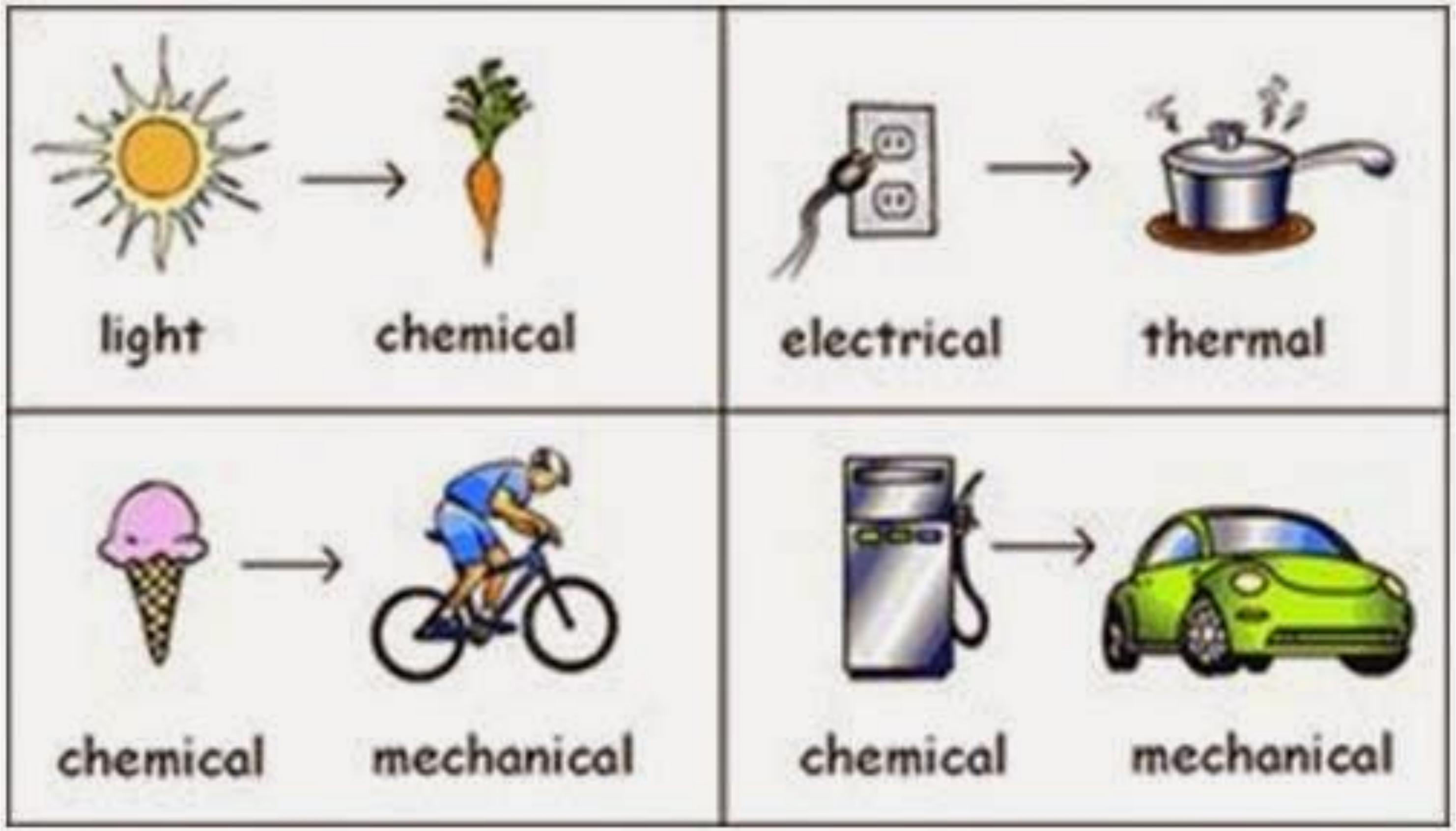


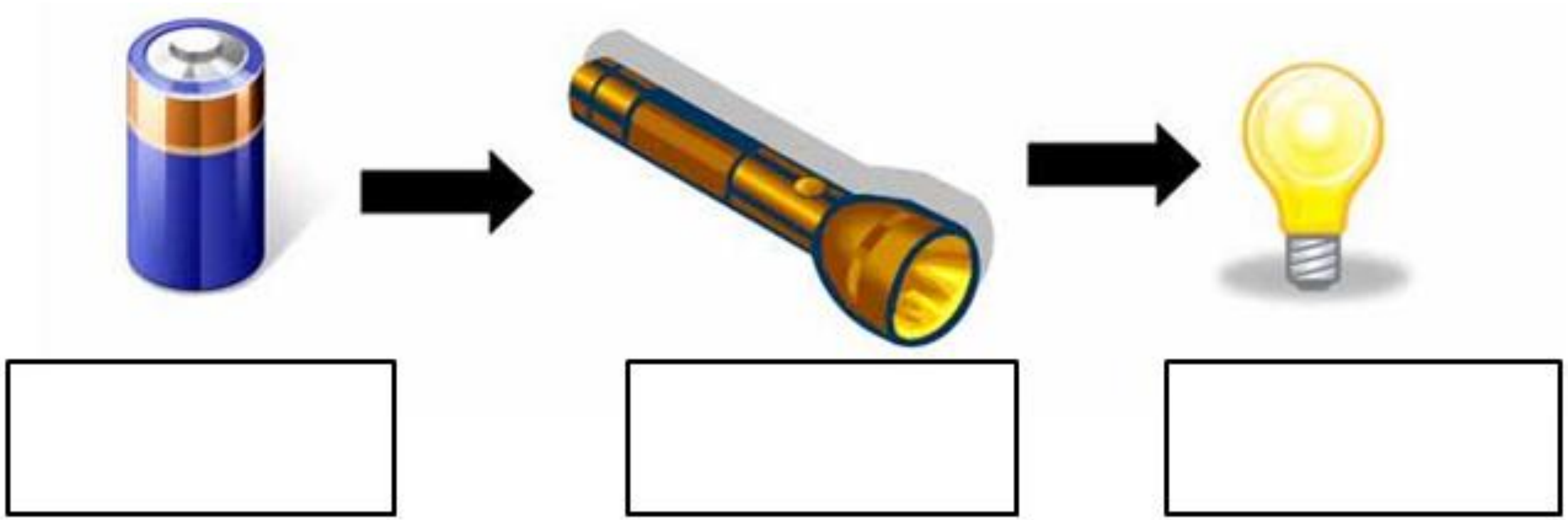
3.1 ENERGY FORMS AND TRANSFORMATIONS

Vocabulary

ENERGY	the ability to do **work**

What is the purpose of a machine or device?

- Many devices and machines convert, or **transform**, energy from one form to another.



What forms of energy are there?

Forms of Energy

- **Electrical energy**: the energy of charged particles
  - occurs when electrons travel from place to place

Forms of Energy

- **<u>Chemical Energy</u>**: the energy stored in chemicals.
  - A type of potential (stored) energy
  - Energy is released when chemicals react
  - Examples: food, “batteries”, and fossil fuels contain chemical energy

Forms of Energy

- **<u>Mechanical energy</u>**: the energy possessed by an object in motion.
  - Examples: a person biking, a thrown baseball, the blades of a blender chopping food

https://youtu.be/3OmpnfL5PCw Will it blend?

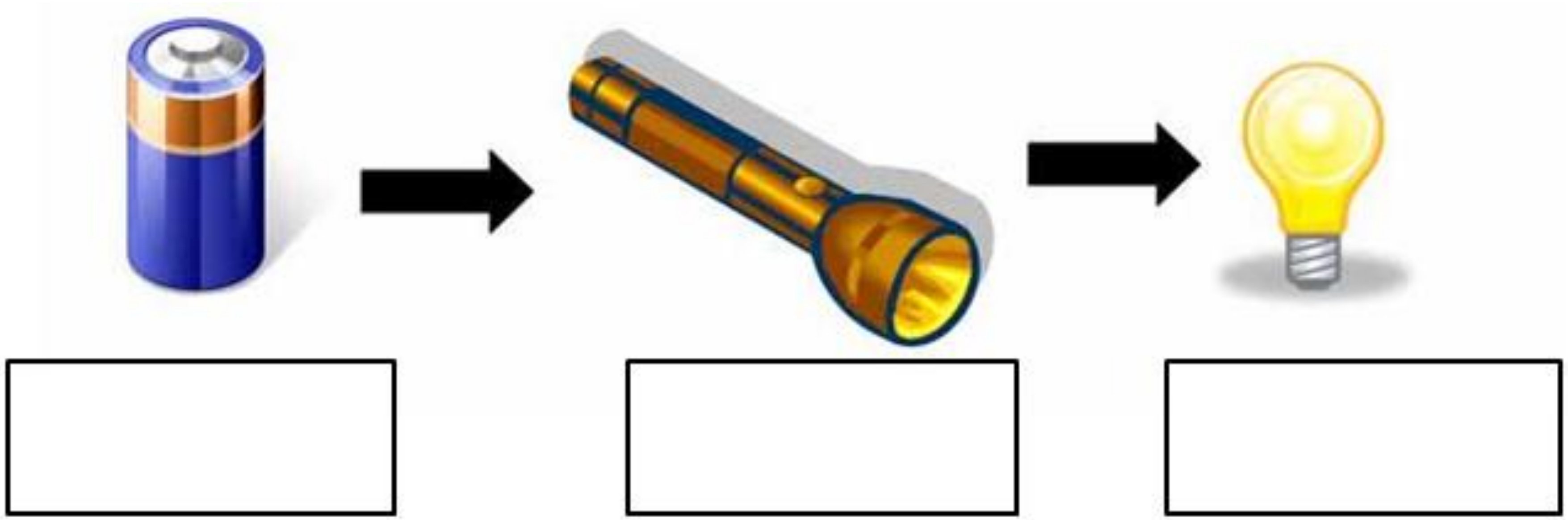
Forms of Energy

- **<u>Gravitational Potential Energy</u>**: the stored energy of an object at a height
  - Examples: water falling from a height, object at the top of a cliff

Forms of Energy

- Other forms of energy: **thermal** (heat), **light**, and **sound**

What forms of energy are involved in using a flashlight?



✓ Check Your Understanding

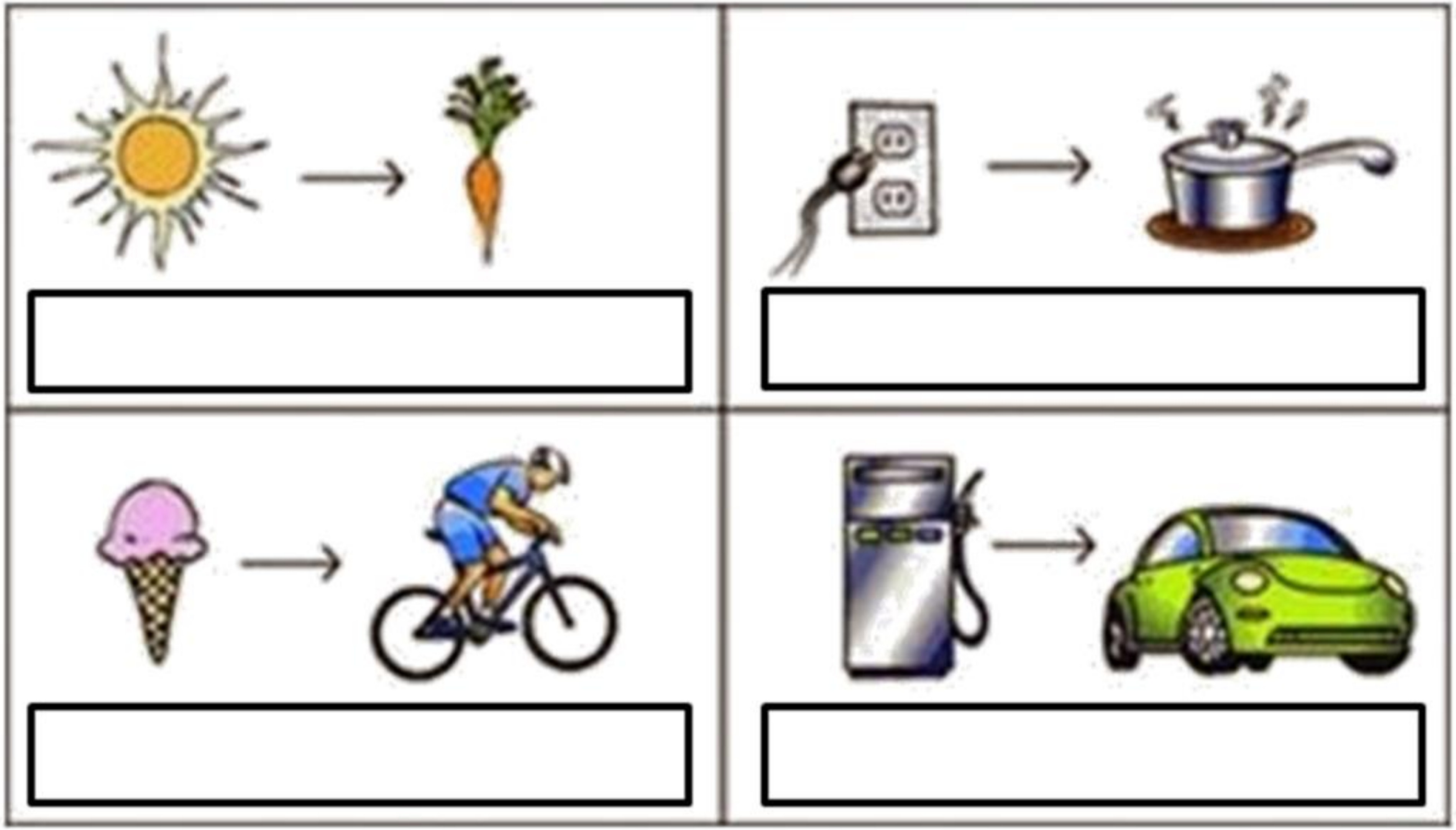
✓ Check Your Understanding

✓ Check Your Understanding

Energy Transformations

- Energy is **constantly** changing from one form to another
  - You are constantly transforming the **chemical** energy of your food to the **mechanical** energy of your body

Energy Transformations



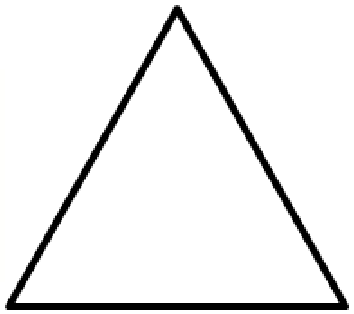
3.3 MEASURING ENERGY INPUT AND OUTPUT

Calculating

POWER

POWER (P)	The rate at which a device converts energy. The unit of power is the Watt (W).

Calculating Power



- The faster a device converts energy, the greater its power rating.
- For an electrical device, we can calculate its power using the formula:

	where P =
P =	I =
	V =

POWER

Example 1

1. A hair dryer has a power rating of 1000 W. It is plugged into a 120 V outlet. What is the current flowing through the hair dryer?

I=8.3 A

POWER

Example 2

2. A TV draws 1.5 A when connected to a 120 V outlet. What is the power rating of the TV?

P=180 W

Example 3

3. A toaster connected to a 110 V power source has 6.0 A of current flowing through it. What is its power rating?

P=660 W

Example 4

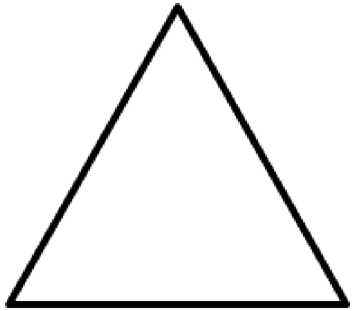
4. An oven has a power rating of 7000 W. If it draws 29.2 A of current, what is the voltage of the outlet?

239.7 V

Calculating

ENERGY (E)	The ability to do work; measured in **Joules (J)**

Calculating



where E =

E =

P =

t =

Example 1

1.) A hair dryer has a power rating of 1000 W. If it takes a person 8.0 minutes to dry their hair, how much energy did the hair dryer use?

E=480,000 J

Example 2

2.) If the TV from question 2 above was on for 2.5 h, how much energy did it use?

E=1,620,000 J

Example 3

3.) If a toaster uses 320 J of energy and takes 2.0 min to toast a bagel, what is its power rating?

P=2.7 J

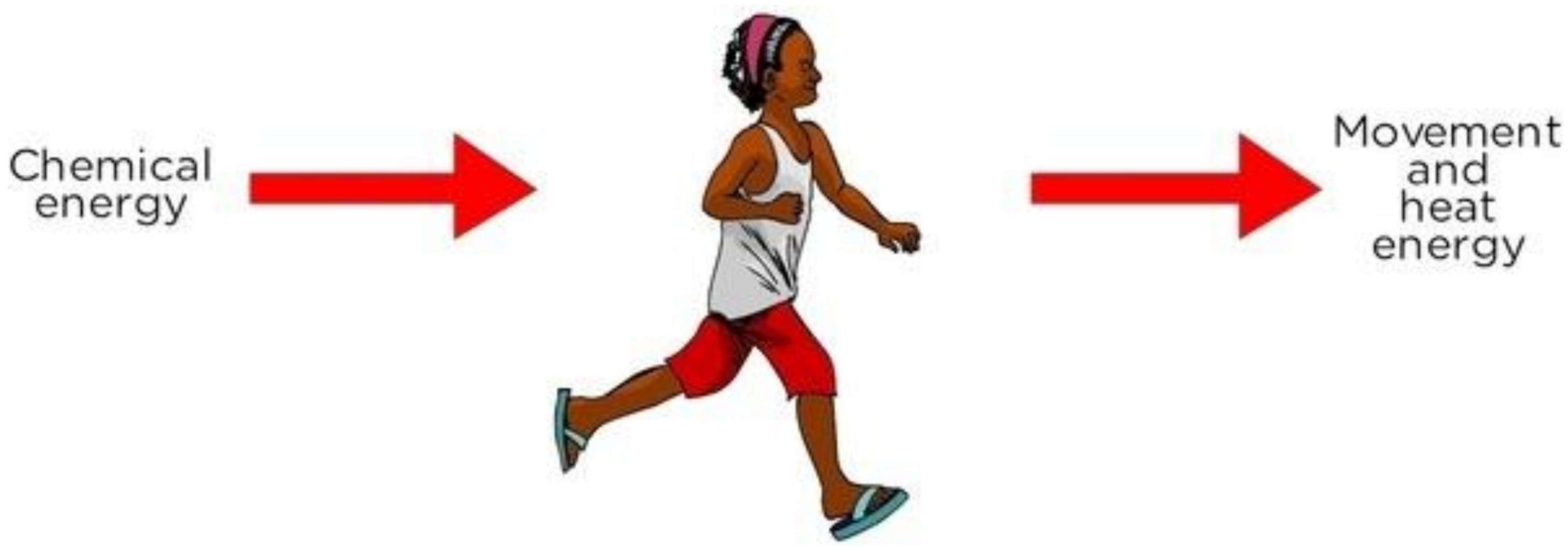
Example 4

4.) A microwave oven has a power rating of 800 W. If you cook a roast in this oven for 30 min at high, how many joules of electrical energy are converted into heat by the microwave?

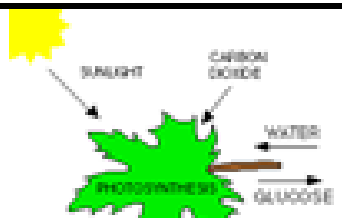
E=1,440,000 J

Input and Output Energy

- The job of a machine is often to transform energy from one form to at least one other form.



INPUT ENERGY → OUTPUT ENERGY



Efficiency of Energy Transformation

- In addition to the form of output energy the machine is supposed to produce, there will always also be some **heat** produced.
- This means no machine is 100% efficient, because it is not transforming all of its input energy to its intended output energy

Figure 3.23 Most of the energy transformed by a light bulb is wasted.

*No process can be 100% **efficient.***
*Some energy will always remain in the form of **thermal (heat)** energy*

-- Second Law of Thermodynamics

Figure 3.23 Most of the energy transformed by a light bulb is wasted.

Calculating

- We can calculate how efficient a machine is by using the formula:

Percent Efficiency =

Example 1

1.) Calculate the percent efficiency of the light bulb in figure 3.23 on the previous page.

5%

Example 2

2.) A wind turbine is able to transform 1,500,000 J of mechanical energy into 1,000,000 J of electrical energy. Calculate the efficiency of the wind turbine.

67%

Example 3

3.) A small tractor is 12% efficient at producing useful output from input fuel. How many joules of input fuel energy will this tractor need to produce 1000 J of useful output?

Input Energy=8333.3 J

Example 4

4.) A 100 W bulb is turned on for 2.0 h. If the useful energy output is 25000 J of energy, what is the efficiency of the bulb?

3.5%

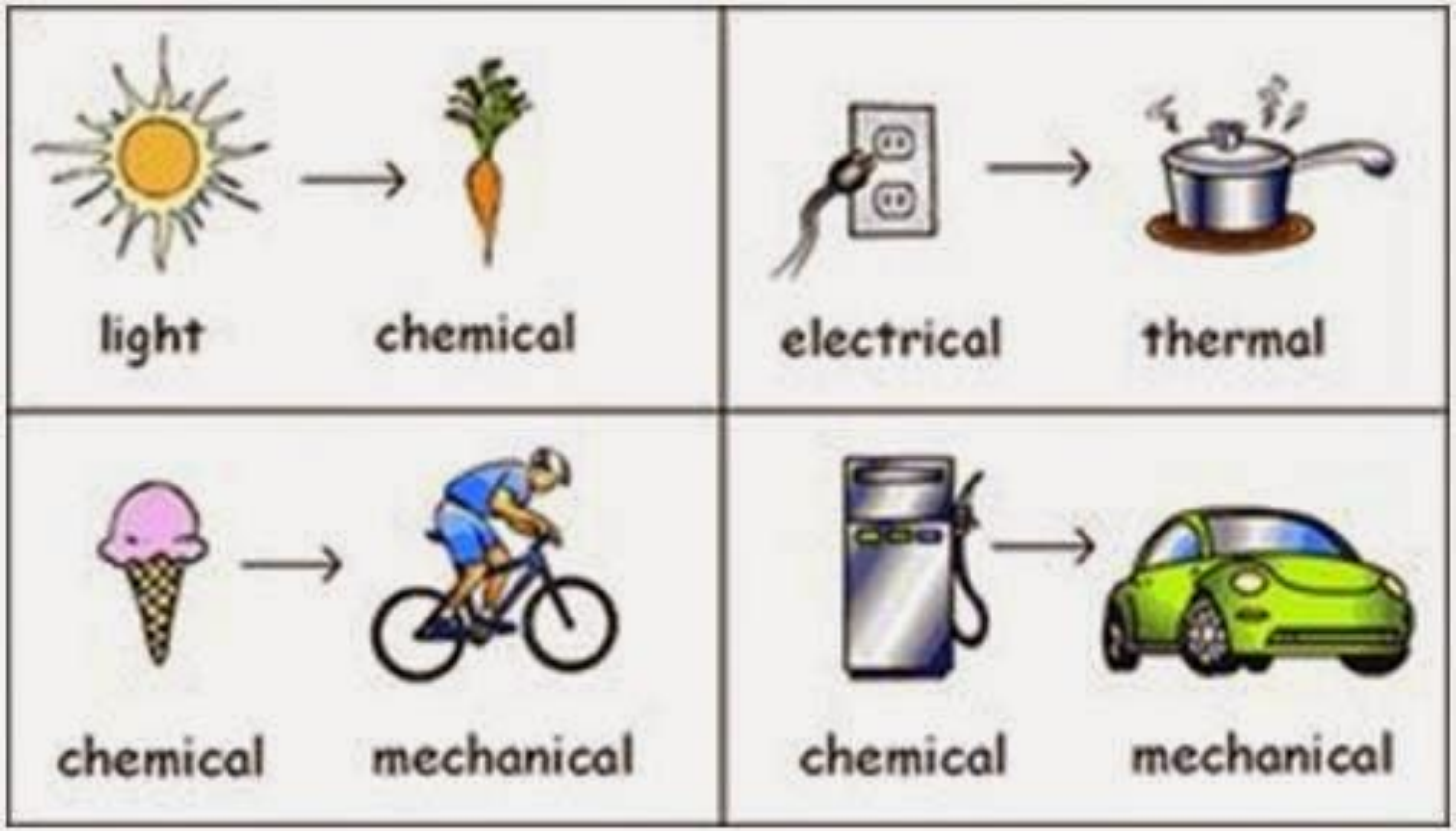
✓ Check Your Understanding

✓ Check Your Understanding – Answers

1. a.) 1200 W

   b.) 648,000 J

   c.) 92.3%



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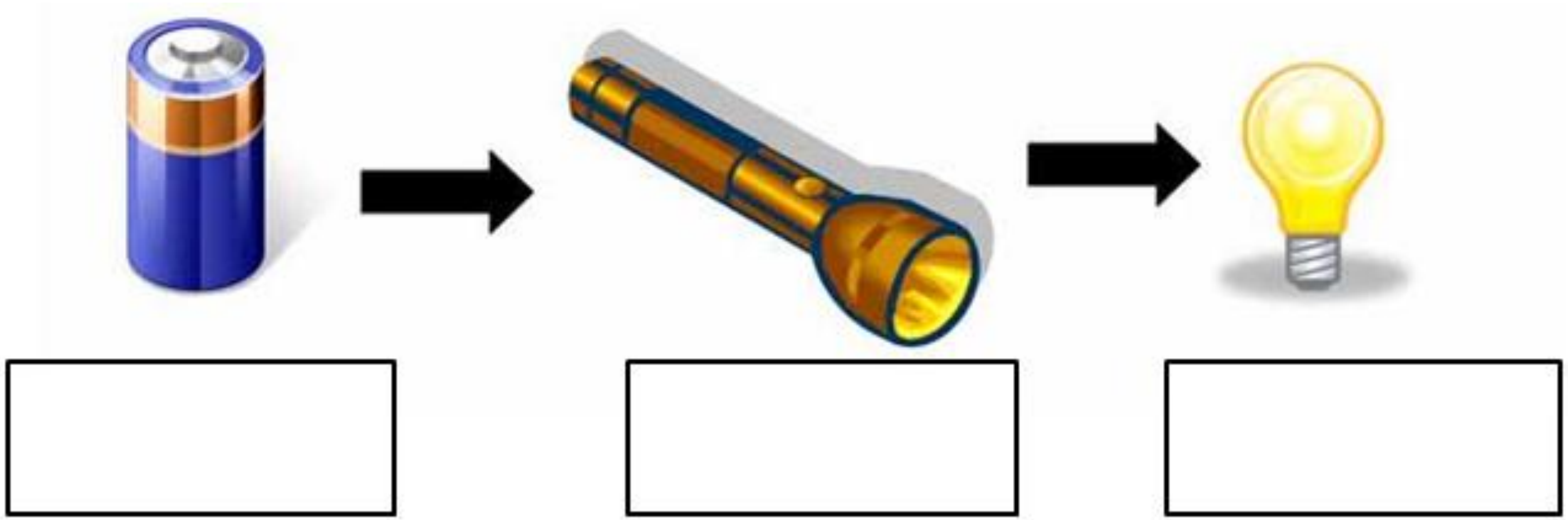

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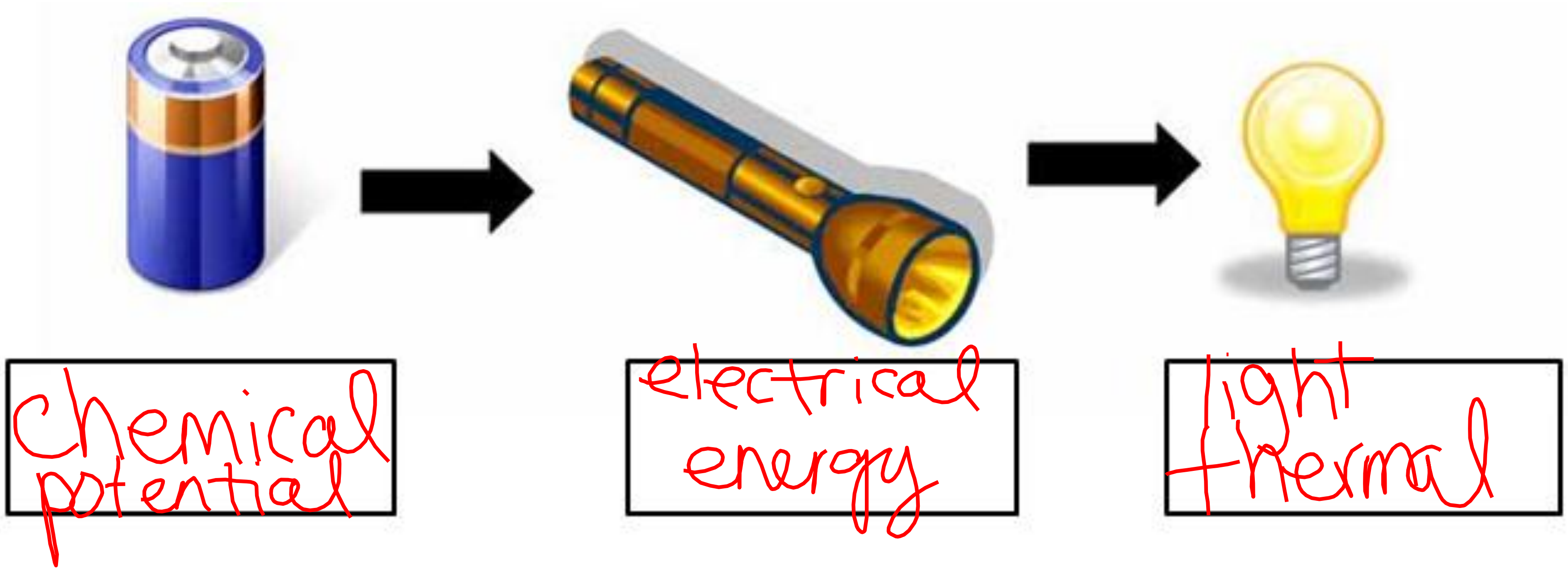
What forms of energy are involved in using a flashlight?



✓ Check Your Understanding

gravitational potential,
thermal

thermal,
chemical,
light

✓ Check Your Understanding

electrical, thermal
chemical, light,
Sound

Chemical - gas
mechanical = pushing, blades
thermal, sound

✓ Check Your Understanding

mechanical
electrical

gravitational
potential
sound

Energy Transformations

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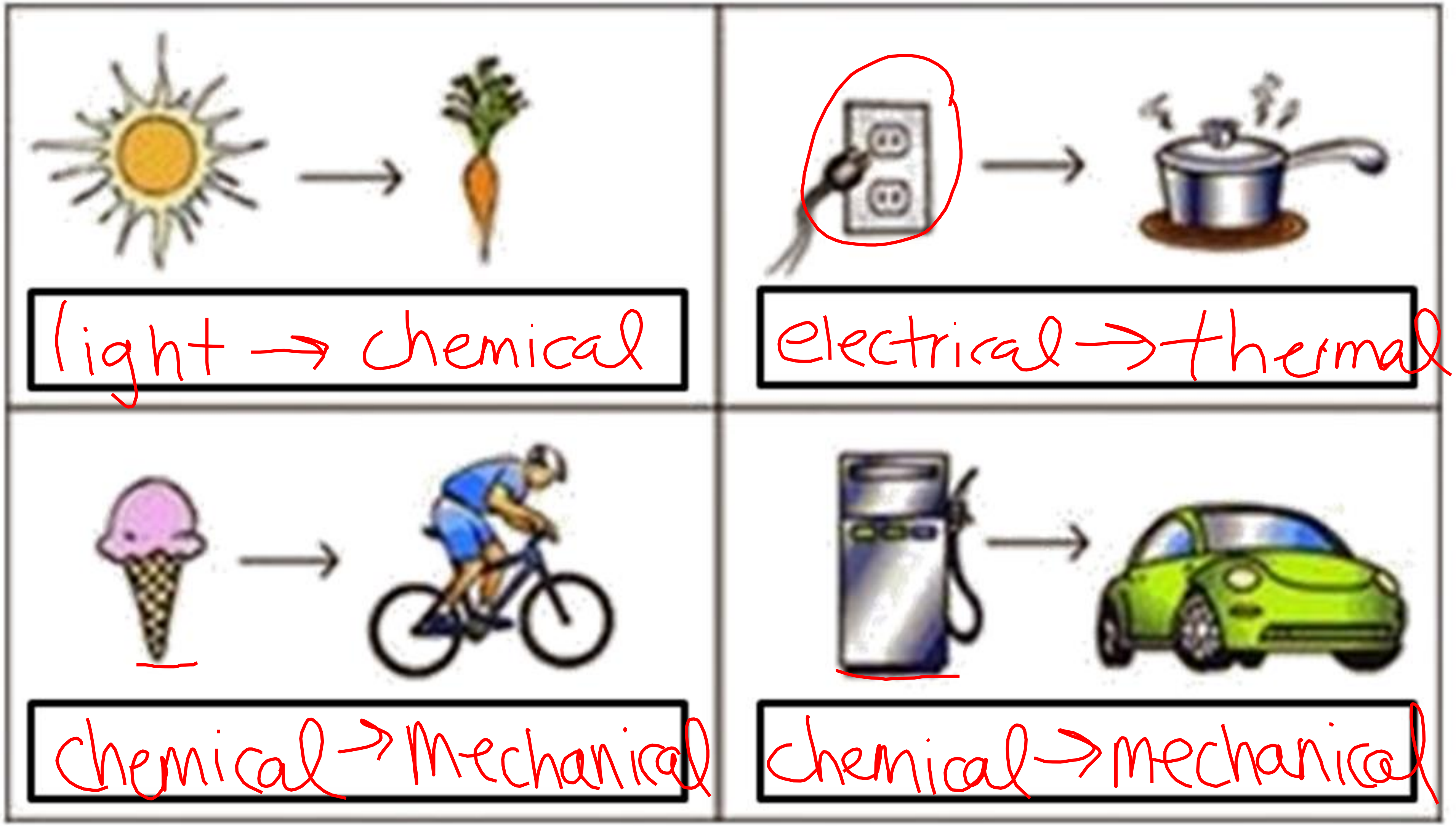
Energy Transformations



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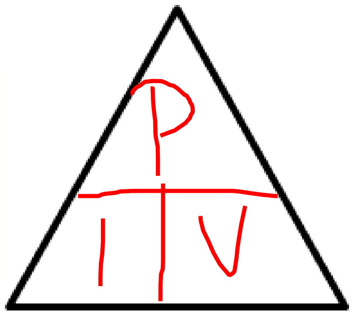
POWER (P)	The rate at which a device converts energy. The unit of power is the Watt (W).

Calculating Power



- The faster a device converts energy, the greater its power rating.
- For an electrical device, we can calculate its power using the formula:

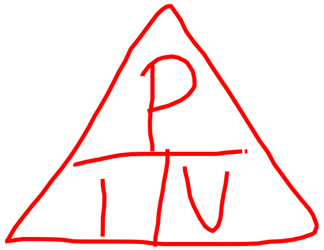
$$P = I \times V$$

where P = Power (W)
I = current (A)
V = Voltage (V)

given on test

POWER

Example 1



1. A hair dryer has a power rating of 1000 W. It is plugged into a 120 V outlet. What is the current flowing through the hair dryer?

$P = 1{,}000\,W$

$V = 120\,V$

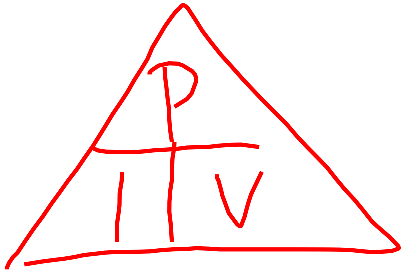
$I = ?$

$I = \frac{P}{V} = \frac{1{,}000\,W}{120\,V}$

$I = 8.3\,A$

I=8.3 A

Example 2



2. A TV draws 1.5 A when connected to a 120 V outlet. What is the power rating of the TV?

$I = 1.5\,A$

$V = 120\,V$

$P = ?$

$P = IV$

$= 1.5\,A \times 120\,V$

$P = 180\,W$

P=180 W

POWER

Example 3

3. A toaster connected to a 110 V power source has 6.0 A of current flowing through it. What is its power rating?

V = 110 V
I = 6.0 A
P = ?

P = I × V = 6.0 A × 110 V

P = 660 W

P=660 W

Example 4

4. An oven has a power rating of 7000 W. If it draws 29.2 A of current, what is the voltage of the outlet?

$P = 7{,}000W$

$I = 29.2A$

$V = ?$

$$V = \frac{P}{I} = \frac{7{,}000W}{29.2A}$$

$$V = 239.7V$$

239.7 V

Calculating

ENERGY (E)	The ability to do work; measured in **Joules (J)**

Calculating

E = P x t

where E = energy (J)

P = power (W)

t = time (s)

Example 1

1.) A hair dryer has a power rating of 1000 W. If it takes a person 8.0 minutes to dry their hair, how much energy did the hair dryer use?

$P = 1000 W$

$t = 8 min \times \frac{60 s}{min} = 480 s$

$E = ?$

$E = P \times t$

$= 1,000 W \times 480 s$

$E = 480,000 J$

E=480,000 J

Example 2

2.) If the TV from question 2 above was on for 2.5 h, how much energy did it use?

$P = 180\ W$

$t = 2.5\ h \times \frac{60\ min}{h} \times \frac{60\ s}{min}$

$= 9{,}000\ s$

$E = ?$

$E = Pt$

$= 180\ W \times 9000\ s$

$= 1{,}620{,}000\ J$

E=1,620,000 J

Example 3

3.) If a toaster uses 320 J of energy and takes 2.0 min to toast a bagel, what is its power rating?

$P = ?$

$E = 320\,J$

$t = 2\,min \times \frac{60\,s}{min} = 120\,s$

$$P = \frac{E}{t} = \frac{320\,J}{120\,s} = 2.7\,W$$

P=2.7 W

Example 4

4.) A microwave oven has a power rating of 800 W. If you cook a roast in this oven for 30 min at high, how many joules of electrical energy are converted into heat by the microwave?

$P = 800 W$

$t = 30 min \times \frac{60 s}{min} = 1800 s$

$E = ?$

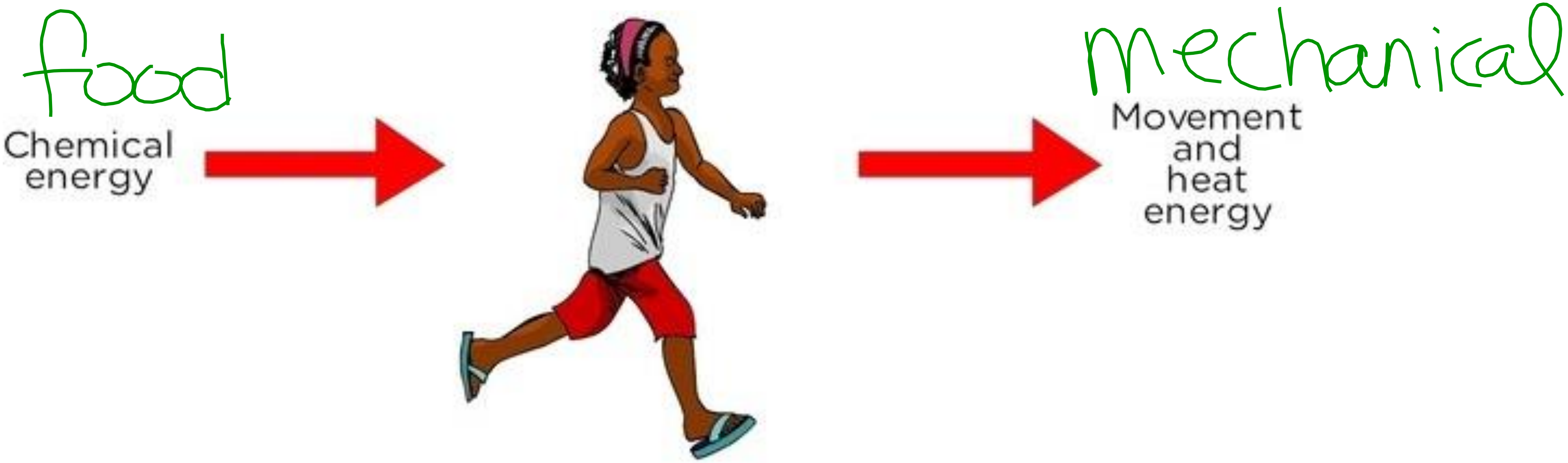
$E = \frac{P}{t} = \frac{800 W}{1800 s}$

$E = 1,440,000 J$

E=1,440,000 J

Input and Output Energy

- The job of a machine is often to transform energy from one form to at least one other form.



INPUT ENERGY → OUTPUT ENERGY

useful → wasted

electrical

thermal

electrical

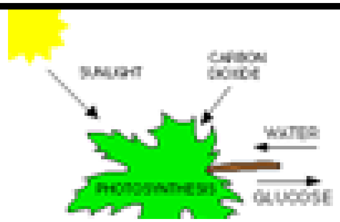
light, thermal

mechanical

electrical

chemical

thermal, light

SOLAR light


Chemical

Efficiency of Energy Transformation

- In addition to the form of output energy the machine is supposed to produce, there will always also be some **heat** produced.
- This means no machine is 100% efficient, because it is not transforming all of its input energy to its intended output energy

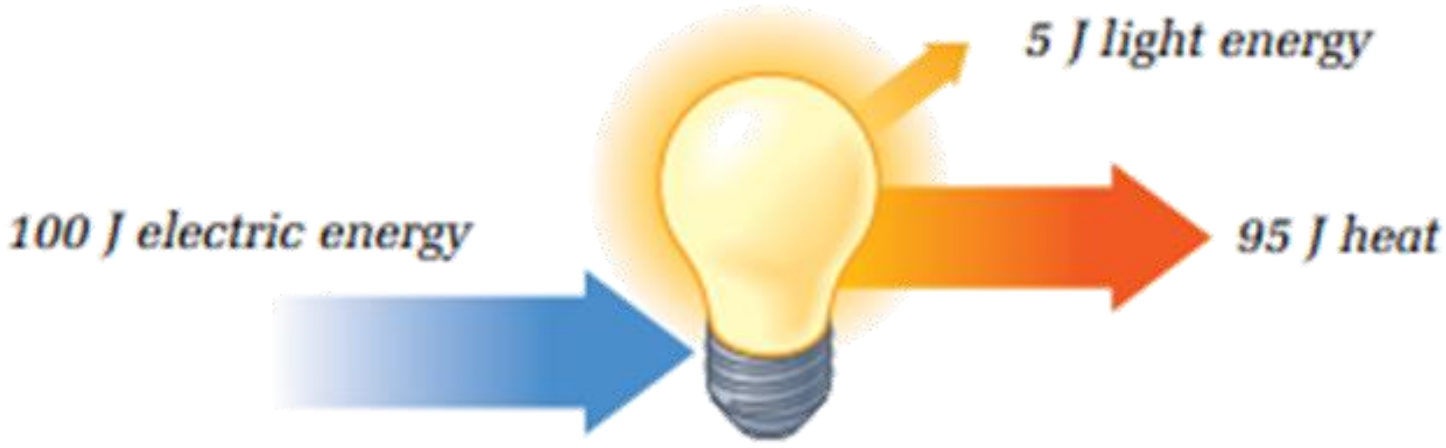


Figure 3.23 Most of the energy transformed by a light bulb is wasted.

No process can be 100% __efficient.__

Some energy will always remain in the form of __thermal (heat)__ energy

-- Second Law of Thermodynamics

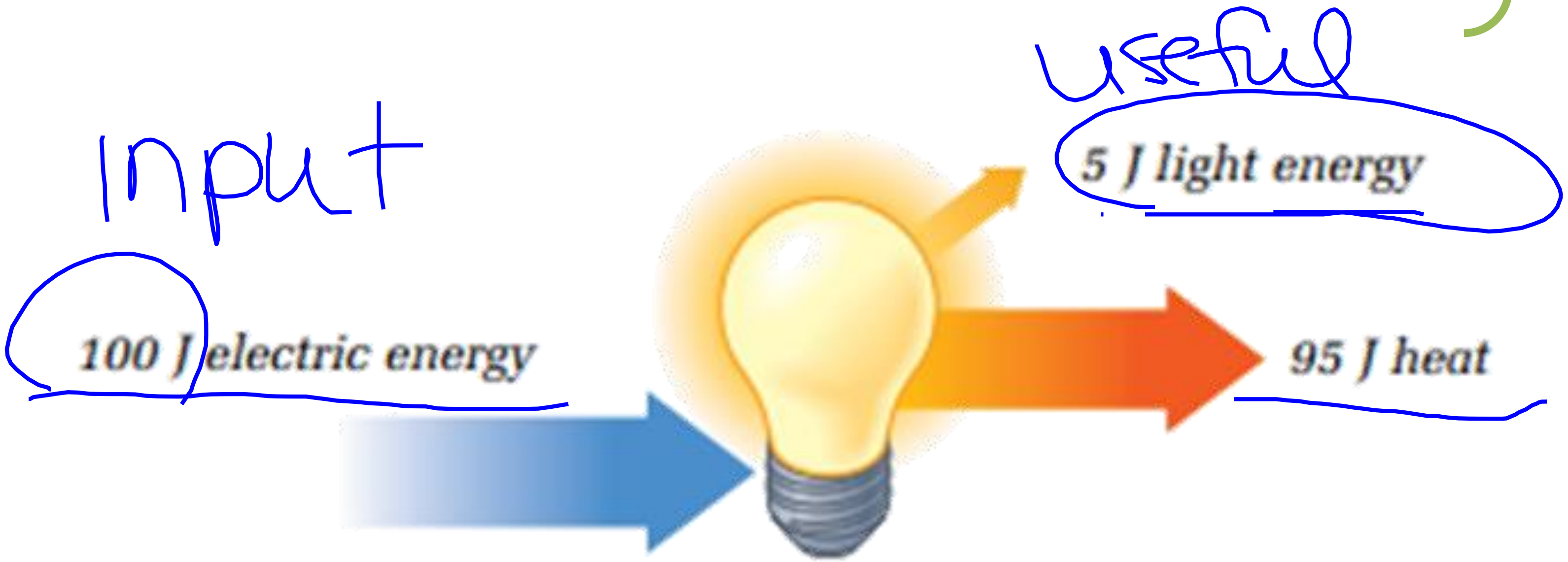


Figure 3.23 Most of the energy transformed by a light bulb is wasted.

Calculating

- We can calculate how efficient a machine is by using the formula:

$$\text{Percent Efficiency} = \frac{\text{Useful Output Energy}}{\text{Input Energy}} \times 100\%$$

Example 1

$$\text{Eff.} = \frac{\text{output}}{\text{input}} \times 100\%$$

1.) Calculate the percent efficiency of the light bulb in figure 3.23 on the previous page.

Input = 100J

useful output = 5J

$$\text{Eff} = \frac{5\text{J}}{100\text{J}} \times 100\%$$

Eff = 5%

5%

Example 2

$$Eff = \frac{O}{I} \times 100\%$$

2.) A wind turbine is able to transform 1,500,000 J of mechanical energy into 1,000,000 J of electrical energy. Calculate the efficiency of the wind turbine.

Output = 1,000,000 J

Input = 1,500,000 J

$$Eff = \frac{1,000,000}{1,500,000} \times 100\%$$

Eff = 67%

67%

Example 3

3.) A small tractor is 12% efficient at producing useful output from input fuel. How many joules of input fuel energy will this tractor need to produce 1000 J of useful output?

Input Energy=8333.3 J

Example 4

E / $P \mid t$

$Eff = \frac{O}{I}$

4.) A 100 W bulb is turned on for 2.0 h. If the useful energy output is 25000 J of energy, what is the efficiency of the bulb?

$P = 100W$

$t = 2.0h \times 60 \times 60$
$= 7200s$

$E =$

$E = P \times t$
$= 100W \times 7200s$

$E_I = 720000J$

$Eff = \frac{O}{I} \times 100\% = \frac{25{,}000J}{720{,}000J} \times 100$

$= 3.5\%$

3.5%

✓ Check Your Understanding

✓ Check Your Understanding – Answers

1. a.) 1200 W
   b.) 648,000 J
   c.) 92.3%
2. a.) 240 W
   b.) 69% efficient
3. a.) 6750 V
   b.) 648,000 J
   c.) 492,480 J
6. a.) 583,200,000 J
   b.) 279,936,000 J of energy saved
   c.) The 52 W bulbs are more efficient.