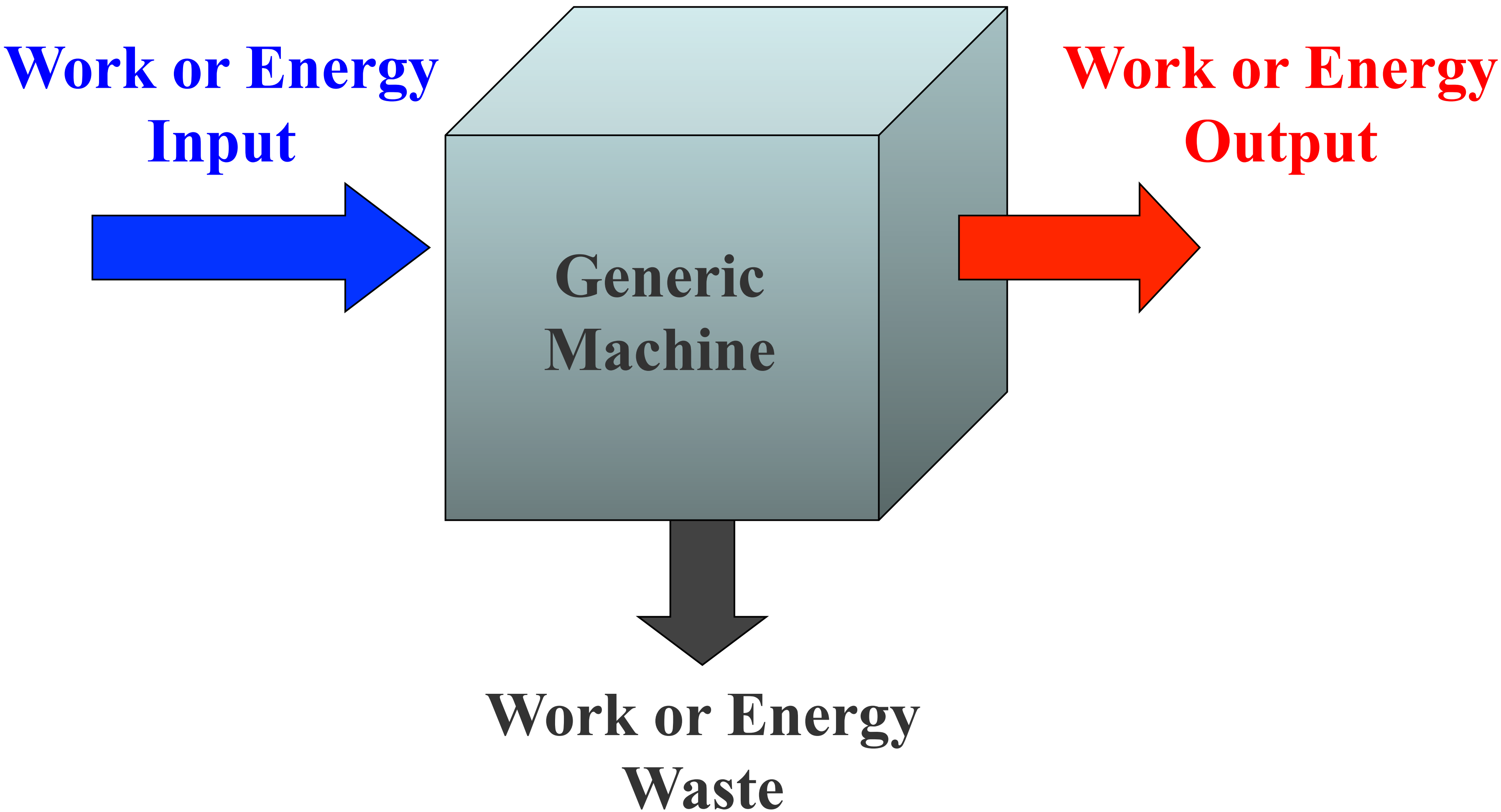

Input
Output
D
A
E
F
B
W
P
W

How can the force "output" of a machine be more than that force "input"?

The force output acts over a shorter distance than the force input.

Because of this a machine does not reduce the amount of work in performing a task.

Efficiency

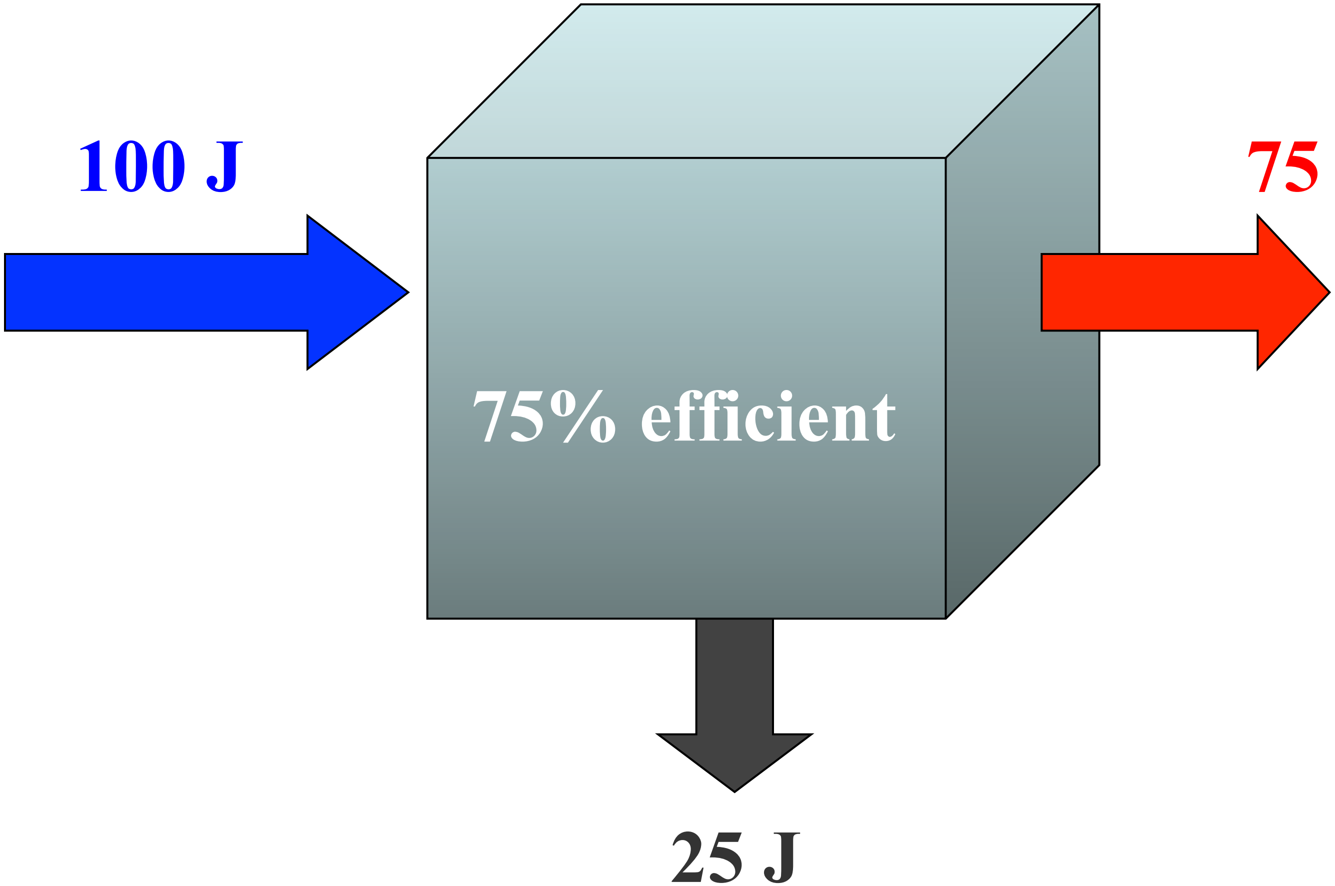

Work or Energy
Input
Generic
Machine
Work or Energy
Output
Work or Energy
Waste

Efficiency

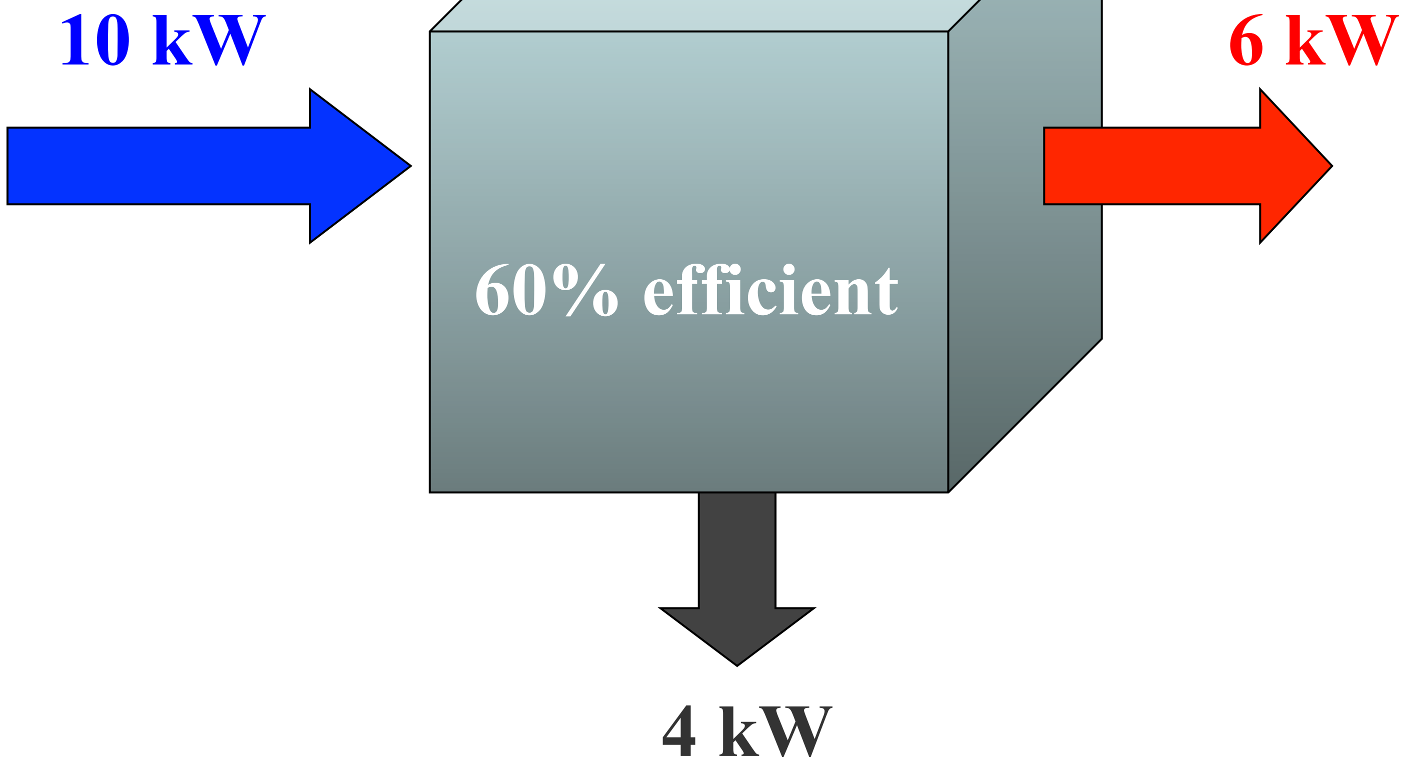
Efficiency is the amount of useful output relative to the input, usually expressed as a percentage.

$$efficiency = \frac{useful\ output}{input}$$

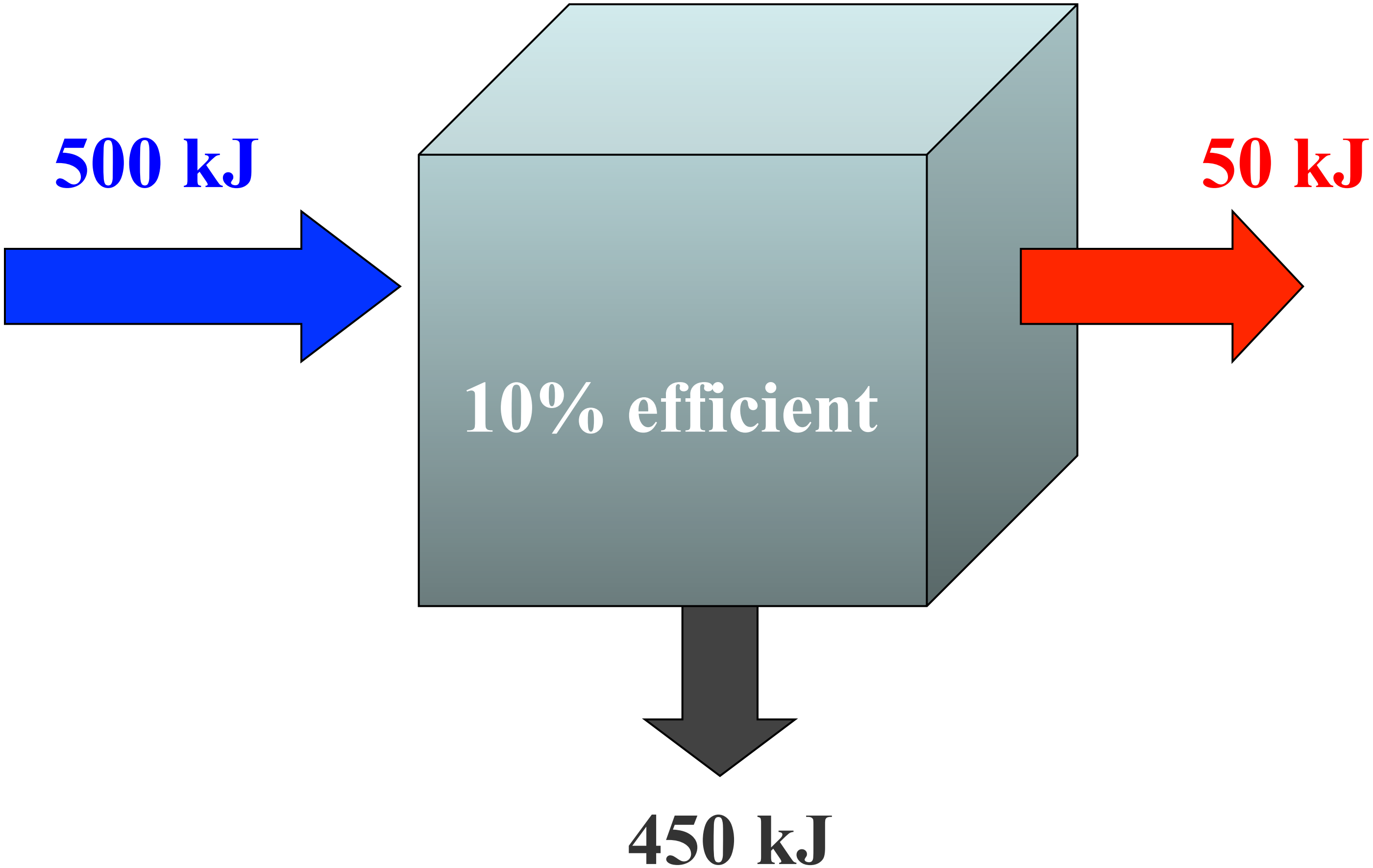
Efficiency



Efficiency



Efficiency



Mini-Lab: the Lever

- Use a meter stick as a lever. Measure the force required to lift a book.
- Assume the book is lifted 1 cm. Use the ratios of the points of application to determine the distance over which the applied force acts.
- Calculate the work input and the work output.
- Determine the efficiency of the lever.
- Repeat with different points of application.
- What would maximize efficiency? What would maximize mechanical advantage?

$$\frac{d_{in}}{d_{out}} = \frac{r_{in}}{r_{out}}$$

$$d_{in} = d_{out} \cdot \frac{r_{in}}{r_{out}}$$