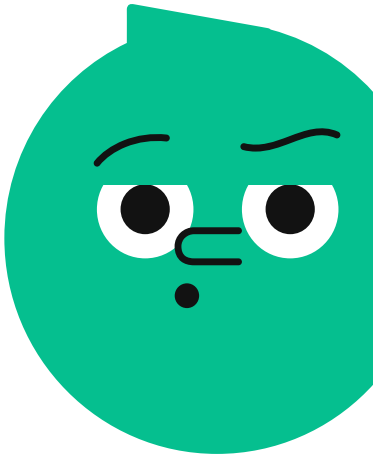
Learning and Evaluation Situation

alloprof
Head to alloprof.ca/en for more ressources



Science and Technology (ST)
Applied Science and Technology (AST)

Secondary IV

Name:

Making the "Bright" Choice

Student Booklet

120 minutes

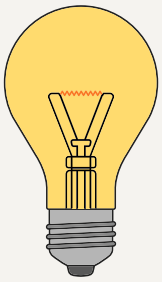
Scenario

Your school science lab is being renovated, and the student committee has asked you to lend a hand by going to the hardware store for some new light bulbs. You need to choose the **most efficient** type of light bulb.

At the hardware store, there are three different types of light bulb.
Each of them uses a different technology.

Type 1

Incandescent Bulb
A19



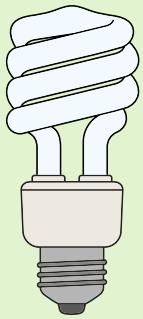
Voltage	120 volts
Luminous Flux	400 lumens
Power	40 watts

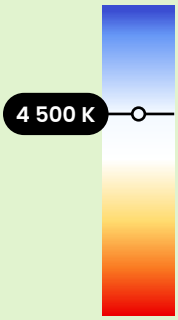
2 700 K warm white

Type 2

Compact Fluorescent Bulb

Luminous Flux **1 600 lumens**	Power **23 watts**



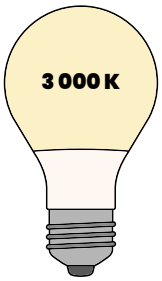


Rated Lifetime **15 000 heures**	Base **A19**

Type 3

LED Bulb
Light-emitting diode

Non-dimmable	A19



Luminous Flux	800 lumens
Power	9 watts

None of the boxes say how efficient the light bulb is.

To determine which type of light bulb is most efficient, you'll need to use your knowledge of **energy** and **energy transformation**. In the process, you'll also acquire new knowledge about **power**, **electrical energy**, and **energy efficiency**.

Reactivate Your Prior Knowledge!

Energy

Definition

Energy is the ability to alter a state or produce change.

The main forms of energy you'll learn about in high school are chemical energy, mechanical energy, electrical energy, radiant energy, thermal energy, and nuclear energy.

Energy is measured in joules (J).

Energy Transformation

Energy cannot be created or destroyed. It can only be transformed from one form to another or transferred from one medium to another.

Definition

Energy transformation is the conversion of one form of energy into another.

For example, a light bulb transforms **electrical energy** into **radiant energy**.

What Makes a Light Bulb Efficient?

1. In your opinion, what information on the light bulb boxes could help you determine how efficient each bulb is?

Which Bulb Uses the Least Energy?

To determine which bulb consumes the least energy, we need to consider the relationship between electrical power and electrical energy.

What is Electrical Power?

Electrical power is the amount of electrical energy a device consumes every second.

It is represented by ***P***.

It is measured in **watt** (**W**).

The electrical power of a device is usually listed on the device itself, its label, or its packaging.

What is Electrical Energy?

Electrical energy is the quantity of energy consumed by a device over a given period of time.

It is represented by ***E***.

It is measured in **joules** (**J**).

The amount of electrical energy consumed varies based on the power of an appliance and how long it is used.

The mathematical relationship between electrical power and electrical energy consumed is represented by the equation below.

Formula

$$E = P\Delta t$$

E : Energy consumed in joules (J)
P : Electrical power in watts (W)
Δt : time difference in seconds (s)

Example

According to the label, a water heater has a power of 3800W. Calculate the electrical energy consumed if it runs for 2 h. 30 min.

2. Find the electrical power for each light bulb type and record it in the table in the Appendix.

3. For each bulb type, calculate the amount of electrical energy consumed after 30 minutes of use.

   Use the calculation spaces provided in the Appendix and record your results in the table.

4. According to your calculations, which bulb type consumes the least electrical energy?

   ☐ Type 1 ☐ Type 2 ☐ Type 3

Which Bulb is the Brightest?

To determine which type of light bulb is the brightest, we need to look at the luminous flux.

What is Luminous Flux?

Luminous flux is a measure of the intensity of the visible light emitted by a light source.

It is measured in lumens (lm).

The higher the luminous flux, the brighter the bulb.

5. Find the luminous flux on the packaging for each bulb type and record it in the table in the Appendix. Then, answer the following question.

   Which bulb type produces the brightest light?

   ☐ Type 1 ☐ Type 2 ☐ Type 3

6. By comparing the luminous flux and electrical energy consumed for each bulb, can you determine which type is the most efficient? Explain your answer.

Which Bulb is the Most Efficient?

To determine which bulb type is the most efficient, you will need to calculate the energy efficiency.

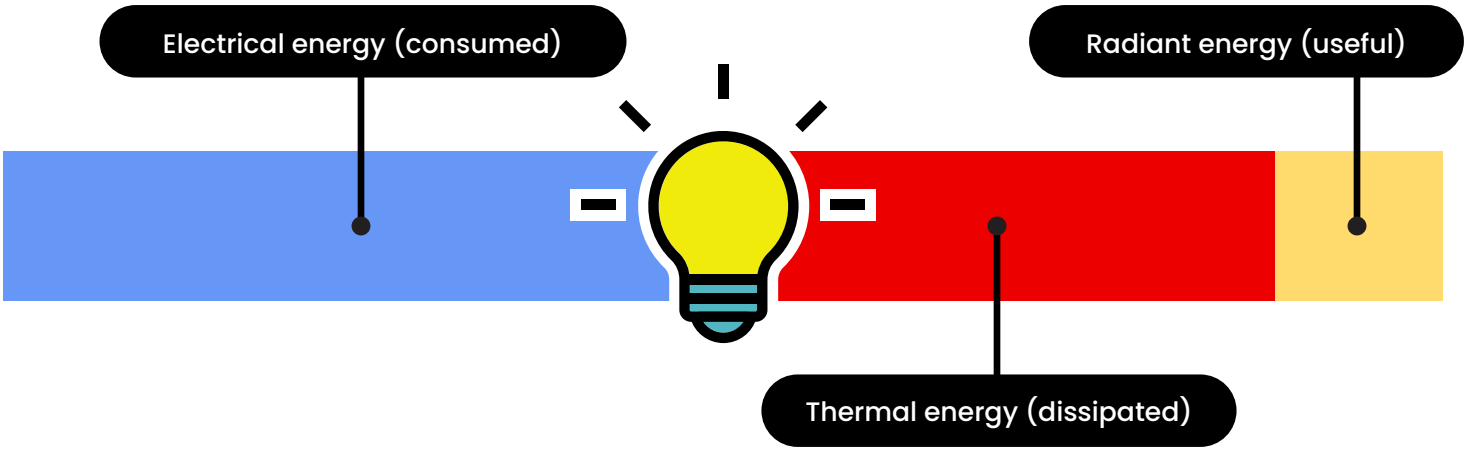
What is Energy Efficiency?

Definitions

- **Energy efficiency** is the ratio of the amount of useful energy to the amount of energy consumed by a device, expressed as a percentage (%).
- **Useful energy** is the portion of energy that is actually used by a device to perform its intended function.

Light bulbs transform electrical energy into radiant energy. In this scenario, electrical energy is the energy consumed and radiant energy is the useful energy.

However, not all the energy consumed is transformed into useful energy. Part of it is transformed into thermal energy. Since thermal energy is not used for the bulb's main function, it's referred to as *dissipated energy*.



Energy efficiency and dissipated energy are calculated using the following formulas.

Formulas

$$\text{Energy efficiency } (\%) = \frac{\text{Amount of useful energy}}{\text{Amount of energy consumed}} \times 100$$

$$\text{Dissipated energy} = \text{Energy consumed} - \text{Useful energy}$$

Example

A water heater that has consumed 34 200 000 J of electrical energy transfers 26 676 000 J in the form of thermal energy to the water in the tank. The rest of the thermal energy is dissipated into the ambient air.

a) What is the energy efficiency of the water heater?

b) How much energy is dissipated?

7. Below are the quantities of radiant energy emitted by each light bulb over a period of 30 minutes.

   Bulb 1: 3 600 J **Bulb 2:** 32 292 J **Bulb 3:** 13 446 J

   Is this useful energy or dissipated energy? Explain your answer.

   Copy the data into the table in the Appendix, then label the column.

8. Using the results you obtained in question 3 and the information provided in question 7, calculate the energy efficiency for each type of light bulb.

   Use the calculation spaces provided in the Appendix and record your results in the table.

9. Based on your new knowledge, can you determine which bulb model is the most efficient? Explain your answer.