Junior Certificate Science

Introduction

The units of work developed for the Junior Certificate Science section of this website were chosen to reflect just some of the areas where Energy links to the subject. There are many areas of the Science Curriculum that link to Energy, so many in fact that Energy could be considered the underlying theme throughout, but too many to be included here at this stage.

The chosen Units of work cover the applications of Energy to sections of physics in the Units 1 Heat and 2 Electricity. Unit 3 Food & Ecology applies to the Biology section of the curriculum and Unit 4 Climate Change, to Earth Science.

Materials developed include some background information on the topic, with suggested web links for more details, and a number of activities. Activities require no complicated or specialist materials. There are experiments, information gathering exercises (for home or in class), worksheets, puzzles, and problem solving challenges.

Each Unit includes printable datasheets which can be copied and used to record results. Questions at the bottom of the datasheets can later be used for evaluation of understanding.

Junior Certificate

Unit 1 Heat - An introduction to heat and temperature	**Unit 2 Electricity –** An introduction to electricity	**Unit 3 Food & Ecology –** An introduction to energy in food	**Unit 4 Climate Change –** An introduction to the Greenhouse Effect and Climate Change

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Unit 1 - Heat

This unit explains the principles of heat and temperature, and includes simple experiments which compare the insulating abilities of a variety of materials. It includes background reading which introduces the concepts tested in;

Activity 1 Temperature worksheet

Activity 2 Keeping Heat In – an investigation

Activity 2 datasheet

Activity 3 Keeping Heat Out – an investigation

Background – An Introduction to heat and temperature

What is heat?
Heat is a form of energy. When something is heated, its molecules are given more energy and so they move around a bit more. The molecules knock off each other, moving further apart which generally makes the substance expand. Heat is measured in Joules (J) or kilojoules (kJ).

What is temperature?
Temperature and heat are not the same. Temperature tells us what level of heat is in something. Temperature is measured in degrees. For this unit, we will use the Celsius scale (°C), so we will talk about degrees Celsius. Fixed points on this scale are the freezing point of water, 0°C and the boiling point of water, 100°C. Normal body temperature is around 37°C.

What is insulation?
When it's cold outside we wear heavier clothes and more of them. At night when we sleep, we cover up with a blanket. On hotwater tanks, many homes have lagging jackets. In these situations, clothes, blankets and lagging jackets provide insulation, helping keep heat trapped for longer. Insulators are materials which don't let heat pass through very easily. It is difficult for heat to pass through insulators, or insulation materials. Having good insulation in our homes means less heat loss so it takes less energy to heat rooms and water.

What is heat transfer?
Heat moves from an area of high temperature to an area of low temperature, until both areas are the same temperature. For example, if you pour warm water over ice-cubes, heat flows from the water to the ice. The ice melts, and the water is cooler than before. What has happened is that the water lost heat and the ice gained heat until both mixed and were the same temperature. Heat can be transferred in three ways; conduction, convection and radiation.

Unit 1 - Heat

Activity 1- Temperature Worksheet

Fill in the blanks:

Here is a thermometer. It measures temperature, in ________ Celsius, which indicates the ________ of heat in a body or substance.

Assign the following temperatures correctly
37°C, 20°C, 100°C, -10°C, 0°C

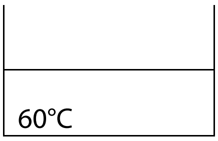
Boiling Water	____________
Ice	____________
Normal body temperature	____________
Room temperature	____________
Freezer	____________

Which has more heat? A or B

a)

b)

a)



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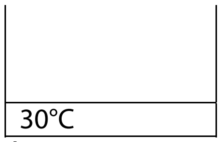

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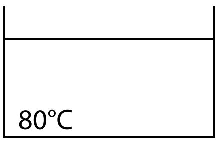

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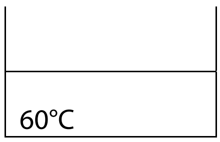

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Unit 1 - Heat

Activity 2- Keeping Heat In- an investigation

Aim To investigate the insulating properties of different materials.

What you need

Soft drink cans x 4, Celsius thermometer, 3 different insulating materials (cotton-wool, newspaper, Styrofoam, bubble-wrap, rubber hands), hot/boiling water, funnel, watch or timer to time minutes

What to do

1. Prepare 3 cans by wrapping them with different materials. Secure material around the cans with rubber bands (see sample). Cover nearly all surfaces of the can, but be sure to leave an opening at the top for the funnel. If using Styrofoam, place can into a tightly fitting Styrofoam container.

2. Leave 1 can unwrapped as a control.

3. Using the funnel, pour hot water into each can and immediately note temperature of the water (Be careful not to spill any water on the insulating material)

4. Take temperature every minute for 20 minutes, or until water reaches room temperature.

5. Use the datasheet to note results

6. Draw a graph to represent results. Plot temperature (°C) on the Y-axis, time (minutes and seconds) on the X-axis, and use a different colour to draw a line for each material.

What's happening?

When the hot water is poured into the cans, heat immediately begins to be transferred from the can to the surrounding air, because the surrounding air is a lower temperature. Remember heat moves from higher temperature to lower temperature. The insulating materials around the cans help block the flow of heat from the can and so keep the water warmer for longer. The best insulating material is the one on the can which keeps its water warmest for the longest time.

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Unit 1 - Heat

Activity 2- Keeping Heat In- Datasheet

Name: ________________________ Date: ________________________

Can 1		Can 2		Can 3		Can 4	
Control		**Material:**		**Material:**		**Material:**	
Mins	Temp	Mins	Temp	Mins	Temp	Mins	Temp
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Which can kept the water warmest for longest? ______________________________

Which is the best insulator? ____

And the worst? ____

Did the results turn out how you thought they would? ________________________

____

What do your results tell you about how to keep things warm? __________________

____

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Unit 1 - Heat

Activity 3- Keeping Heat Out- an investigation

Aim To investigate the insulating properties of different materials.

What you need

Ice-cubes, clear plastic sandwich bags x 4, insulating materials (cotton-wool, Styrofoam, newspaper, bubble-wrap, tin-foil).

What to do

1. Prepare 3 plastic bags by wrapping with different insulating materials, do not seal them.
2. Leave 1 bag unwrapped as a control.
3. Place 2 ice-cubes in each bag and seal.
4. Tim how long it takes for the ice-cubes to melt. Check if it's melted by touch.
5. Note your results.

What's happening?

Heat moves from the air surrounding the bags through the bags. The air is a higher temperature than the temperature of the ice cubes. Different materials keep heat out better than others so the ice-cubes in the 3 bags melt at different rates.

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Unit 2 - Electricity

This unit explains what electricity is, where it comes from, what we mean by "energy efficiency" and includes activities that measure electricity use at home and in school. The background reading introduces the concepts tested in;

- Activity 1 - Test your personal energy efficiency rating
- Activity 2 - Power survey of household appliances
- Activity 2 datasheet
- Activity 3 - Collecting data on school electricity use from old bills
- Activity 3 datasheet

Background – An introduction to electricity

What is electricity?

Electricity is a form of energy. Electricity is a lot of electrons flowing in a current. We call this an electrical current. Electricity is so useful because it can be easily converted to other types of energy. Take for example, your television set – in this electrical appliance, electrical energy is converted into light energy and sound energy.

Where does electricity come from?

The power needed to produce electricity comes from many different sources e.g. Coal, peat, wind and water. These sources are used to power turbines and generators. These turbines spin around to cause a build up of electrical charge in a generator which makes an electrical current flow. Turbines are powered by renewable or non-renewable sources of energy. Non-renewable sources of energy are called fossil fuels and include coal, oil, gas and peat. They are burned to heat water for steam powered turbines. Burning fossil fuels releases gases which harm environment.

Wind, hydro, solar and biomass are all sources of renewable energy. The blades in a wind turbine turn a generator to produce electricity. Renewable sources of energy are by far the better option but provide just 6% of the total installed electrical capacity and 2% of all energy required in Ireland. The rest, 92% of our electricity comes from burning fossil fuels.

What do we mean by "energy efficiency"?

Energy efficiency means not wasting energy. It refers to appliances, buildings and even to human behaviour! If you are only making one cup of tea but your boil a full kettle of water, that's not very efficient is it? Energy is waster in heating more water than is needed. Appliances also waste electricity. They always take in more energy tan gets put to good use. For example, a television converts electricity into light and sound energy, which is great, but some also gets converted into heat, which is a waster. No energy conversion process is 100% efficient but the more efficient the process, the less energy is wasted.

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Unit 2 - Electricity

Activity 1- Test your personal energy efficiency rating

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

	Please tick as appropriate		
	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			
I don't leave the television, video, or computer on standby mode when not using them.			
I only turn on the dishwasher when there's a full load.			
I cycle, walk or take the bus to school or to the shops near my house.			
I don't leave my radiator on when my bedroom's not in use.			

How to add up your scores:
Have you ticked a box for each statement? Okay, then give yourself 3 points for "always", 2 points for "sometimes" and 1 point for "never". Add up your points and see what they reveal about you.

What do the scores mean?
15-21 You are a super energy saver, keep up the good work!
8-14 You're not bad at saving energy but could do better.
0-7 You are a total energy waster and need to change your ways!

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Unit 2 – Electricity

Activity 2- Power survey of household appliances

Aim To investigate power consumption of household appliances

What you Need Access to household appliances

Useful Tip

The amount of electricity something needs to work is its power consumption. Power is measured in kilowatts (kW) and electricity use is measured in kilowatt hours (kWh). Kilowatt hours measure how fast electricity is used.

Some appliances need more power than others. For example, a small radio left on for one hour would use very little power compared to an electric heater left on for the same time.

Caution Be sure that appliances are not connected to the mains electricity supply (plugged in) before moving them or lifting them.

What to do

1. Take a look at different electrical appliances, make sure that they are disconnected from the mains.
2. Find an information label on the appliance. Note its power consumption which is the amount of watts or kilowatts the appliance needs to work for one hour
3. Use the datasheet provided to collect your data and answer the questions
4. look at the examples below

Activity 2- Examples

Here are some examples of appliances and their power consumption:

- Lightbulb 60 w
- Heater 2 kw
- Radio 100 w
- Oven 3 kw
- Toaster 800 w

As you will see, some appliances such as ovens and heaters need more power than others.

Overuse of these appliances can really push up electricity bills.

Unit 2 – Electricity

Activity 2- Power survey of household appliances - Datasheet

Name: ______________________ Date: ______________________

	Appliance	Power Consumption
1	Toaster	800W (or 0.8W)
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Which appliance needs the most power?

____

Which appliance needs the least?

____

Can you think of ways to save electricity by using appliances more efficiently? List three:

1. ____
2. ____
3. ____

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Unit 2 - Electricity

Activity 3 - Collecting data on school electricity use from old bills

Aim To monitor school electricity use.

What you Need Old electricity bills

Useful Tip
Electricity use varies a lot during the year. This activity monitors electricity use and investigates changes over time. It is best done by taking a look at old bills that is if you are lucky enough to have good record keepers in your school to show them to you.

Bills are issued by only every two months so for this activity to work best, you should have at least three bills covering the past 6 months. If you have bills covering a whole school year that's even better. If not, you might want to collect them from the start of the school year and do this activity in the spring.

What to do

1. Gather together as many electricity bills as you can. It is best if they cover a full school year, but even if they cover a six month period, that's okay.

2. Fill in the table on the datasheet. Fill in the billing period, months, and the meter readings from your bill, which will be given as "present" and "previous". Then subtract previous from present to get how many "units" were used in that time.

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Unit 2 - Electricity

Activity 3- Collecting data on school electricity use from old bills- Datasheet

Aim: To monitor school electricity use

Name: ______________________ Date: ______________________

Sample data:

Billing period	Present	Previous	Units
6 Jun – 10 Aug	99675	98866	809

Billing period	Present	Previous	Units

To compare the amount of electricity used over the year, make a histogram chart plotting months on the x-axis and the number of units used on the y-axis. Now answer the following questions:

1. Which period had the highest electricity use?

____

2. Which period had the lowest electricity use?

____

3. What was the average two-month period electricity use?

____

4. Explain why you think more electricity is needed at certain times?

____

____

5. Are there any times during the school year when very little electricity is needed? What are they?

____

____

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Unit 3 – Food and Ecology

This unit looks at energy flow in nature, how much energy is available in different foods, and the energy costs involved in some modern food production processes. The background reading introduces the concepts tested in:

- Activity 1 - Investigation of stored energy in food
- Activity 1 Datasheet
- Activity 2 - "Energy costs" of food products
- Activity 2 Datasheet

Background – An introduction to energy in food

Remember that energy is the ability to do work? Well think how much work your body must do to keep you alive an healthy. It takes energy to allow you to move, think, dance… it even takes energy for you to sleep because your body keeps all your systems working while you rest.

Where does this energy come from?

- All energy comes first and foremost from the sun. Remember the law of conservation of energy? "Energy cannot be created or destroyed, it can only change from one form to another". This means that the energy going into an ecosystem from the sun is the only energy available to drive and support all living things which are there.

- Green plants, algae and some micro-organisms trap a small amount of the sun's energy when it hits earth. They do this by photosynthesis. This means plants can make their own food by changing light energy to chemical energy.

- Animals, including humans, cannot make their own food so they must eat plants and vegetables and also other animals to get their energy. Animals release the energy from food by respiration. The relationships between organisms and their food sources can be demonstrated by food chains and food webs. A food web represents energy flow in ecosystem.

How is energy stored in food?

Different foods have different amounts of energy stored in them. The energy food you're your body likes most is carbohydrates. Starch and sugar are types of carbohydrates, so foods such as bread would contain lots of energy. There is also lots of energy in fat, but this is released more slowly into the body and too much is not very good for you. To get energy from food, your body breaks down carbohydrates to the simple sugar glucose.

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Unit 3 – Food and Ecology

Activity 1- Investigation of stored energy in food

Aim To investigate amounts of stored energy in different foods

What you need

Lots of different packaged food items (or just the wrappers and labels)

Useful tip

You can find out how much energy is in different foods by checking the label. Energy in foods is usually measured in kilocalories (kC), or kilojoules (kJ) per 100 gram.

What to do

1. Take a look at the packaging on different foods.
2. Make a list of the foods and record the amount of energy contained in each. This will be given in something like kilocalories (kC) or kilojoules (kJ) per 100g or per serving
3. Try to make your data comparable by using the same units of energy and volume. If this is not possible, just note the information you are given and make the necessary conversions. 1 kC is about the same as 4.2 kJ.
4. Try to get all your results in "kJ per 100g or kJ per 100ml"
5. Use the datasheet to record your results and don't forget to answer the questions at the end. To get you started, there are 3 examples filled in.

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Unit 3 – Food and Ecology

Activity 1- Investigation of stored energy in food – Datasheet

Name: ______________________ Date: ______________________

Food	Energy	Unit/Volume	Conversion (if necessary)
Bread	895	kJ/100g	
Orange drink	296	kJ/100ml	
Crackers	305	kC/100g	=(305 x 4.2) =1281kJ/100g

1. Which food contains the most energy?

____

2. Which food contains the least energy?

____

3. Not all foods with lots of energy are good for you. Why is this?

____

4. What happens when people eat foods with more energy than their body needs?

____

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Unit 3 – Food and Ecology

Activity 2- Investigating the energy costs of food

Aim To trace the energy used in bringing different foods from where they are produced to where we eat them.

What to do

1. Choose three different foods and put them as headings in the columns in the datasheet provided

2. Think about where the foods came from and different main ingredients they contain. How many stages of transport, processing and packaging did they go through before arriving at the shop or supermarket for you to purchase? Remember, at every stage work was done so energy was required.

3. List as many of those stages for each food as you can think of.

4. Each stage gets awarded points depending on how much energy is involved. Award points to the stages as follows:

    - Involved the sun's energy – 0 points
    - Involved farmed animals – 1 point
    - Involved human labour, machinery or processing – 1 point
    - Involved transport – 1 point
    - Involved transport overseas – 3 points
    - Involved packaging – 2 points
    - Record results on the datasheet.
    - If the foods you picket have different ingredients, you will have to give points for these too! But don't worry about all ingredients, just the main ones.

5. At the end, add up the points for each food. The foods with the highest points have the highest "hidden" energy costs.

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Unit 3- Food and Ecology

Activity 2- Investigating the energy costs of food - Examples

Example

Food: **Potatoes**	Pts:	Food: **Beef burgers, packet**	Pts:
Grown on the farm (sun energy)	0	Cattle grazes on grass (farmed animals)	1
Harvested & delivered to shop (labour / machinery) (transport)	1	Abbatoir (labour / machinery) (transport)	1 1
		Meat made into burgers at factory (transport) (processing) (packaging)	1 1 1
		To supermarket (transport)	1
Total Energy Cost points:	1		7

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Unit 3 – Food and Ecology

Activity 2- "Energy Costs" of food – Datasheet

Name: ______________________________ Date: ______________________________

Food:	**Pts**	**Food:**	**Pts**	**Food:**	**Pts**
Total Energy Costs:					

Which food used most energy for its production?

____

Which stage of production overall required most energy – was it transport, processing, packaging, etc.?

____

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Unit 4 – Climate Change & Greenhouse Gases

This unit looks at Climate change and the effects of greenhouse gases. The background reading introduces the concepts tested in:

- Activity 1 - Climate Change Puzzle
- Activity 2 – Cutting greenhouse gas emissions
- Activity 2 - Datasheet
- Activity 2 - Table with examples

Background – An introduction to the Greenhouse Effect and Climate Change.
What is Climate Change?

The raising of the earth's temperature is having huge effects on weather and climate. Scientists do net yet agree on what will happen in future years, but already they know that the polar ice caps are melting. This has caused sea- levels to rise. It is thought that the overall temperature of the earth will be warmer, leading to more storms, floods, droughts and sudden changes in weather. Ireland, being an island, could be in danger from all of these occurrences.

What causes Climate Change?

Over the billions of years that life has been on the planet, the climate has always been changing. In the beginning of time it was really important that gases warmed up the earth, otherwise, it would not be suitable for plants or animals to live here.

In recent decades, however, through human activity, the rate of climate change has been speeded up. Burning fossil fuels for energy is the major world contributor to climate change as it releases vast amounts of greenhouse gases, mainly carbon dioxide. Other sources include exhausts from cars and other vehicles, cutting and burning trees, and emissions from livestock.

How can we combat Climate Change?

Governments all over the world have been working on strategies to try and reduce the impact of climate change. It is really important that all countries reduce the amount of greenhouse gas emissions. Using less energy or using energy only from renewable sources, means less greenhouse gases are emitted. You can help by cutting down on energy you use and in other ways

Unit 4 – Climate Change & Greenhouse Gases

Activity 1- Puzzle

Can you figure out the scrambled words? They are all to do with energy and climate change.

BAONCR XDODIIE

2

LOALBG NAWGIRM

8 7 6 5

SIOSFL LUESF

4

GEERYN

1

NEEHGRUESO

9

SOMSEINIS

3

1 2 3 4 5 6 7 8 9

When you have done all the words, put the corresponding letters into the numbered boxes to find out the missing word. The missing word is an environmentally friendly source of energy.

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SEAI SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Unit 4 – Climate Change & Greenhouse Gases

Activity 2- Cutting greenhouse gas emissions

You and your class mates are Ministers for the Department of the Environment and Local Government. You have been given the task of reporting to the Taoiseach on what you think should be done for a National Climate Change Strategy. The aim is to reduce greenhouse gas emissions, mainly of carbon dioxide. Using the following basic information, you are going to decide what action to take and why.

Note: These are not actual figures, but rounded off estimates for the purpose of the exercise. They have been loosely based on projections for 2000 contained in the National Climate Change Strategy.

These are the amounts of greenhouse gases in terms of Carbon Dioxide released in the current year. They total **73 million tonnes** of carbon dioxide, which is 35% higher than the amount released in 1990. To meet targets that Ireland agreed to, there has to be a reduction of at least 13Mt per year from now on. Have you any idea how this will be done? Have a look at the Activity 2 – table with examples which shows where this year's emissions have come from.

What to do:

1. You have to suggest ways to reduce the total amount of CO_2 produced per year by 13 million (Mt) tonnes by choosing a combination of the options listed in the provided Activity 2 - datasheet.

2. When you have decided with your team, tick the options you are recommending and list reasons for and against those actions.

3. But it's not as easy as it may seem. You can only choose an option if you and your team can suggest ways to do it, or suggest an alternative to meet the needs of the people of your country. For example, we could easily reduce energy use overnight if we told everyone not to cook food, but then what would we eat?

4. For every option you choose, add up the carbon dioxide savings.

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Unit 4 – Climate Change & Greenhouse Gases

Activity 2- Cutting greenhouse gas emissions- Emissions table

Table

Where this year's emissions have come from

Sector	**Source**	**Percentage of total**	**Amount/million tonnes CO2**
Agriculture	Livestock gases (methane), fertilizer and use of manure in agriculture	35%	25.5Mt
Energy	Electricity production from coal, oil and peat	22%	16Mt
Residential and Commercial	Household and business heating	13%	9.5Mt
Industry		8%	5.9Mt
Transport	Road Traffic (petrol and diesel)	15%	7.3Mt
Waste	Landfill	3.3%	2.4Mt
Other		8.7%	6.4Mt
Total		100%	73Mt

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Unit 4 – Climate Change & Greenhouse Gases

Activity 2- Cutting greenhouse gas emissions- Datasheet

Please tick the strategies recommended only if you can suggest ways of carrying them out or alternatives to take their place.

Sector	Recommended Actions	CO2 Savings	
Energy	Reduce electricity production from fossil fuels and reduce the amount of electricity needed	6Mt	
Transport	Improve transport system and make vehicles more energy efficient	3Mt	
Residential	Save energy used in buildings and homes	1Mt	
Industry	Save energy used in industrial processes	2Mt	
Agriculture	Change foodstuffs to reduce gases from national herd and improve farm management practices	2Mt	
Waste	Reduce amount of waste going to landfill	1Mt	
Total		15Mt	

What is the total amount of carbon dioxide emissions your recommendations would save?
Is this enough?
For each action you have recommended, list the main difficulty you would see with carrying it out.
If the government were to go ahead with your recommendations, what would be the total amount of carbon dioxide emissions?
Is this enough?

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