

Efficiency

To work out how efficient a system is we need to consider the Total energy put into the system and the Useful energy produced. We use the formula:

$$\% \text{ efficiency} = \frac{\text{Useful energy out}}{\text{Total energy in}} \times 100$$

Also note:

Kinetic energy $E_k = \frac{1}{2} m \times v^2$	Potential energy $E_p = m \times g \times h$	Work done $E_w = F \times d$	Power $P = \frac{E}{t}$
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Use the formula to calculate the % efficiency of the following systems.

1. In a set of school experiments:

- a) A cart with 10J of potential energy runs down a ramp, gaining 8J of kinetic energy.
- b) A Bunsen burner provides 250J of heat to a beaker, using 300J of chemical energy
- c) 4J of electrical energy is used to produce 2.5J of sound energy.
- d) A small motor lifts 500g, 1.2m onto a desk, using 12J of electrical energy.
- e) Three lamps are lit in a circuit. 20J of electrical energy produces 1.2J of light energy.
- f) A kettle uses 46kJ of electrical energy to produce 40kJ of heat.

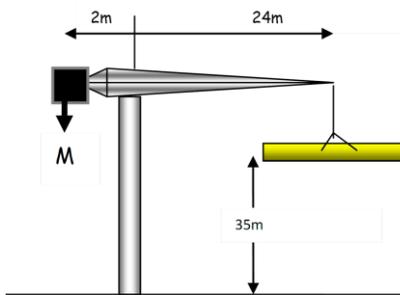
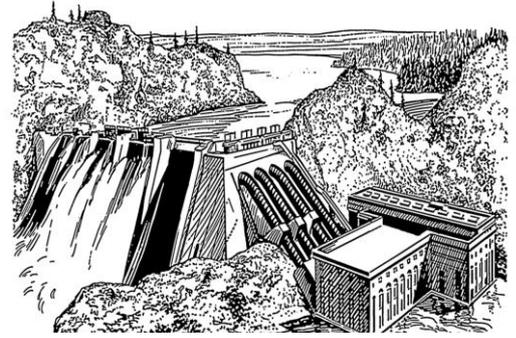
Use the formula to calculate the useful energy output of the following systems.

- 2.
 - a) 3000J of fuel (chemical energy) is used by a model engine which is 40% efficient. How much kinetic energy is produced?
 - b) 20J of energy is used by an electric motor which is 65% efficient. How much work energy is produced?
 - c) The makers of a heating element claim it is 98% efficient. How much heat should be produced each second from the 2kW element?
 - d) 2400J of electrical energy is used by a starter motor which is 22% efficient. How much work is done by the motor?

How much energy is put into the following situations, if:

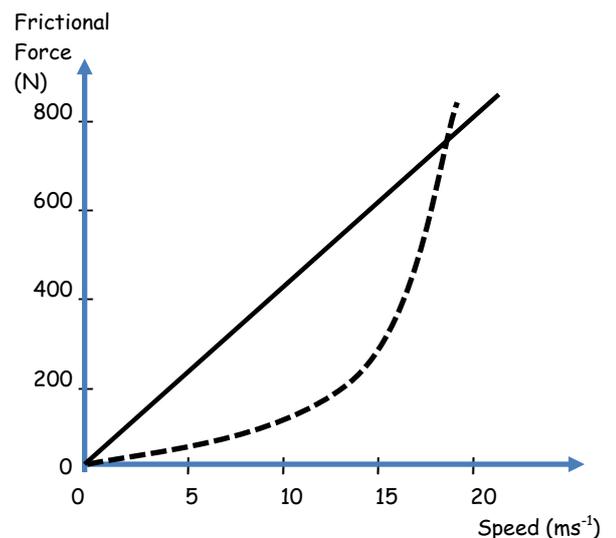
- 3.
 - a) A ball is kicked, it gains 50J of potential energy, and the kick is shown to be 55% efficient.
 - b) The same ball kicked at a different angle lost 35% of the initial energy, gaining 60 J of potential energy.

4. Water falls through a height of 30m from a reservoir to the turbines in a power station. An average of $1.5 \times 10^4 \text{kg}$ of water passes through the turbines each second.
- Calculate the average potential energy lost by the water every second.
 - On average the water leaves the turbines at 12.5ms^{-1} . Calculate the average kinetic energy of water leaving the turbines.
 - The power station usually runs at 28% efficiency. Determine its electrical power output each second.



5. A crane on the building site of a new skyscraper is lifting a pipe to form part of a drainage system. The pipe has a weight of 20kN. The mass **M** on the back of the crane is set to keep the crane balanced while lifting the pipe.
- How much potential energy has the pipe gained as it is lifted from the ground?
 - The motor in the crane is 76% efficient; the pipe takes 20 seconds to reach the height shown. Determine the output power of the motor.
 - Determine the value of **M**.
 - The cable snaps, the pipe falls. Calculate the impact velocity of the pipe as it hits the ground 35m below.

6. A new electric car is tested in a vehicle lab. The graph shows how the engine output of the car increase with speed. The dotted line shows frictional forces on the car.
- What does the shape of the graph tell you about the relationship between Engine output and Speed?
 - Use the graph to estimate the Engine output and Friction; at
 - 5ms^{-1}
 - 10ms^{-1}
 - 15ms^{-1}
 - Use your figures from part b) to determine the efficiency of the car at
 - 5ms^{-1}
 - 10ms^{-1}
 - 15ms^{-1}



Show all calculations.

- What is the top speed of the car? Explain your answer.

ANSWERS to follow.....