

L06 - Work and Power

Q1: Which car would you choose to compete in a 100 m drag race?



Goes faster.
Gains more E_K in less time.

$$P = \frac{\Delta E}{\Delta t}$$

More "powerful"

Q2: Which loader would you choose to fill a dump truck up with gravel?



"More powerful"
Lift more weight in same time.
Gains more $E_p = mgh$

$$P = \frac{\Delta E}{\Delta t}$$

Power

Power is the amount of **work** that can be done in a given amount of **time**.

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

Remember that **work** is **change in energy**.

Q3: Which car is more powerful?



↗
Gains more $E_k = \frac{1}{2}mv^2$
in less time.

$$P = \frac{\Delta E}{\Delta t} = \frac{\frac{1}{2}mv^2}{\Delta t}$$

Q4: Which loader is more powerful?



↗

$$P = \frac{\Delta E}{\Delta t} = \frac{mgh}{\Delta t}$$

Do you have the Power?



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Q5: Which Physics 20 student is the most powerful?

Ascending a staircase requires work to be done over a given time period.
Work = change in Potential Energy ($E_p = mgh$)
Power = Work / Time

① $\text{___ lbs} \div 2.2 = \text{___ kg}$

② $E_p = mgh$
 $= (\quad) (9.81)(4m)$

③ $P = \frac{E_p}{t}$

Efficiency Formula

$$Eff(\%) = \frac{Useful\ E_{out}}{Total\ E_{in}} \times 100\%$$

$$Eff(\%) = \frac{Useful\ P_{out}}{Total\ P_{in}} \times 100\%$$

Use the following information to answer Q6:

Incline Planes as Simple Machines

An inclined plane, also known as a ramp, is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. The inclined plane is one of the six classical simple machines defined by Renaissance scientists. Moving an object up an inclined plane requires less force than lifting it straight up, at a cost of an increase in the distance moved.

In the example below, a force of 70N is required to push a 10kg box up a wooden incline plane.

The diagram shows a right-angled triangle representing the inclined plane. The vertical side (height) is labeled 3m. The horizontal side (base) is labeled 4m. The hypotenuse (the ramp) is labeled 5m. A box labeled 10kg is shown on the ramp, tilted to match the angle of the incline.

Q6: What is the efficiency of the ramp?

$$E_{in} \rightarrow W = Fd \\ = (70)(5) \\ = 350J$$

$$E_{out} \rightarrow E_p = mgh \\ = (10)(9.8)(3) \\ = 294.3J$$

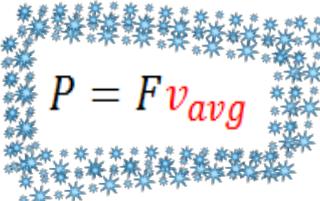
$$Eff(\%) = \frac{Useful\ E_{out}}{Total\ E_{in}} \times 100\% = \frac{294.3}{350} \times 100 = \boxed{84\%}$$

Alternate Equations for Power

Symbol	Quantity	Units
d	Distance	Meters (m)
t	Time	Seconds (s)
v	Speed	(m/s)
F	Force	Newtons (N)
W	Work	Joules (J)
E	Energy	Joules (J)
P	Power	(J/s) or Watts (W)

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

If $P = \frac{W}{\Delta t}$ and $W = F\Delta d$, then $P = \frac{F\Delta d}{\Delta t}$ ⇒

If $P = \frac{F\Delta d}{\Delta t}$ and $v_{avg} = \frac{\Delta d}{\Delta t}$,  $P = Fv_{avg}$ ⇒

Use the following to answer Q7-Q8:

An elevator and its occupants have a mass of 1300 kg. The elevator motor lifts the elevator to the 12th floor, a distance of 40.0 m, in 75.0 seconds.

Q7: What is the power output of the elevator?

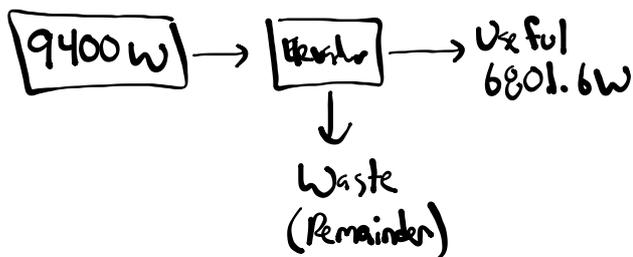
$$P = \frac{W}{t} \text{ or } P = \frac{\Delta E}{\Delta t}$$

$$P = \frac{mgh}{t}$$

$$P = \frac{(1300)(9.81)(40)}{75}$$

$$P = 6801.6 \text{ W}$$

Q8: What is the efficiency of the system if the motor must generate 9.40 kW of power to do the specified work?



$$EFF(\%) = \frac{\text{Useful } P_{out}}{\text{Total } P_{in}} \times 100\% = 72.4\%$$

Practice

- Pg 325 #1-3
- Pg 328 #1,3,4

