C1: ENERGY AND FOOD

Overview

These activities can be used to introduce students to energy – what it does, where it comes from, and how it can be measured. The focus is on the connection between **work**, **energy** and **food**, and the activities aim at helping students to learn how to read food labels and to understand the factors that affect reaction rates and the role of effective surface areas.

Suggested approaches:

- Let the students brainstorm and collect their ideas about energy.
  - ? ***What does energy do?***
  - ? ***Where does it come from?***
  - ? ***Can it be measured?***
  - ? ***How is it measured?***
  - ? ***Is there a connection between work, energy and food?***
- During the brainstorm set up the activity **C1 ACTIVITY 1: FOOD ENERGY**. Use this activity to refine the students' understanding of the energy changes taking place.
- The energy released by food is calculated using the formula shown in Figure 1. It is advisable that students are familiar with this formula before undertaking the tasks, so that they are able to compare their results with the data given on food labels.

  Introduce the formula explaining that 4.2 is the specific heat capacity of water, i.e. the amount of joules (J) required to raise the temperature of 1 gram of water by 1°C.

$$\text{Energy released from food per gram (J)} = \frac{\text{mass of water (g)} \times \text{temperature rise (°C)} \times 4.2}{\text{mass of food sample (g)}}$$

Figure 1: Formula for calculating energy released

- After observing the teacher carrying out the first part of **C1 ACTIVITY 1: FOOD ENERGY**, students can set up their own investigation to find out how much energy is supplied by each of a selection of foods.

NOTE:
Energy in Action is an online schools resource from SEAI.
If you're reading a printout and wish to view this online to access links, visit www.seai.ie/energyinaction

C1 ACTIVITY 1: FOOD ENERGY

Background

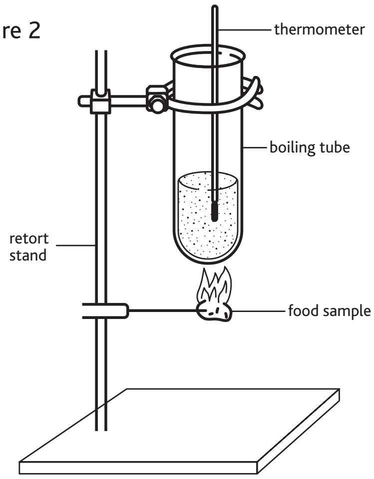
This investigation provides students with a visual and measurable example of how food provides energy. The activity is carried out in two stages; stage one is a teacher-led activity which serves to introduce the concept of burning food to supply sufficient heat energy to cause the temperature of water to rise. Although the activity is carried out by the teacher only, the students are involved through taking various readings and carrying out the calculations involved. This activity is an ideal opportunity for questions to be asked by both the teacher and the students rather than the teacher always being the questioner!

Stage two provides the students with an opportunity to apply what they learned in stage one. This time the students investigate the energy supplied by a selection of food types and compare their calculated energy with the energy information provided on the food labels. A follow-up challenge for the students might be to explain why their calculated results differ from those on the labels.

Equipment required:

- Bunsen burner
- Heatproof mat
- Retort stand with clamp
- Boiling tubes
- Measuring cylinder
- Thermometer
- Mounted needle or similar
- Food sample (i.e. a cracker or a piece of bread)
- Safety goggles
- Electric scales

Figure 2



STAGE 1 – TEACHER ACTIVITY WITH STUDENTS ACTING AS ASSISTANTS

What to do:

1. Ask one student to measure approx. 25 ml cold water into a boiling tube and clamp it onto the retort stand.
2. Assign a group of students the job of calculating the mass of water used.
   (Hint: density of water = 1 g/cm^3 and mass = volume/density)
3. Ask another student to record the temperature of the water in the boiling tube.
4. Ask another student to record the mass of the food sample being investigated.
5. Show the students how to carefully skewer the food sample onto the mounting needle taking care not to lose any crumbs.
   Possible questions:
   - ? ***Why is it important not to lose any crumbs?***
   - ? ***What measurement might be affected if some crumbs are lost?***
6. Now hold the food in the lighted Bunsen burner until it catches fire.
7. As soon as it is alight, place the burning food under the boiling tube as shown in Figure 2 until the flame goes out.
8. As soon as the flame goes out stir the water before reading the temperature.
9. Possible questions:
   - ? ***Why should the water be stirred first?***
   - ? ***How is water heated?***
   - ? ***How might this affect the temperature of the water?***
10. Let one of the students record the highest temperature.
11. Set the class the task of calculating the energy released from the food, using the recorded values and the formula shown in Figure 1.

STAGE 2 – STUDENTS INVESTIGATING THE ENERGY RELEASED BY DIFFERENT FOOD TYPES

Equipment required:

- Bunsen burner
- Heatproof mat
- Retort stand and clamp
- Boiling tubes
- Measuring cylinder
- Thermometer
- Mounted needle or similar
- Selection of food types together with their individual food labels
- Safety goggles
- Electric scales

What to do:

1. Measure approx. 25 ml cold water into the boiling tube and clamp it onto the retort stand.
2. Calculate the mass of water used.
   (Hint: density of water = 1 g/cm^3 and mass = volume/density)
3. Stir and record the temperature of the water in the boiling tube.
4. Record the mass of the food sample being investigated.
5. Carefully skewer the food sample with the mounting needle taking care not to lose any crumbs.
   ? ***Why is it important not to lose any crumbs?***
6. Hold the food in the lighted Bunsen burner until it catches fire.
7. As soon as it is alight, hold it under the boiling tube as shown above until the food flame goes out.
8. As soon as the flame goes out stir the water before reading the temperature.
   ? ***Why is it important to stir the water?***
9. Record the highest temperature reached and log it on the record sheet.
10. Repeat the procedure for the other food samples.
11. Review the data and decide on a suitable graph to draw.
12. Draw the graph and comment on it.
13. Compare the results for the individual food items with the energy information written on the food labels.
    ? ***Is there a discrepancy between the values?***
    ? ***If so, can you offer a possible explanation for this?***

C1.1 WORKSHEET A: FOOD ENERGY RECORD SHEET

	Food Sample Name	Mass (g)	Mass of water (g)	Temp. rise	Energy used = $\frac{\text{mass of water (g) x temperature rise (°C) x 4.2}}{\text{mass of food sample (g)}}$
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Graphing Results

ENERGY IN ACTION
ACTIVITIES FOR JUNIOR CYCLE

C1 ACTIVITY 2: FIRE CLOUDS (A TEACHER DEMONSTRATION ONLY)

Background

This activity is a spectacular demonstration of the energy released from a powder. It provides an early introduction to **variables** that affect **reaction rates** and to the role of **effective surface areas**. Dried milk powder contains **carbohydrates** and **fats** that **release energy on combustion**.

There are two parts to this activity. First, a small pile of the dried milk is burned and secondly a similar quantity is sprinkled onto a glowing splint. The pile will burn slowly as the effective surface area is small, whereas the sprinkled powder has a much greater surface area and so a fire ball effect is created.

Ensure that the activity is carried out behind a safety screen and in compliance with the school's safety procedures. This is not an outdoor activity. Consider that the height from which the powder is sprinkled will determine the height of the resultant fire ball.

This activity can be used to illustrate why chewing food aids digestion, and why some foodstuffs are finely cut before cooking. It also highlights the dangers posed by dust from granary silos, coal mines, paper making factories, etc. It should be mentioned that carefully controlled dust explosions are commonly used by pyrotechnicians, special effects artists, etc.

A safer but less spectacular alternative investigation could be carried out by the students to compare the dissolving rate of jelly crystals to that of gelatine.

Suggested approach:

- Before demonstrating the activity, show the class the two piles of milk powder and tell them that you are going to light one pile as it is but will sprinkle the second pile. Ask them to **predict** the outcome and to **explain** the reasons for their predictions.

Equipment required:

- Safety goggles for each person in the room
- Safety screen
- Approximately 60 g of milk powder
- Measuring spoon (a 5 ml measure)
- Spatula
- Retort stand and clamp
- Bunsen burner
- Heatproof mat
- Metre stick
- A long splint
- Tape or a bulldog clip

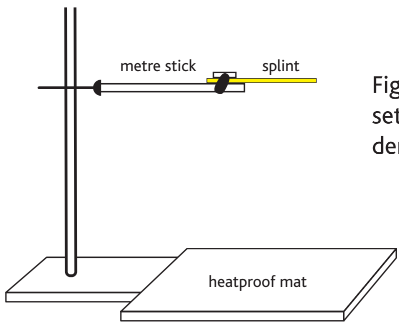


Figure 3: Experimental setup for Fire Clouds demonstration

What to do:

Ensure that all students are behind the safety screen and wearing the safety goggles throughout.

1. Fix a long splint to the end of the metre stick using the tape or clip.
2. Measure about two heaped spoons of the milk powder into a pile on the heatproof mat.
3. Try to ignite it by holding the Bunsen burner to it.
4. Fix a long splint to the end of the metre stick and light it.
5. Clamp the splint on the retort stand so that the splint can burn freely above the heatproof mat as shown in Figure 3.
6. From a height (no greater than the top of the safety screen), sprinkle the milk powder over the burning splint.

   ? ***Can the students explain the difference between the reactions?***

Resources:

- This activity is available on page 17 of Science on Stage 1 & 2. Click here to view it online.

C1 ACTIVITY 2 DISCUSSION POINTS: DUST

1. The **Fire Clouds** activity illustrates the dangers posed by dust from granary silos, coal mines, paper making factories, etc. Having observed and discussed the activity, the topic of dust explosions and their containment can be explored.
2. Students might also research how pyrotechnicians and special effects artists make use of controlled dust explosions.

C2: MY ENERGY AUDIT

Overview

While issues like renewable and non-renewable energy, climate change, and resource efficiency are often investigated in the school context, it does not always follow that the understanding and knowledge gained through these investigations are then applied by the students to areas and situations outside the classroom.

In **My Energy Audit** the students take stock of their personal use of energy. In **C2 ACTIVITY 1: FOOD MILES** students, using online resources, may realise that calculating food miles is a way of personalising the environmental impact of food from crop to table to waste disposal. **C2 ACTIVITY 2: TESTING PERSONAL ENERGY EFFICIENCY** introduces students to the concept of energy efficiency both at home and in school.

This theme of energy efficiency is continued in **C2 ACTIVITY 3: ENERGY LABELS AND APPLIANCES**, where students are given an opportunity to examine a number of aspects of energy labelling, such as the meaning and rationale of energy labels, tracking energy transfers, and calculating the running costs of appliances both at home and in school. This is also an opportunity for students to consider energy efficiency in light of energy conservation.

C2 ACTIVITY 4: ENERGY SANKEYS introduces the students to another way of visualising energy efficiencies. The International Energy Agency (IEA) makes extensive use of Sankey diagrams to depict the energy efficiency levels of member countries.

SEAI's One Good Idea is a challenge to students who, having assessed their own energy usage both at home and in school, are now in a better position to involve their peers in the project and come up with good energy saving ideas.

C2 ACTIVITY 1: FOOD MILES

Background

Students are probably familiar with the phrase 'food miles' but may not be sure what it means, especially in terms of energy and global warming. The term refers to the distance food is transported from the time of its production until it reaches the consumer. This is a factor used when assessing the environmental impact of food, including the impact on global warming. In this activity, the students select a number of food items, source their origins and then calculate the food miles using an online food miles calculator.

What to do:

1. Start with a short brainstorming session to get the students thinking about the weekly shopping basket. Put the following questions to the class:
   - ? ***Who takes part in grocery shopping for their home?***
   - ? ***When choosing food to purchase, are they conscious of the country of origin or does price decide?***
   - ? ***What is meant by the term food miles?***
2. Using **C2.1 WORKSHEET B: WHAT'S THE COST OF YOUR SHOPPING BASKET?** the students can compile their list at home, and verify the origin of the food from the food label. They can then calculate the food miles using the online food miles calculator. This data could prove very useful to them when approaching the One Good Idea project.
3. Set students the task of investigating how many of the products are available nearer home. Then ask them to draw up a list of prices to compare locally available products with long-distance imported ones. It may be appropriate to introduce the ethical aspect of cash crops here. The following link may be useful for research on this issue: http://www.sustainablefood.com/guide/Fairissue.html.

C2.1 WORKSHEET B: WHAT'S THE COST OF YOUR SHOPPING BASKET?

Make a list of food items in an average weekly shopping basket bought by your household. Calculate their food miles using the food miles calculator found at www.foodmiles.com.

FOOD ITEM	COUNTRY OF ORIGIN according to its label	AIR MILES TRAVELLED (km)	ESTIMATED CO_2/CARBON EMISSIONS
e.g. Fairtrade coffee	Brazil	8,650 km	By airplane – 1,935 kg CO_2 or 528 kg carbon emissions
Total air miles travelled/ Total CO_2 emissions of your shopping basket:			

Note: The food miles calculator does not take into account all factors involved in the production of the goods. It only calculates the distance travelled by the item from the country of origin to the country of destination. For instance, it does not consider the energy taken to produce the food, the pollution created, refrigeration level necessary, distance it had to travel from point of harvest to point of packaging, or the distance it travelled to get to your local shop after reaching Ireland.

C2 ACTIVITY 2: TESTING PERSONAL ENERGY EFFICIENCY

Background

This activity introduces students to the concept of energy efficiency in the home and at school, and is good preparation for participation in SEAI's One Good Idea project. The activity encourages students to develop an awareness of their personal energy efficiency profile. By calculating their own carbon footprint, for example, they may come to appreciate how their habits can impact on the environment. The concept of carbon footprints is introduced via the online resource What's your carbon number?, which includes links to carbon calculators as well as to other useful online resources. The self-awareness exercises **C2.2 WORKSHEET C: HOW GOOD IS YOUR ENERGY EFFICIENCY AT HOME?** and **C2.2 WORKSHEET D: HOW GOOD IS YOUR PERSONAL ENERGY EFFICIENCY AT SCHOOL?** provide opportunities for students to critically examine their energy use and identify behaviour changes that would improve their energy efficiency.

What to do:

Introduce the concepts of energy usage and energy saving as follows:

1. Start with a brainstorm about personal energy consumption and collect responses to the following questions:
   - ? ***What does the phrase energy efficient mean?***
   - ? ***What does it mean to be energy efficient?***
   - ? ***Does efficiency refer to appliances or to the way they are used?***
   - ? ***What is the connection between energy use and sustainability?***
   - ? ***What is meant by a carbon footprint?***
2. Introduce students to the concept of carbon footprints, making use of the SEAI's online resource What's your carbon number? which contains links to a carbon footprint calculator and other helpful resources.
3. Distribute the self-auditing sheets **C2.2 WORKSHEET C: HOW GOOD IS YOUR ENERGY EFFICIENCY AT HOME?** and **C2.2 WORKSHEET D: HOW GOOD IS YOUR PERSONAL ENERGY EFFICIENCY AT SCHOOL?** All the instructions are included on the sheets.
4. Following the completion of these activity sheets, scores should be shared to inspire a discussion about the highest and lowest scores. An interesting exercise might be to draw up a graph of all the scores and comment on the resultant shape.
5. Challenge the students to think of other ways they can save or waste energy in their daily routines. Having gathered some suggestions, let the students now measure their carbon footprints before and after they decide on energy saving strategies. The comparison may cause them to revisit their 'energy saving' ideas.
6. In 1990, the Netherlands introduced a tax called the carbon tax. Since then many other countries have introduced this type of tax. In 2010 the Irish Government introduced this tax. In 2012, Australia introduced this tax, but it was repealed in 2014. Rather than explain what this carbon tax is, let the students research the topic. They should then present their arguments for and against carbon tax in the form of posters or a class debate.

Resources:

- For introductory research into carbon tax:
  - ? ***Click here for a simple explanation on how carbon tax is applied here in Ireland.***
  - ? ***Click here for another site explaining carbon tax as applied in Ireland.***
  - ? ***Click here for an interesting article on how carbon tax is applied across the world. There are also links to other articles on the implications of carbon tax.***
- The SEAI website has a great fact-sheet called What's your carbon number? It might be a good way to introduce the concept of carbon footprints to the class.
- The Power of One, Electricity saving tips and four videos on how to save energy at home from SEAI are useful resources to explore with the class after they have done their energy audits.
- Click here for a variety of support material for saving energy at school including fact-sheets and informative videos.

C2.2 WORKSHEET C: HOW GOOD IS YOUR ENERGY EFFICIENCY AT HOME?

Tick the box below which you think best describes your behaviour. Then add up your score and find out whether you are an energy saver or an energy waster.

SCORING METHOD:
Each 'always' = 3 points
Each 'sometimes' = 2 points
Each 'never' = I point

AND WHEN THEY ARE ADDED UP...
If your score is 15 – 21 you are an excellent energy saver!
If your score is 8 – 14 you are not too bad but could do better.
If your score is 0 – 7 you need to change your ways.

	ALWAYS	SOMETIMES	NEVER
When leaving a room which is not in use I switch off the lights.			
I boil the kettle with only the amount of water I need.			
I use a ring on the hob which best fits my pot/pan.			
I switch off the television, video, or computer instead of leaving it on standby when not in use.			
I only turn on the dishwasher when there's a full load.			
I cycle, walk or take the bus to the shops.			
I switch my radiator off when my bedroom's not in use.			
I unplug my mobile when it is fully charged.			
I leave my mobile unplugged overnight.			
I use only CFL bulbs in my bedroom.			

Your score ☐ The class average ☐

C2.2 WORKSHEET D: HOW GOOD IS YOUR PERSONAL ENERGY EFFICIENCY AT SCHOOL?

Tick the box below which you think best describes your behaviour. Then add up your score and find out whether you are an energy saver or an energy waster.

SCORING METHOD:
Each 'always' = 3 points
Each 'sometimes' = 2 points
Each 'never' = I point

AND WHEN THEY ARE ADDED UP…
If your score is 15 – 21 you are an excellent energy saver!
If your score is 8 – 14 you are not too bad but could do better.
If your score is 0 – 7 you need to change your ways.

	ALWAYS	SOMETIMES	NEVER
When leaving a room which is not in use I switch off the lights.			
I use paper towels instead of a hand-dryer.			
I switch off PC screens when I'm not using them.			
I close doors when I'm leaving a room.			
I only turn on the dishwasher (in the laboratory/Home Economics room) when there's a full load.			
I cycle, walk or take the bus to school.			
When entering rooms I open blinds fully.			

Your score ☐ The class average ☐

C2 ACTIVITY 3: ENERGY LABELS AND APPLIANCES

Background

In this activity students examine some aspects of selected appliances. They learn what energy labels are, how to read them, and why not all appliances carry energy labels. Students are taught to interrogate the labels and to look at all aspects of the appliance's energy use. They examine the energy conversions involved in the appliances, calculate their running costs, and consider the connection between energy efficiency and energy conservation. To help to engage students and deepen their understanding, the teacher can set them the task of drawing up simple flow charts.

Suggested approaches:

- With the class, examine the electrical appliances used in the classroom.
  - ? *Do any of them have an energy label?*
  - ? *Which appliances carry an energy label and which ones do not?*
  - ? *Can the students suggest any reasons why some appliances carry labels and others do not?*
  - ? *Where should they look for the energy label?*
  - ? *Do they understand any or all of the information on the label?*
  - ? *Can they find the power rating of the appliance?*
  - ? *Do they know where to look for the power rating?*
  - ? *What is the use of knowing the rating?*
  - ? *Why do we have energy labels?*
  - ? *How might energy labelling contribute to energy conservation?*
- Energy labels rank the energy efficiency of an appliance from A (most efficient) to G (least efficient). Using the sheet labelled **C2.3 WORKSHEET E: DOMESTIC APPLIANCES** ask the students to guess which appliances are legally obliged to carry energy labels and the energy efficiency rating of each appliance. Remind the students to consider whether all the energy is being used solely for the purpose of the appliance, or if there is any loss via heat, sound, or light (for example a washing machine is for washing clothes but also generates noise).
- By way of involving home usage the students can select a number of appliances for inspection at home. Ask them to fill in the first two columns of **C2.3 WORKSHEET G: HOW MUCH DO YOUR HOME APPLIANCES COST?** and bring it into class. They can calculate the cost as a class exercise.
- Challenge the students to list all appliances they can think of that are legally obliged to carry an energy label. At the moment there are 14 categories of domestic appliances but the list is increasing. Click here for an interesting site on energy labelling. Click here for *S.1 No. 351 of 2014 Energy Labelling*, which gives the list of households appliance categories that must be labelled.
- Arrange the students in groups of three. Assign one of the listed items from this energy labelling list to each group and set them the following task:
  - ✓ *Find two versions of the same product on the market, each with a different energy label.*
  - ✓ *Indicate what information is shown on the energy labels.*
  - ✓ *Suggest reasons why two similar products can carry different energy labels.*
- Arrange the students in small groups. Present each group with **C2.3 WORKSHEET E: DOMESTIC APPLIANCES** and assign them one appliance per group along with the following tasks:
  - ✓ *Calculate this appliance's running cost for a given period (e.g. three days, a week, for a family of four over the course of a week...).*
  - ✓ *Draw a flow diagram showing the various energy transfers which take place from the time an appliance is switched on to the time it is switched off. Highlight which energy transfers could be considered 'wasted energy'.*
  - ✓ *Present your findings to the class for discussion and debate on the issues that have been highlighted.*

What to do:

- Decide on a starting approach:
  - ✔ *Introducing energy labels*
  - ✔ *Introducing appliances for calculating energy consumption, then moving onto the subject of energy conversions*
  - ✔ *Introducing appliances for students to track energy transfers*

Resources:

- The SEAI has an online appliance energy cost calculator. This could be used as a resource for helping students to appreciate the energy usage of appliances. Students could each select five appliances and find out how much it would cost to run each one over a ten-year period. They could then use this figure to work out the cost for shorter periods.
- Click here for a number of fact-sheets and videos which aim at supporting the strategic monitoring of energy consumption and emphasising the resulting savings.

C2.3 WORKSHEET E: DOMESTIC APPLIANCES

OVEN
Power rating: 927 W

TV
Power rating: 350 W

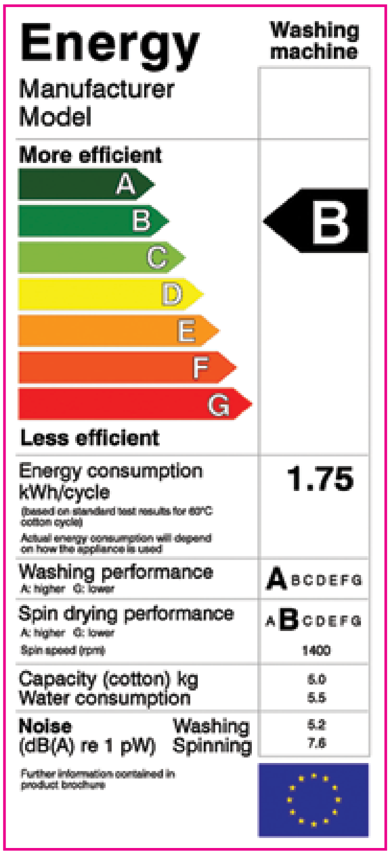
BLENDER
Power rating: 450 W

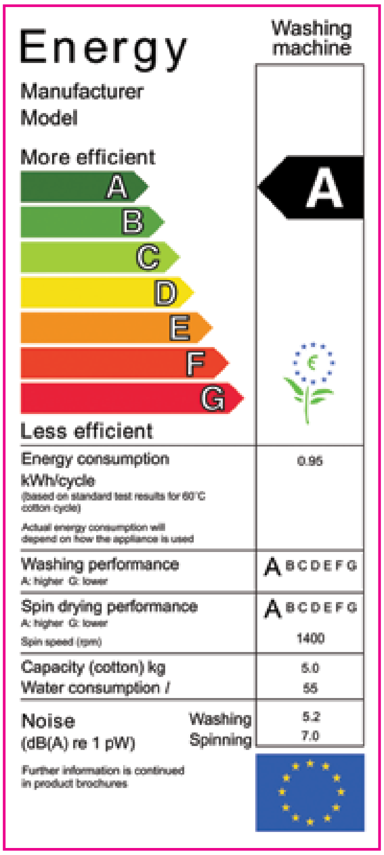
TOASTER
Power rating: 1150 W

VACUUM CLEANER
Power rating: 1700 W

C2.3 WORKSHEET F: ENERGY LABELS

- *On what are these labels found?*
- *Where are they located?*
- *What useful information do they contain?*





C2.3 WORKSHEET G: HOW MUCH DO YOUR HOME APPLIANCES COST?

Name:______________________________ Date:____________________

	APPLIANCE	POWER RATING	COST TO RUN (PER HOUR)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

1. Which appliance requires the most power?

____

____

2. Which appliance requires the least power?

____

3. Can you think of ways to save electricity by using appliances more efficiently?

____

____

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.

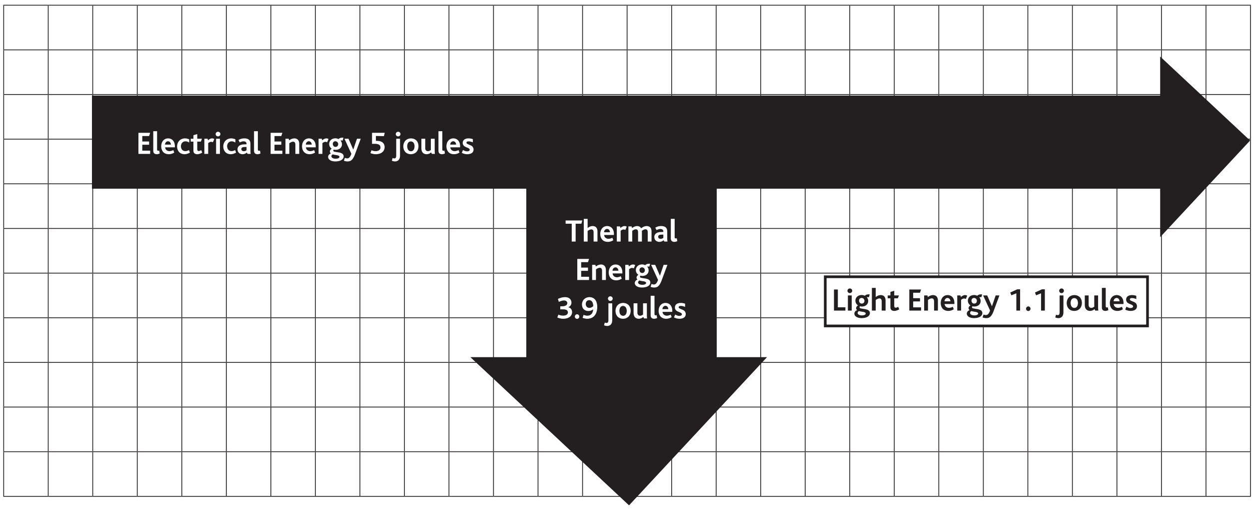


Figure 4

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?*

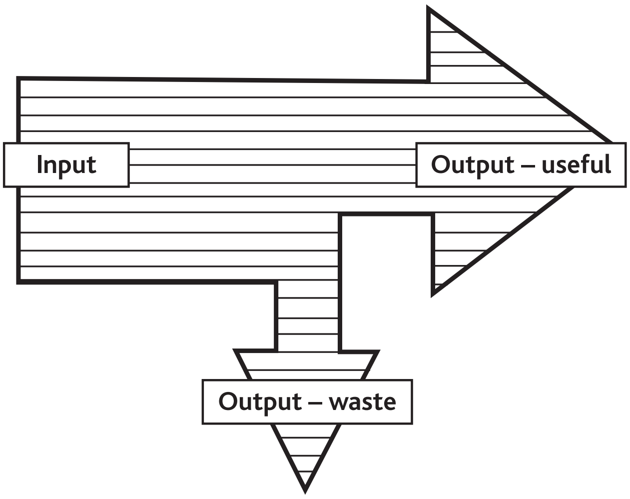


Figure 5

- 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?***

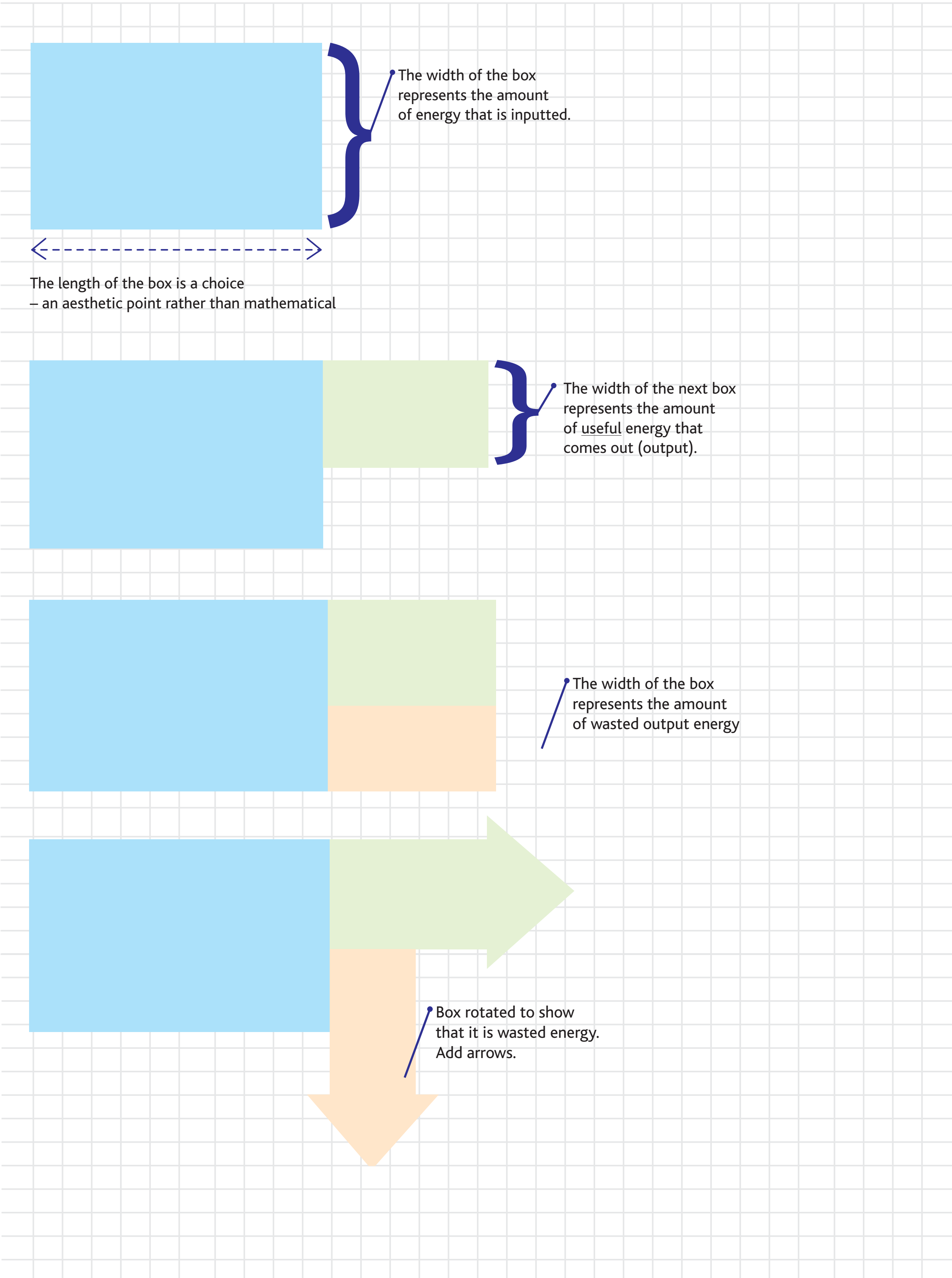
  ? ***What are the consequences of this law, intended or otherwise?***

  ? ***What about catalytic converters – are they efficient or do they simply reduce the emission of noxious gases?***

Resources:

- Click here for more on efficiency from SEAI.
- Click here for an interesting, accessible webpage on the history of the light bulb.

C2 ACTIVITY 4 (I): CONSTRUCTING A SANKEY DIAGRAM



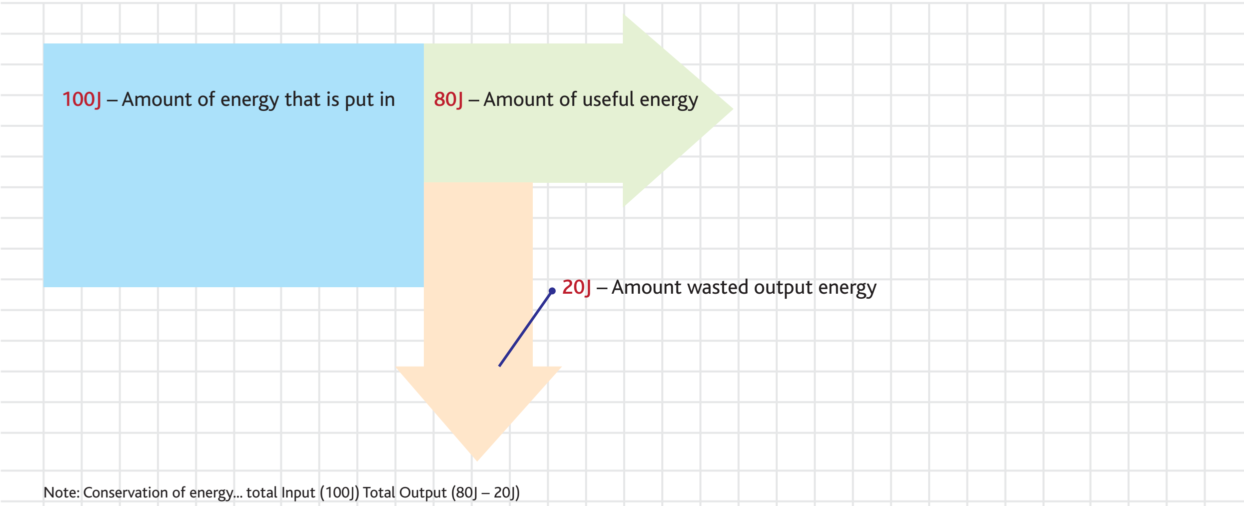
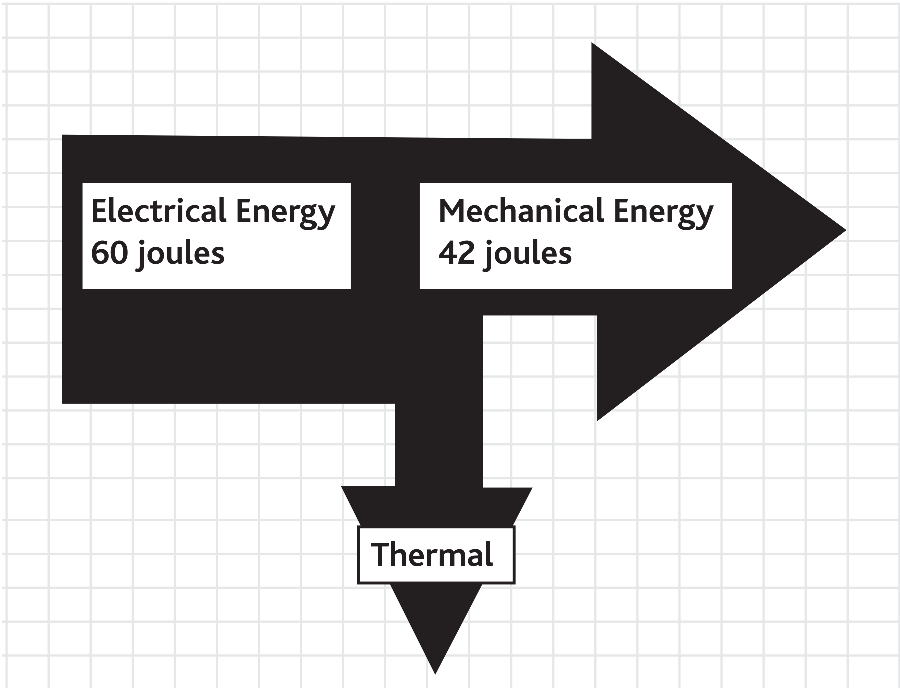


Figure 6 – Examples of Sankey diagrams

C2.4 WORKSHEET H: READING A SANKEY DIAGRAM

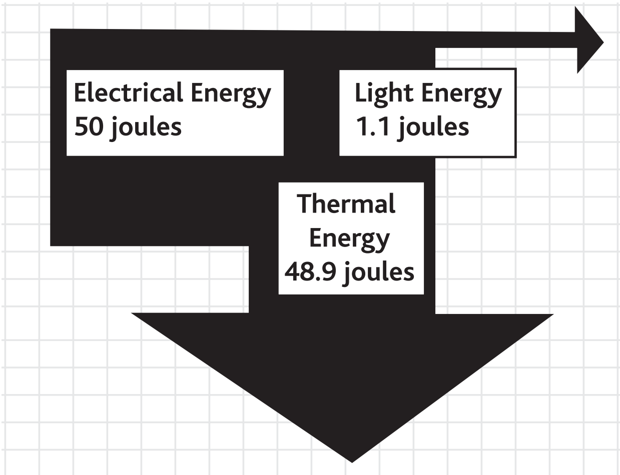


1. How much thermal energy does the motor produce?
   a) 62 joules
   b) 18 joules
   c) 60 joules
   d) 42 joules

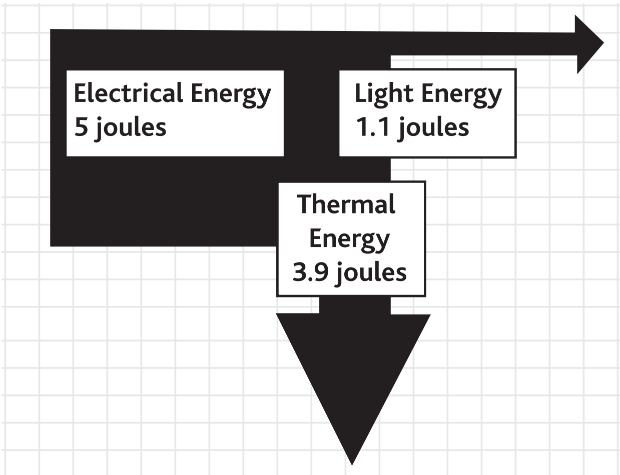
Answer:

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

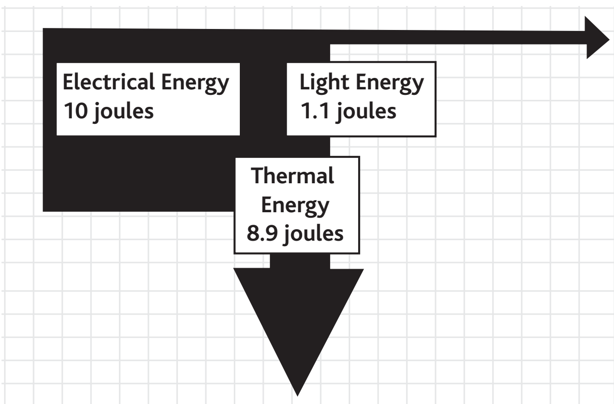
A. Filament Lamp



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?

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6. Explain what the letters CFL represent.

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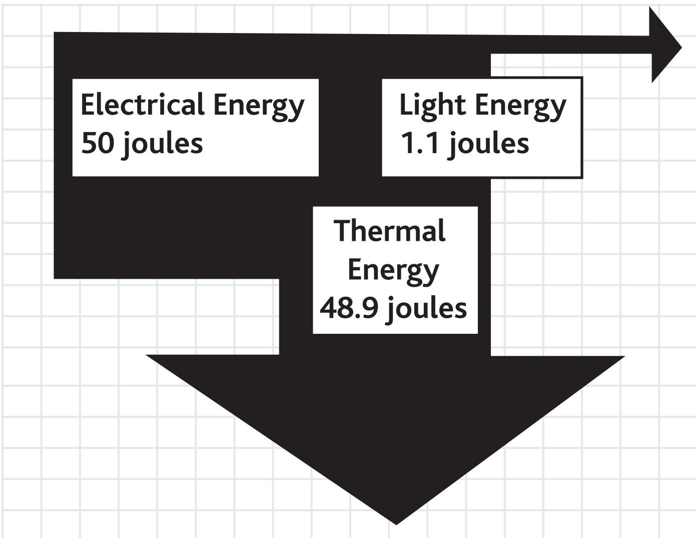
____

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



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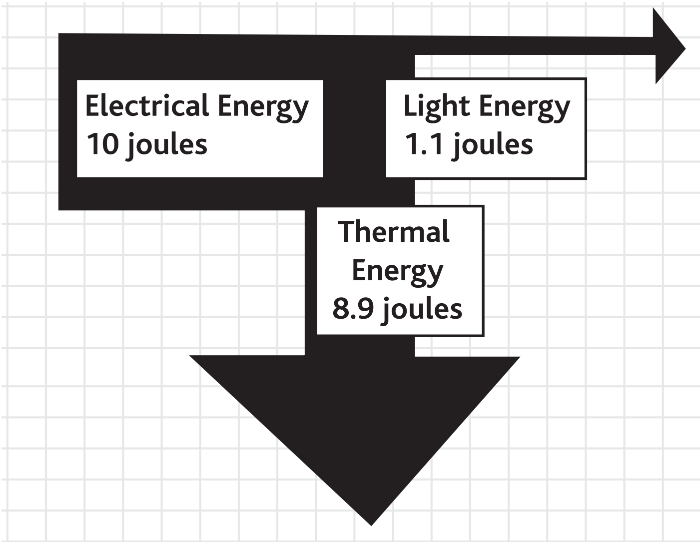
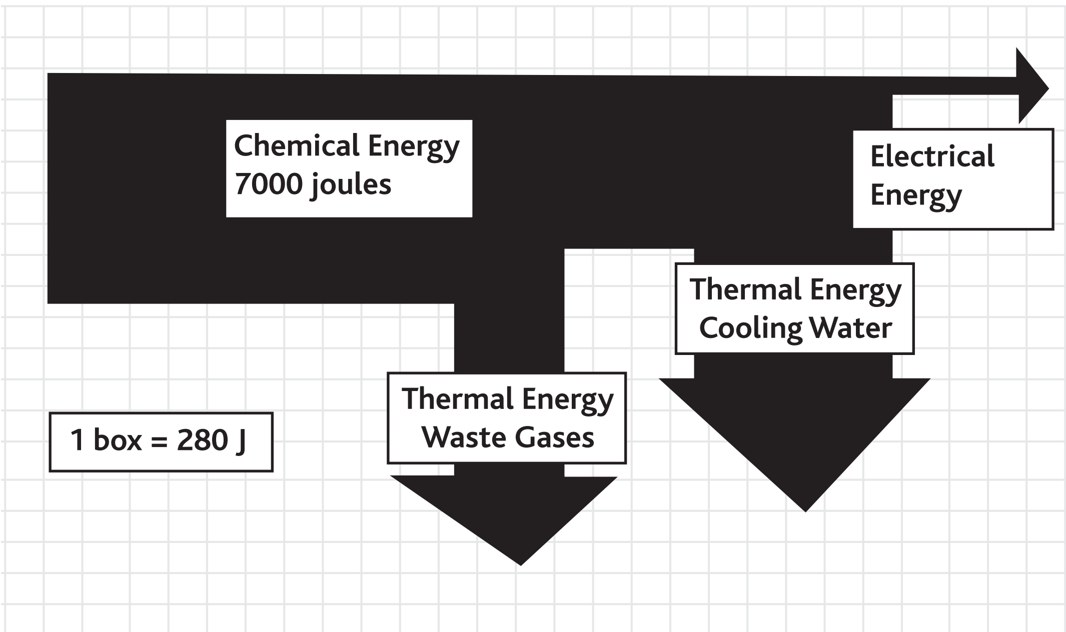
8. What is the efficiency of the CFL lamp in the diagram below? Suggest another phrase instead of 'thermal' which could be substituted and still retain the same meaning.



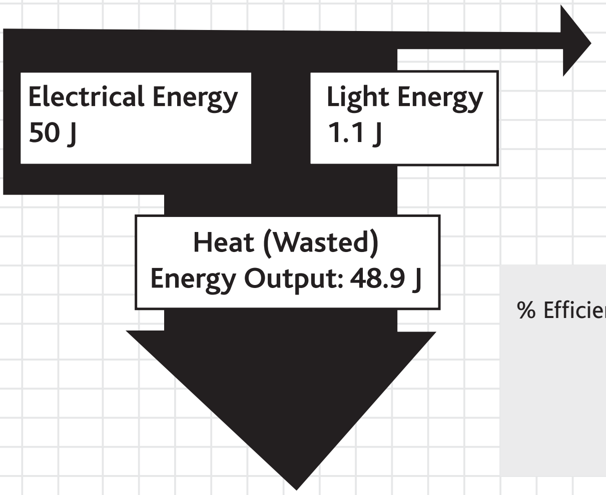
9. How much useful energy is produced by this power station? [Hint: check the scale.]



10. What is the efficiency of this power station?

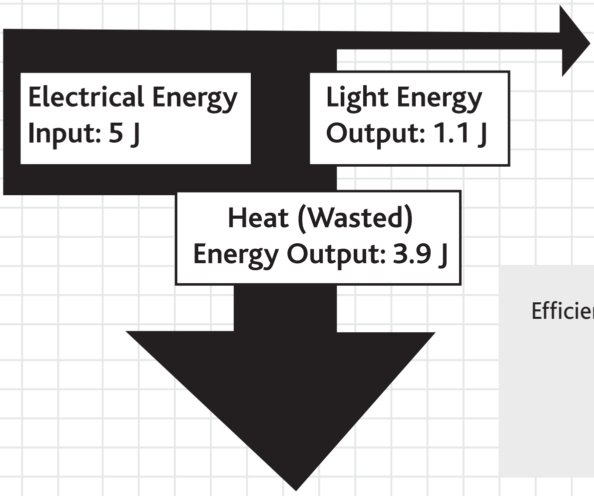
C2 ACTIVITY 4 (II): EXAMPLES OF IN-DEPTH ANALYSIS

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.

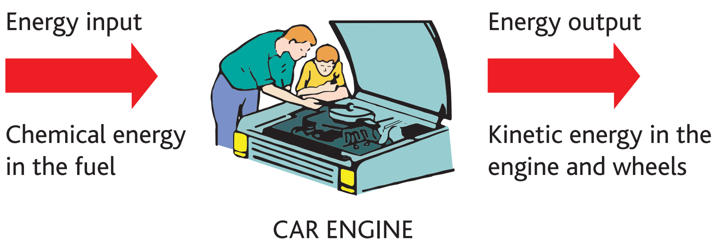


Figure 9: Energy transfer diagram for a car engine

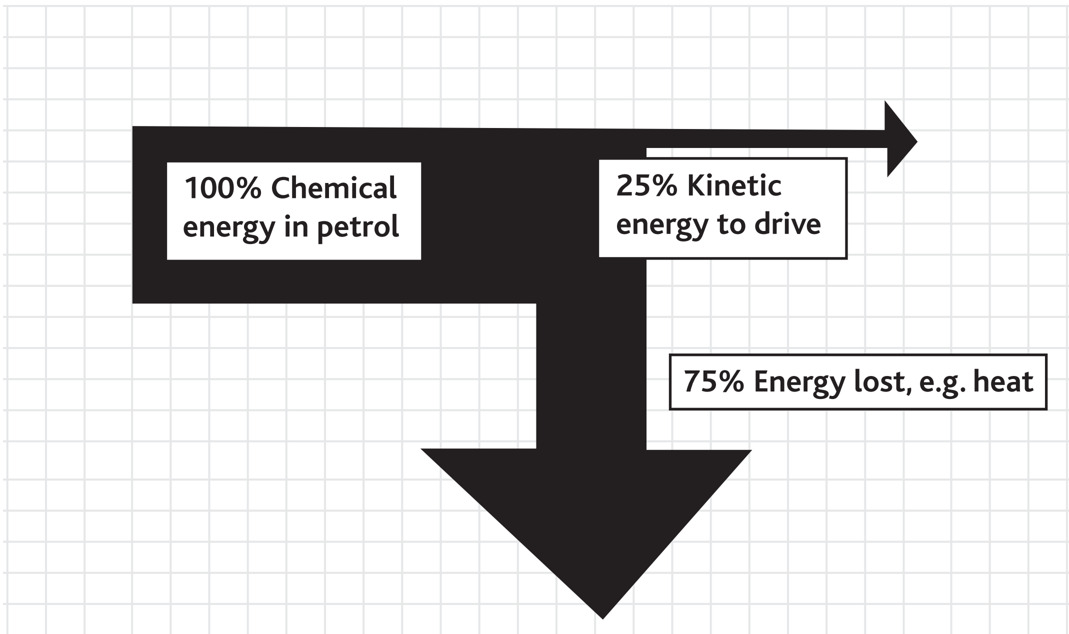


Figure 10: Sankey diagram for a car engine

Power Stations

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

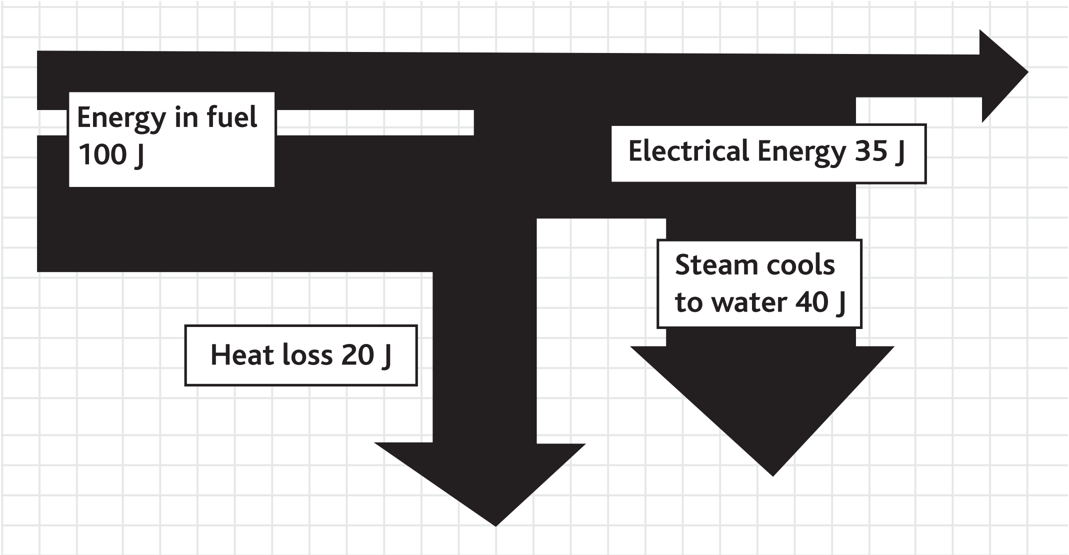


Figure 12: Sankey diagram for a power station

The IEA makes extensive use of Sankey diagrams to illustrate the energy usage of various countries. Click here to see how this is achieved. Click here to check out how the IEA maps Ireland's energy usage.

C2 ACTIVITY 5: ONE GOOD IDEA

Background

In 2010 SEAI introduced the One Good Idea project for post-primary school students. The project aims at encouraging students to examine simple ways that they can contribute to energy efficiency and sustainability. The curriculum-compatibility, wide span and campaign style of the project make it unique amongst educational initiatives in Ireland. The project incorporates a wide range of school subjects and develops important academic and life skills such as researching, creative collaboration, launching a multi-media campaign, and pitching. The great advantage of the project is that students from different academic areas and skill sets work as a team to develop and present their ideas.

Suggested approaches:

- Show the One Good Idea introductory video to the class and use it as a starting point for a brainstorming session.
  THE PROJECT HAS TEN TOPICS FOR THE STUDENTS TO CHOOSE FROM:
  - ***Saving energy at home***
  - ***Saving energy at school***
  - ***Greener travel***
  - ***Climate justice***
  - ***Plant a tree***
  - ***Reduce your food miles***
  - ***Clean green energy***
  - ***What's your carbon number?***
  - ***Greener fashion***
  - ***Saving water saves energy***
- You could take one or two of the project topics and use them for the activities in **C2: MY ENERGY AUDIT**. This might highlight some of the problems in these areas and students could be challenged to contribute to a better outcome.
- Challenge the class to present you with 'Dragon's Den style' proposals to convince you to choose their ideas.
  USE THE FOLLOWING RULES:
  - ***Groups must use one of the set topics;***
  - ***There is a three-minute time limit on the presentation.***

  Once students have a feel for the project style then they can examine the project stages in more depth on the SEAI website.
- Although reaching these stages depends on a group being successful in the preliminary steps, knowing the overall expectation is often a great motivation for the students, and helps to get some momentum going from the start.

The Project Stages

1. **Proposal:** Students decide on **one idea** related to one of the ten specified topics, and a **target group** (primary school children, their peers, adults, wider community, clubs, associations, etc.). It is important that their idea ties in with the topic, and thorough **research** should be done at this stage. The next step is to come up with an **innovative way** to **communicate** their **One Good Idea** to their audience.
2. **Campaign:** Here students plan a type of **press campaign** using **print** or **visual media**. They could **design** posters, leaflets and creative merchandise, **write** press releases, poems or songs, **perform** sketches or **make** promotional videos.
3. **Pitch:** Students present their **One Good Idea** in a Dragon's Den style, but using video, rather than in person – a type of one-way video conferencing. This stage enables the students to hone their video-making skills.
4. **Present:** In this final stage the group presents their **One Good Idea** in person. The group will now have the opportunity to **showcase** their work throughout all the stages.

Resources:

SEAI has a wealth of information, suggestions, videos and fact-sheets to support students through the One Good Idea project.

- Click here for general information about One Good Idea for secondary schools.
- Click here for research advice.
- Click here to view winning One Good Idea campaigns.
- Click here for details of what each project stage involves, as well as useful tips for creating a successful campaign.

C3: GLOBAL WARMING

Overview

The Earth's atmosphere is our protective layer, shielding us from harmful cosmic rays as well as helping to maintain a relatively safe environment for us to live in.

In the 19th century scientist John Dalton worked out that this protective layer was composed of various gases, principally nitrogen and oxygen. In 1896 the Swedish chemist Svante Arrhenius introduced his theory of 'greenhouse' warming but at that time the greenhouse effect was not considered a threat to life. Since then a variety of studies have shown that our atmosphere is composed of carbon dioxide, water vapour, methane, sulphur dioxide, ozone and various oxides of nitrogen. These gases absorb heat energy from Earth and so contribute to heating the atmosphere, creating knock-on effects on the global temperature.

The industrial revolution relied heavily on the burning of fossil fuels for energy, and this led to an increase of gases in the atmosphere, particularly carbon dioxide. Carbon dioxide is also emitted as part of the respiration process. There is a delicate balance between the emission of this gas and its re-absorption into nature. However, overabundance of this gas is one of the factors contributing to our changing climate and the overall rise in global temperature.

Today there is much debate about global warming or climate change. There are some who still believe global warming to be just another theory, and others who think that immediate change is needed to stop it from threatening our survival. The problem is that the effects of global warming develop over an extended period and so the damage to the ecosystem is not immediately obvious.

C3 ACTIVITY 1: GLOBAL WARMING IN A BOTTLE is a small scale investigation of the effect of an overabundance of carbon dioxide.

One of the consequences of global warming is the increase in sea levels. The second activity, **C3 ACTIVITY 2: THE EFFECT OF GLOBAL WARMING ON THE POLAR ICE CAPS AND MELTING GLACIERS**, looks at two simple models to assess what happens when an iceberg in the sea melts and when an ice mass melts into the sea.

Suggested approaches:

- Ask the students to list the sources of carbon dioxide:
  - ✓ *Respiration of all living organisms*
  - ✓ *Plants using it as part of the photosynthesis process*
  - ✓ *Burning of fossil fuels in homes*
  - ✓ *Factory emissions*
  - ✓ *Transport emissions*

Prompt the students to consider the importance of the rain forests and the global consequences of depleting these areas.

- **STRAND A: ENERGY AND SUSTAINABILITY** looks at how we manage our energy resources. Now consider the consequences of mismanaging them. This is a great opportunity for the students to enhance their research and debating skills by examining the various treaties relating to climate change:
  - ? *Were there successful outcomes?*
  - ? *Which countries were signatories and which were not?*
  - ? *What reasons may have been given for an inability to comply with the proposed recommendations?*

Resources:

- The United Nations website focuses on all aspects of climate change.
- The Center for Climate and Energy Solutions website looks at climate change and energy demands.
- Click here for an overview of the main issues relating to climate change.
- Click here to view the Environmental Protection Agency (EPA) website which contains a wealth of excellent source material pitched at a local level, as well as a number of short videos explaining the various challenges to environmental protection.

C3 ACTIVITY 1: GLOBAL WARMING IN A BOTTLE

Background

Carbon dioxide (CO_2) is one of a number of gases that contribute to **global warming**. In this activity, students mimic the global warming effect by creating high levels of CO_2 in a bottle. This demonstrates the heating consequences of CO_2.

Equipment required (per group):

- Two large, clear plastic fizzy drinks bottles
- Alka-Seltzer tablets (or similar)
- Beaker with water
- One heating lamp (or similar)
- Two thermometers (digital thermometers give better results)
- A CD pen or other marker suitable for writing on the bottles

Suggested approaches:

- This investigation can be used as a starting point for a discussion on global warming or the carbon cycle among other topics. Before beginning, contextualise the learning with a short introductory discussion on **greenhouse gases, global warming** and their **consequences**.
- As the temperature rise is gradual, it is best if each group is given a different number of tablets.
- It is not imperative for the students to have prepared CO_2 in the laboratory before taking part in this activity. It is enough to explain to them that the effervescence indicates the release of CO_2.

What to do:

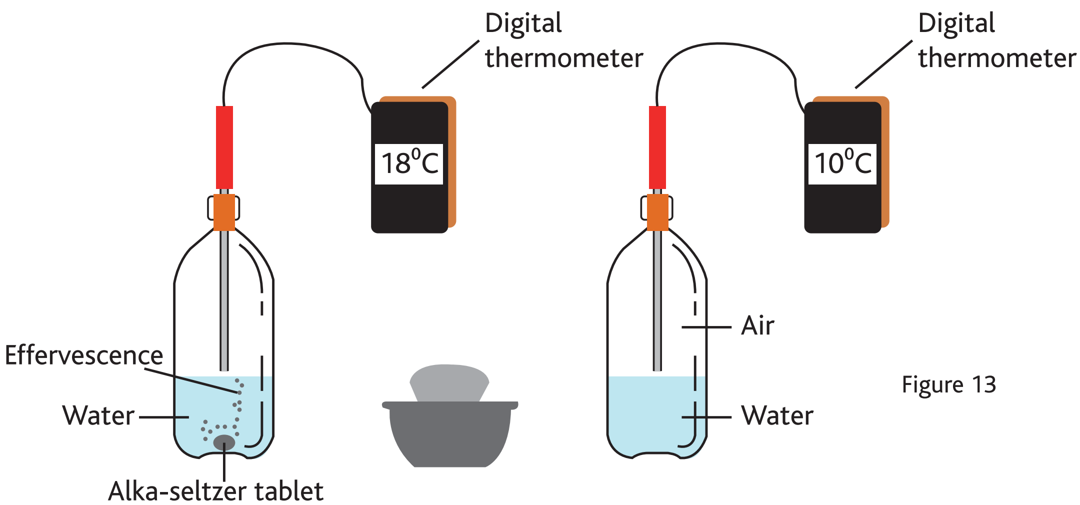


Figure 13

1. Set up the bottles as shown in Figure 13. Put equal quantities of water into each bottle (about ⅓ l).
2. Take the initial temperature of both bottles and record them.
3. Uncap one of the bottles, drop the Alka-Seltzer tablets into it and re-cap it.
4. Place both bottles at equal distances from the heater and switch it on.
5. Monitor the temperature of both bottles within an agreed time.
6. Compare your results with those of the other groups.

   ? ***Are there differences in results?***

   ? ***Why might this be?***

C3 ACTIVITY 2: THE EFFECT OF GLOBAL WARMING ON THE POLAR ICE CAPS AND MELTING GLACIERS

Background

This activity looks at how global warming affects sea levels, by looking at the difference between floating icebergs and the ice-covered landmasses of Greenland and Antarctica. Melting icebergs, no matter how large, will not result in increased sea levels, whereas chunks of ice landmass breaking (calving) from Antarctica, or melting glaciers from Greenland, will.

This activity mimics the effects of ice(bergs) melting in the waters of the oceans and ice (landmass-glaciers) melting into the surrounding oceans. The students will probably be surprised to discover that an ice(berg) melting does not contribute to a rise in water levels, whereas the ice (landmass-glaciers) melting into the water does.

Equipment required (per group):

- A drinking glass (any size)
- Two wide, transparent containers (A and B shown in Figure 14)
- Ice cubes
- Film canister (or similar) weighted with ballast, sand, small nails or pebbles, to ensure it doesn't float (D shown in Figure 14)
- Small plastic container (C shown in Figure 14)
- Marker
- Mounting needle
- Tea light
- Matches
- Water
- Salt (optional)

Suggested approaches:

- This is an ideal activity to set up at the start of the class, leave aside, and revisit later when all the ice has melted.
- Some of the groups could decide to add salt while other groups do not. At the end the groups can compare results and see if using salt water results in a marked difference from using fresh water.
- After carrying out this activity, you could present the students with an extra challenge. Place some ice cubes in a glass and fill it up to the brim. Ask the students to predict what will happen when the ice cubes melt in this container:
  - ? ***Will the water overflow?***
  - ? ***Will there be no change?***
  - ? ***Will the water level drop in the glass?***
- If possible, take a photo of this setup for comparison between the water levels now, and later, when the ice cubes have melted.
- While waiting for the ice to melt, facilitate a discussion or a brainstorming session about climate change.

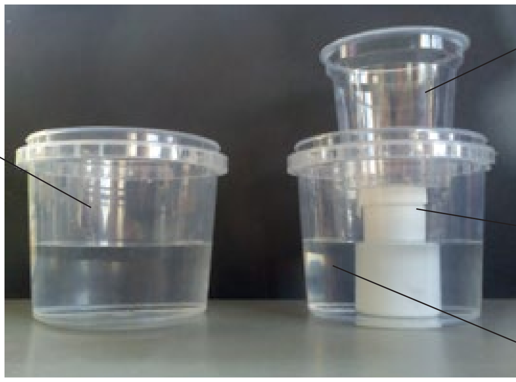


Figure 14

Suggested approaches:

- This is an ideal activity to set up at the start of the class, leave aside, and revisit later when all the ice has melted.
- Some of the groups could decide to add salt while other groups do not. At the end the groups can compare results and see if using salt water results in a marked difference from using fresh water.
- After carrying out this activity, you could present the students with an extra challenge. Place some ice cubes in a glass and fill it up to the brim. Ask the students to predict what will happen when the ice cubes melt in this container:
  - ? ***Will the water overflow?***
  - ? ***Will there be no change?***
  - ? ***Will the water level drop in the glass?***
- If possible, take a photo of this setup for comparison between the water levels now, and later, when the ice cubes have melted.
- While waiting for the ice to melt, facilitate a discussion or a brainstorming session about climate change.

What to do:

Preparing the equipment: Heat the mounted needle with the flame from the tea light. Make several holes in the base of container C to make it behave like a sieve.

1. Pour equal quantities of water into containers A and B. You can add salt to make salt water (but this does not change the outcome).
   - ✓ ***Explain to the class that containers A and B represent the sea.***
2. Stand item D, the weighted film canister, in container B. Make sure it does not float.
   - ✓ ***Explain to the class that D represents a landmass surrounded by sea.***
3. Mark the water level in container B.
   - ✓ ***Explain to the class that you are marking the sea level.***
4. Put some ice cubes into container A, making sure they float (i.e. make sure they are not touching the bottom).
   - ✓ ***Explain to the class that the ice cubes represent floating icebergs.***
5. Mark the water level in container A.
   - ✓ ***Explain to the class that you are marking the sea level.***
6. Put the same quantity of ice cubes into container C and place it onto D.
   - ✓ ***Explain to the class that container C with the ice cubes on it, represents the frozen ice caps of the Antarctic or Greenland.***
   - ✓ ***Ask the students to predict what will happen when the ice cubes in container A melt, and when the ice cubes in container C melt.***
7. This setup can be left aside and revisited when all the ice cubes have melted. If possible leave it in a relatively warm place to mimic global warming.