C2 ACTIVITY 4: ENERGY SANKEYS

Background

Sankey diagrams represent the flow of energy visually by identifying energy stores, energy transfers, and points where energy could be wasted. It is important that the energy we use is not wasted, and knowing the energy transfer helps us to determine the efficiency of a device. Students may be familiar with various graphic representations of data such as bar charts, pie charts and scatter graphs. However, these representations often depend on the interpretation of the reader as well as the quantity of data used.

In 1898 an Irish man called Captain Matthew Sankey used a flow chart to show the energy efficiency of a steam engine. This type of flow chart is now referred to as a Sankey diagram, and is used to investigate the energy efficiencies of systems as well as the cash flow of businesses. The diagrams are constructed from data and represent the energy transfers involved, quantifying these transfers and thus highlighting the efficiency of the system in question.

A **Sankey diagram** is shown in Figure 4. The width of the arrows represents the quantity of energies involved, and their directions indicate where the energy flows. In Figure 4, the arrow to the right represents **useful** output and the downward arrow represents output of **wasted** energy. It also shows the conservation of energy: an input of 5 J results in a total output of 3.9 J + 1.1 J.

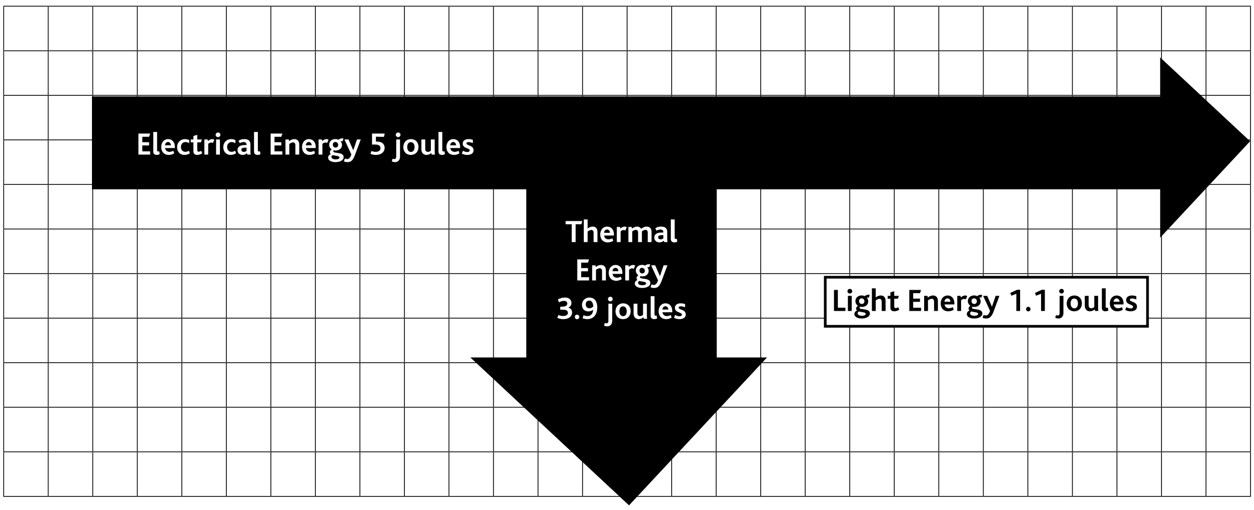


Figure 4

Suggested approaches:

- As an introduction to Sankey diagrams, ask students to describe the various types of graphs they use in other subjects such as maths, geography and business studies. Raise the following questions:
  - ? *Why are these graphs used?*
  - ? *What type of information do they give?*
  - ? *What shapes do these graphs take?*
  - ? *How do we interpret the resultant patterns?*
  - ? *How useful are these graphs?*

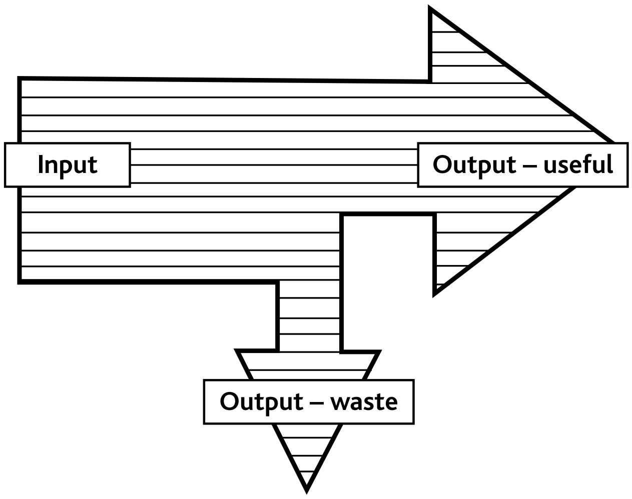


Figure 5

- Show Figure 5 to the class and ask for comments and questions. Ask a group of two or three students to compile a list of the questions that arise. This is a good opportunity to show the students how to construct a Sankey diagram using **C2 ACTIVITY 4 (I): CONSTRUCTING A SANKEY DIAGRAM** as a teaching aid. Afterwards, review the list of questions and ask the students if there are any they can now answer themselves.
- Ask the students to tell you what they understand by the terms efficiency and energy efficient. Put the following questions to them:
  - ? ***In what circumstance might a microwave be more efficient than a cooker?***
  - ? ***When would a microwave be more efficient than a kettle?***
- The efficiency of a device that transfers energy – its 'energy efficiency' – refers to the amount of the energy supplied (input) that is transferred into usable energy (output). The efficiency of an appliance is usually calculated as the percentage efficiency. Not all the input energy is transferred into usable energy. There will be some loss of energy through unwanted heat, sound, etc. Because of this energy loss an appliance will never be 100% efficient.

The energy efficiency of a device can be calculated using the following formula:

$$\%\ \text{Efficiency} = \frac{\text{Useful energy output} \times 100}{\text{Total energy input}}$$

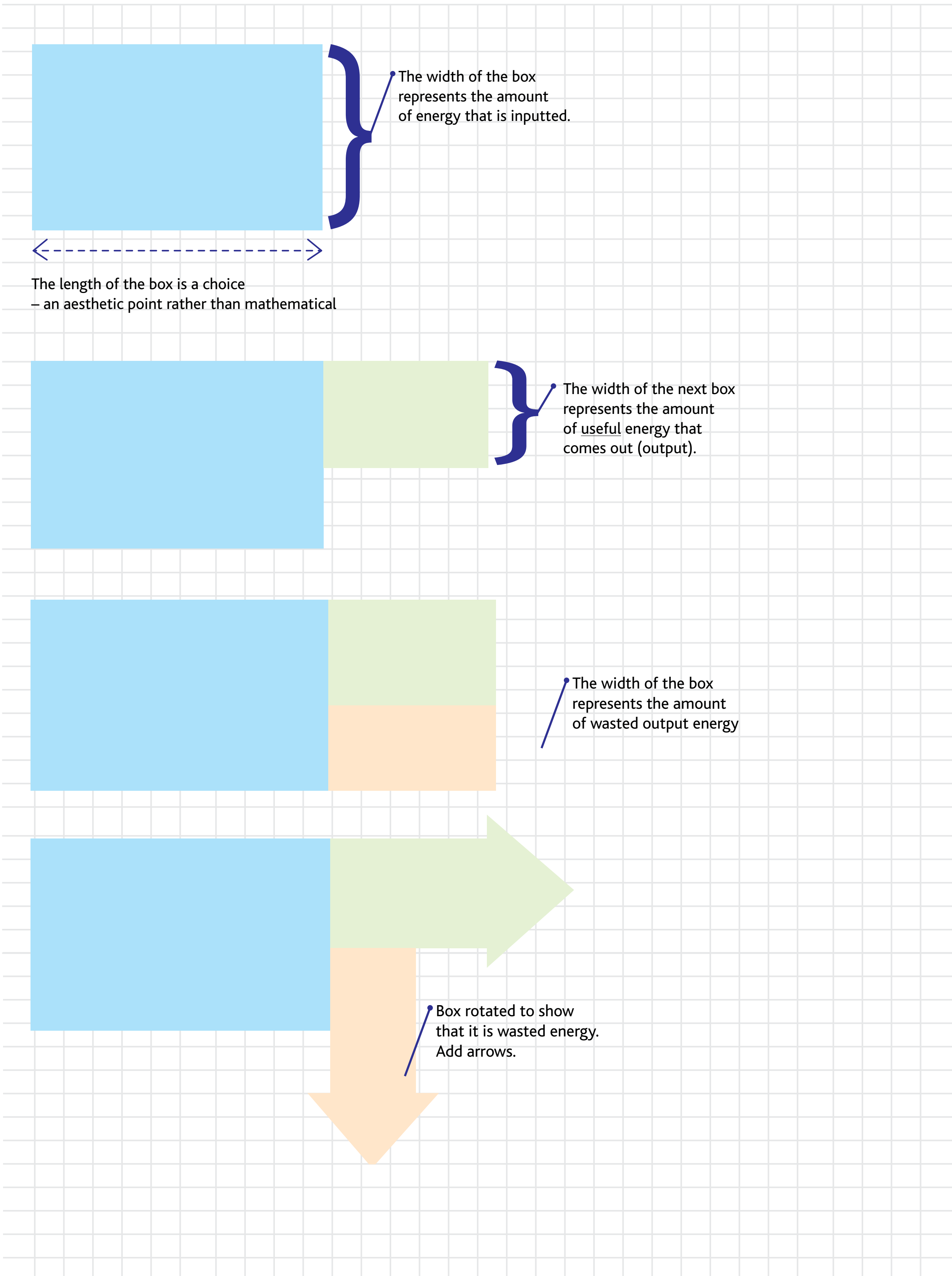
What Next:

- After establishing these basics, you may wish to move to the analysis and use it to prompt a discussion about energy efficient light bulbs. The following questions could be investigated, thus enabling students to hone their research and practise their presentation skills.
  - ? ***Why has the EU eliminated the use of incandescent (filament) light bulbs?***
  - ? ***What are the consequences of this law, intended or otherwise?***
  - ? ***What about catalytic converters – are they efficient or do they simply reduce the emission of noxious gases?***

Resources:

- See SEAI website for tips on energy efficiency.
- See energy.gov for information on the history of the light bulb.

C2 ACTIVITY 4 (I): CONSTRUCTING A SANKEY DIAGRAM



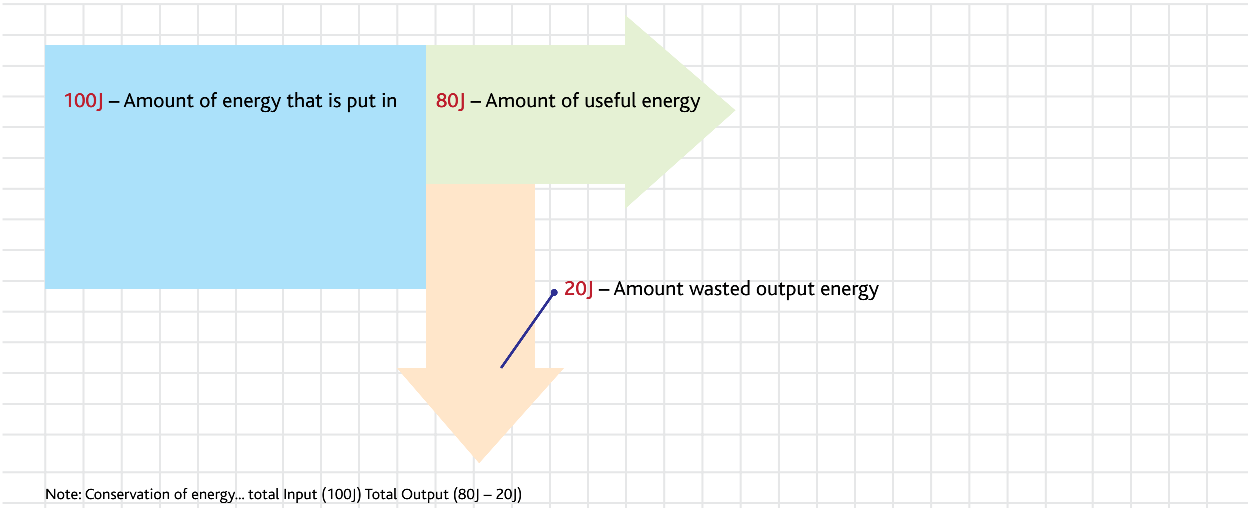
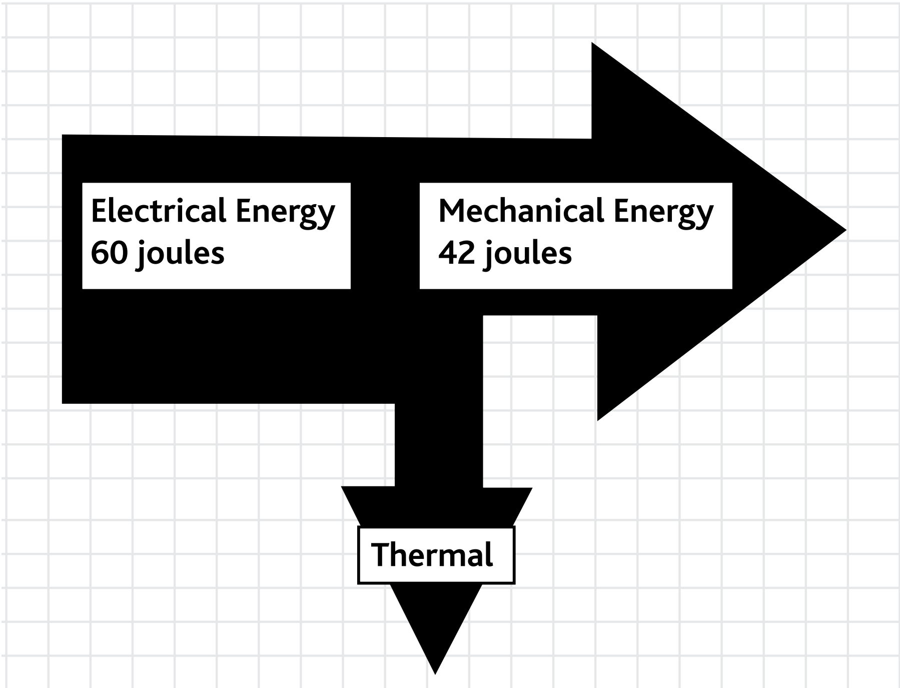


Figure 6 – Examples of Sankey diagrams

C2.4 WORKSHEET H: READING A SANKEY DIAGRAM

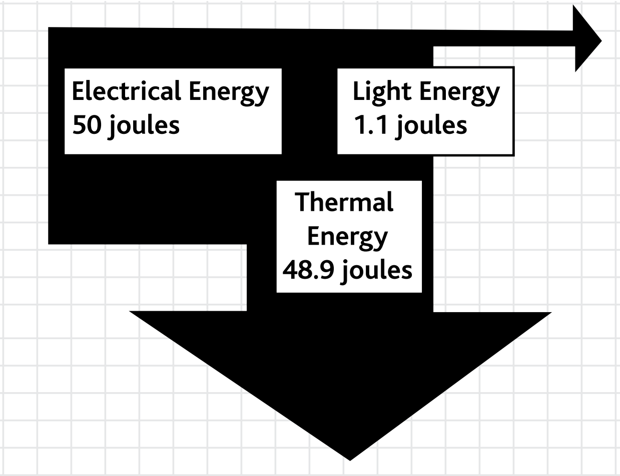


1. How much thermal energy does the motor produce?
   a) 62 joules
   b) 18 joules
   c) 60 joules
   d) 42 joules

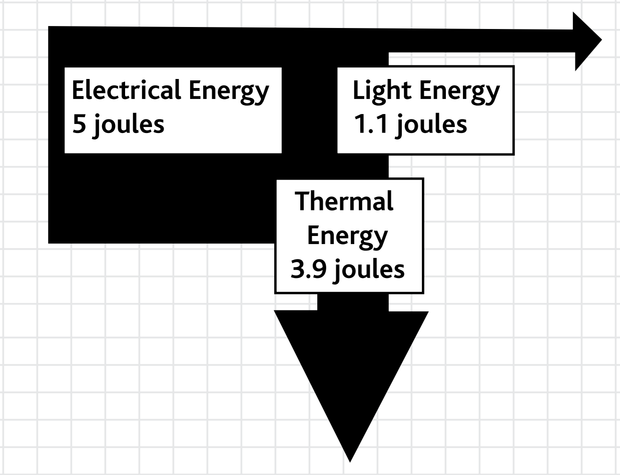
Answer: ☐

2. Which of the three lights, **A**, **B** or **C** is the most efficient? Give a reason for your answer.

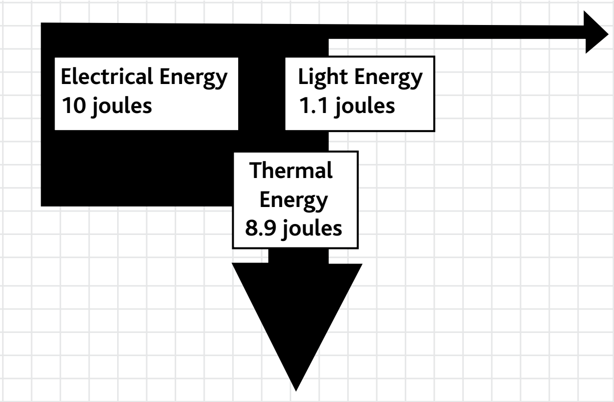
A. Filament Lamp



B. LED Lamp



C. CFL Lamp



Answer:

3. How much heat energy is emitted by each of the light bulbs in question 2?

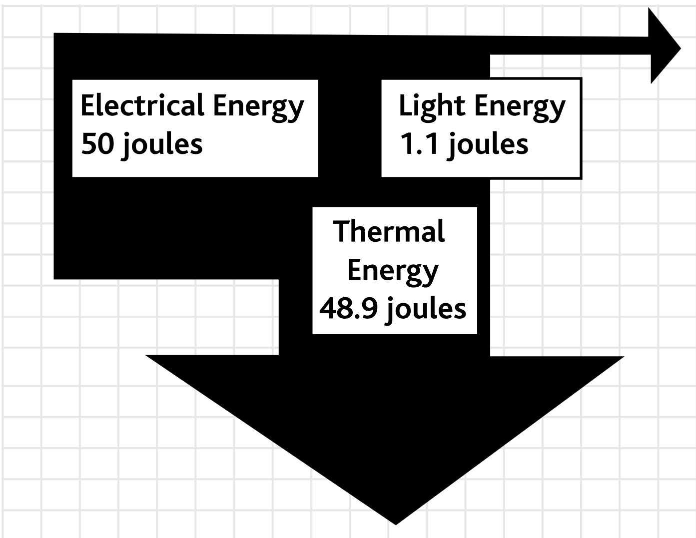
A: ☐ B: ☐ C: ☐

4. Which of the light bulbs in question 2 is most efficient? Give a reason for your answer.

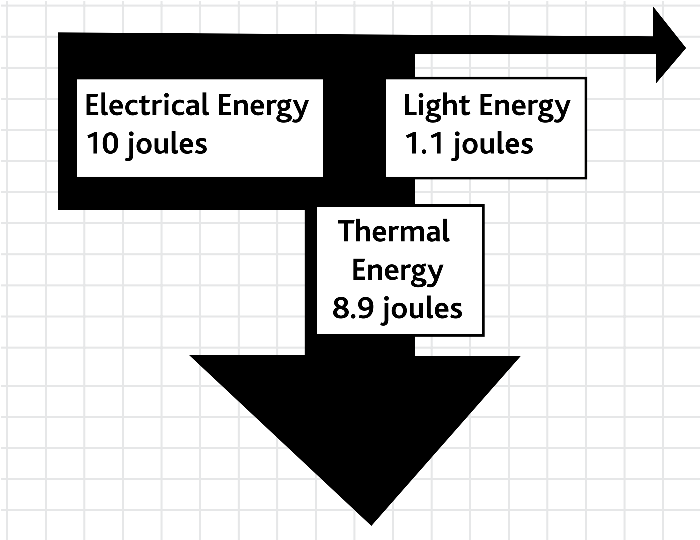
5. What is a filament bulb?

6. Explain what the letters CFL represent.

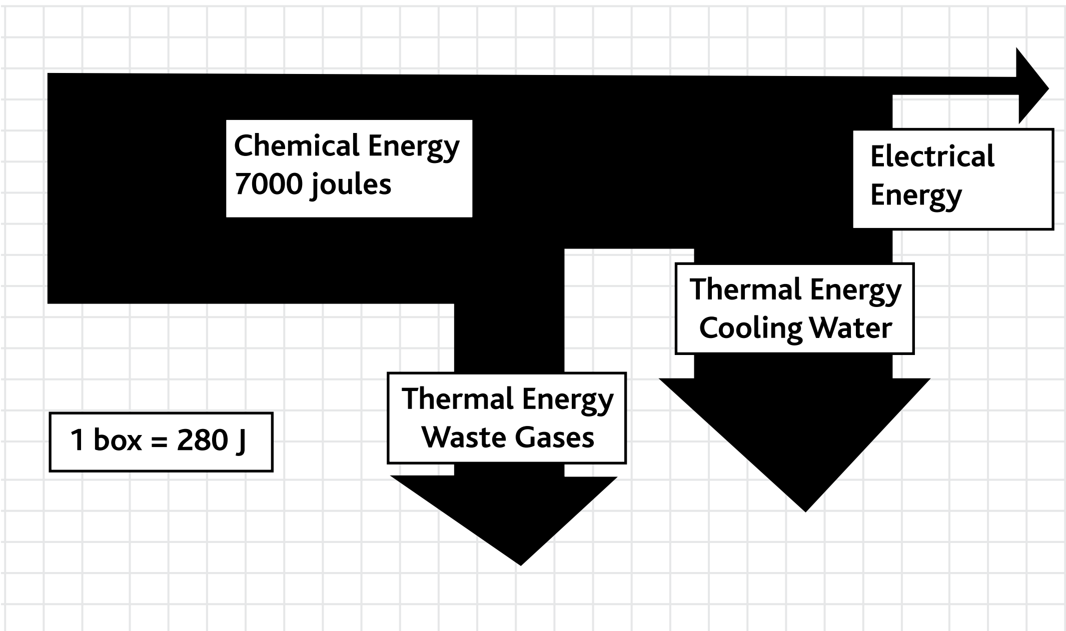
7. Is this filament lamp efficient? Give a reason for your answer.



8. What is the efficiency of the CFL lamp in the diagram below? Suggest another phrase instead of 'thermal' which could be substituted and still retain the same meaning.



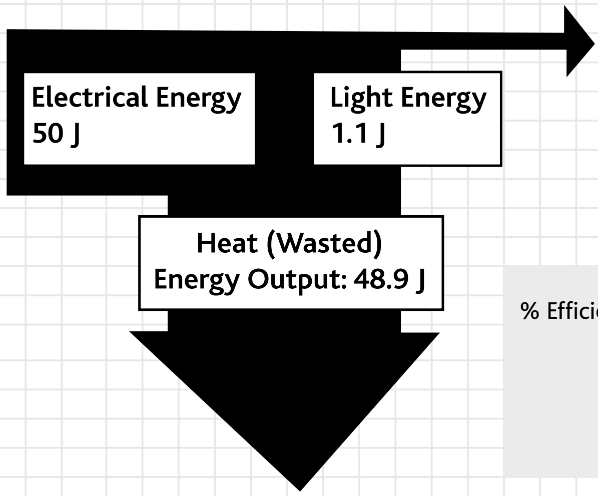
9. How much useful energy is produced by this power station? [Hint: check the scale.]



10. What is the efficiency of this power station?

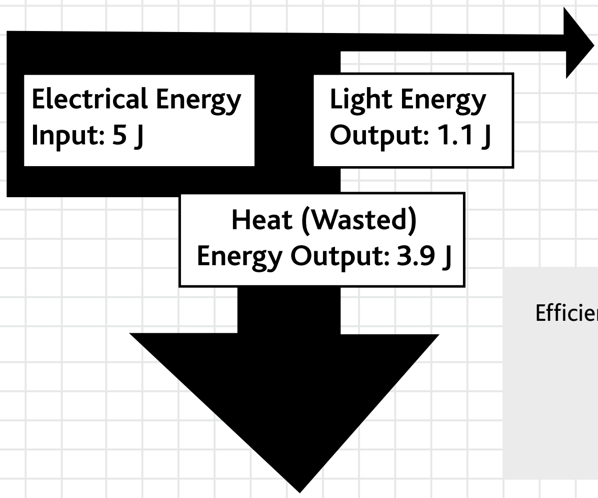
C2 ACTIVITY 4 (II): EXAMPLES OF IN-DEPTH ANALYSIS

The efficiency of old filament bulbs and modern energy efficient bulbs are shown below in Figure 7 and Figure 8.



$$\% \text{ Efficiency} = \frac{\text{Useful Energy Output}}{\text{Total Energy Input}} \times 100$$
$$= \frac{1.1}{50}$$
$$= 2.2\%$$

Figure 7 – Sankey diagram of a filament bulb



$$\text{Efficiency} = \frac{\text{Useful Energy Output}}{\text{Total Energy Input}} \times 100$$
$$= \frac{1.1}{50}$$
$$= 22\%$$

Figure 8 – A Sankey diagram of an energy efficient bulb

An electric motor consumes 100 watts (100 joules of electrical energy per second [J/s]) of power and gives 90 watts of usable energy power. What is its percentage efficiency?

$$\% \text{ Efficiency} = \frac{90 \text{ W}}{100 \text{ W}} \text{ X}100$$
$$= 90\%$$

C2 ACTIVITY 4 (III): EXAMPLES OF ANALYSING SYSTEMS FOR ENERGY EFFICIENCY

Car

A car engine transfers chemical energy which is stored in the fuel (petrol) into kinetic energy in the engine and wheels.

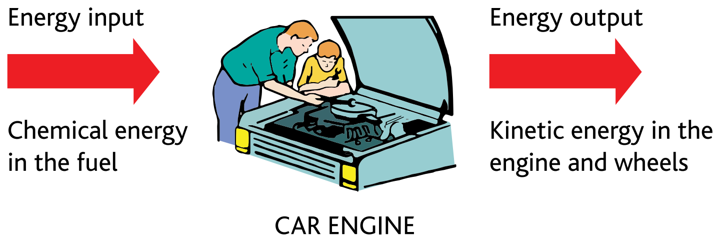


Figure 9: Energy transfer diagram for a car engine

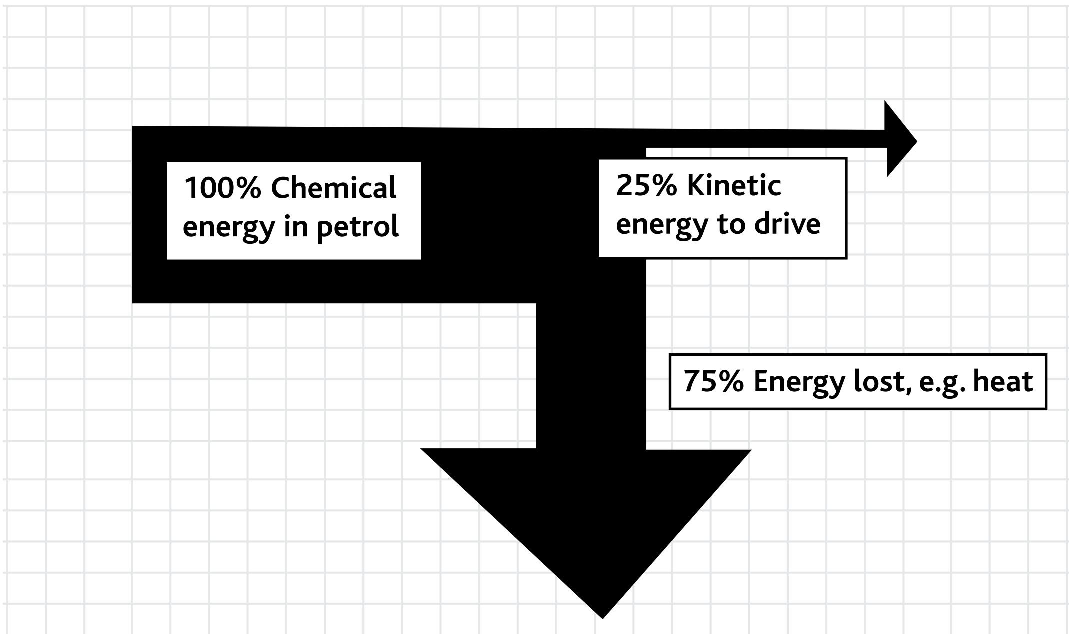


Figure 10: Sankey diagram for a car engine

Power Stations

Figure 11: Power station (Edenderry Power Plant, Bord na Móna)

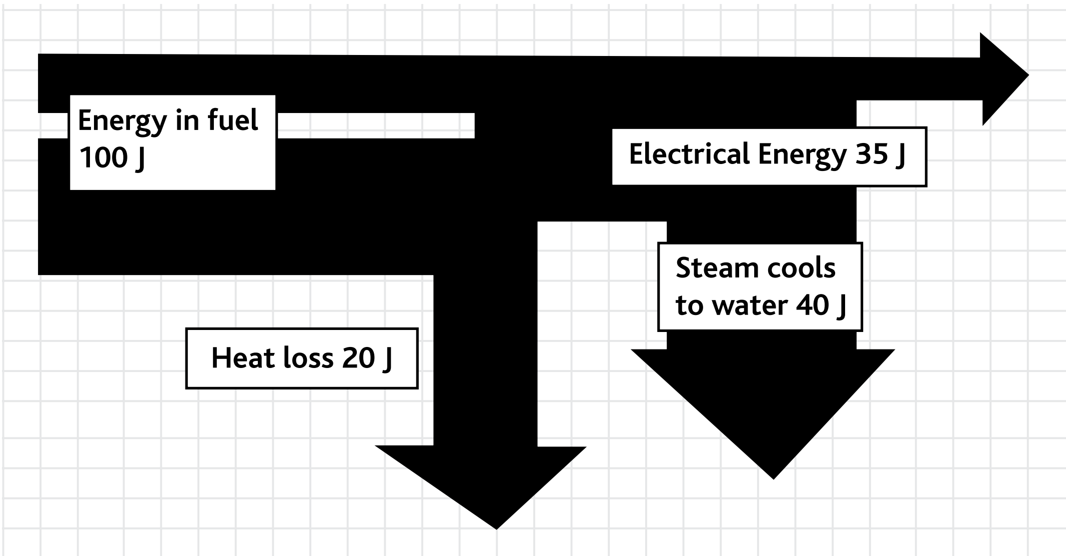


Figure 12: Sankey diagram for a power station

The IEA makes extensive use of Sankey diagrams to illustrate the energy usage of various countries. Check out how the IEA maps Ireland's energy usage.

C2 ACTIVITY 5: TAKE ACTION - ONE GOOD IDEA

Background

From 2010 to 2020 SEAI ran the One Good Idea project for post-primary school students. The project aimed at encouraging students to examine simple ways that they can contribute to energy efficiency and sustainability. The project incorporated a wide range of school subjects and developed important academic and life skills such as researching, creative collaboration, launching a multi-media campaign, and pitching. Students from different academic areas and skill sets work as a team to develop and present their ideas.
Students can still use the One Good Idea template to develop their own action project.

Suggested approaches:

- Show the some of the finalists videos from the 2020 competition to the class and use it as a starting point for a brainstorming session. Topics include Saving Energy, Food Miles and Climate Action. A full list of topics and fact sheets are available on the resources page of the website.
- Once a topic has been chosen students should carry out some research to determine what the problem is and what actions they can take to solve the issue.
- Perhaps carry out a survey on what your peers know about the subject.
- Students can create an awareness campaign around the issue and what can be done to take action. This could be posters, a short video, talks to other classes or announcements at assembly among others.
- Following the campaign do another survey to see if the campaign has made a difference. Have you saved energy? Have students and teachers behaviour changed? Can you continue your campaign?
- Remember - it is all about the individual and group changes that can make a big difference.