Carbon Reduction Lesson Plans

Norfolk County Council

netzero Norfolk

Introduction

This suite of lessons has been designed for pupils in year 5 & year 6 to support schools in educating pupils about the impact of climate change. In the Primary National Curriculum, climate change does not currently feature. Climate change and the necessity to reduce our global carbon emissions has been widely reported in the media (e.g. the Met Office). In addition, government initiatives such as the creation of a model science curriculum for primary schools to include climate change education (see Education Hub Blog) are demonstrating that this remains a priority for leaders and educators.

Each lesson within this booklet can be taught in isolation, or the suite can be taught as a sequence. The lessons have been designed with a scientific and mathematical focus. Each lesson should take between 60 – 90 minutes to deliver and come with an accompanying pupil workbook.

We would be very grateful if you are able to fill in this short feedback form once you have taught one or more of the lessons. This will help us to improve any resources we create for schools moving forwards.

Contents

Lesson One

The Big Idea: To compare CO2 emissions from cars in the context of fractions.		
Fluency Objectives To find fractions of whole numbers.	**Reasoning Objectives** To apply knowledge of fractions to deduce how many journeys can be made based on carbon dioxide emissions.	**Problem Solving Objectives** To solve problems related to carbon dioxide emissions and fractions.
Common Misconceptions Unclear of the difference between the numerator and denominator and the relationship between the two. Finding the unit fraction and forgetting to consider the numerator as number of parts required.	**Key Vocabulary** Carbon dioxide Greenhouse gas Fossil fuel Numerator Denominator Parts Whole Fraction	**Resources required** Cuisenaire rods/unifix cubes to introduce bar model (if required)

Suggested Lesson Structure:

Stage 1: Record the method of transport used by pupils to travel to and from school. This data could be recorded as a table and used to create a graph in a future session. Discuss whether their method of transport could be changed e.g. could they choose to cycle to school instead of travelling by car.

Pupils could use the following link to search for a family member's car to see an average of how many units of carbon dioxide are emitted per use.

https://carfueldata.vehicle-certification-agency.gov.uk/

Pupils could total up a rough estimate of how many units of carbon dioxide are used to take them to and from school in one week.

Stage 2: Discuss figures to suggest that the average car emits up to 6.5 metric tonnes of carbon dioxide per year. These figures come from the Department for Business, Energy and Industrial Strategy.

Use the example that in one month, a family car is used fifteen times during the month and in total for those 15 journeys, uses 270 units of carbon dioxide. We want to calculate how many units on average is used per journey therefore we are looking for 1/15 of 270. Use the bar model to exemplify this. How would pupils work out the value of each section and therefore the energy used per journey?

270 units of CO^2														

270 ÷ 15 = 18 units of CO2 per journey.

270 units of CO^2														
18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

Pupils could now be given a further 1-2 hypothetical examples to calculate based on units of carbon dioxide emitted by different types of cars. Pupils could be encouraged to use the bar model to support their calculations.

Examples:

- 390 units of CO2 are emitted for a car used 6 times per week.
  How many units are emitted per day?

- 736 units of CO2 are emitted for a car used 8 times per month.
  How many units are emitted per day?

Stage 3: Pupils will continue to develop their mathematical reasoning skills through the next activity.

Allow pupils access to the following problem:

Alice has driven her car for a total of 5 hours and emitted a total of 750 units of CO2. How many units were emitted after 2 hours of her journey?

Example to show 2/5 of 750.
750 ÷ 5 = 150
150 x 2 = 300

750 units of CO^2				
150	150	150	150	150

Alice has burned 300 units of CO2 after 2 hours of her journey.

Pupils to discuss how to work out how many units of CO2 would have been emitted if she had been driving for 6/7/8 hours.

Stage 4: Introduce main problem to class. Allow sufficient time for pupils to talk about this and have a go at solving.

Using the criteria and table below, suggest which journeys are most suitable. Show your workings and give reasons for your choices.

Riley is 12 years old. His family car emits 9000 units of CO2 per month. To avoid emitting more than 9000 units of CO2 next month, which journeys can Riley make in the car.

Criteria:
• 1/3 of Riley's journeys must be for an educational purpose. • 1/9 of Riley's journeys must be for sport. • 1/9 of Riley's journeys must be for visiting family. • 2/9 of Riley's journeys must be for social events. • 2/9 of Riley's journeys must be for helping family with chores

Educational Purpose		Visiting Family	
Church	150	Grandma's house	650
School	450	Sister's flat	200
Library	280	Dad's house	150
Maths tutor	270	Uncle's bungalow	175
English tutor	200	Grandad's nursing home	200
Football scholarship	300	**Social Events**	
Piano tutor	400	Best friend's birthday party	500
Spanish lessons	300	Sleepover	400
Violin lessons	200	Playing online at a friend's	300
Art class	175	Going to the park	250
French lessons	150	Going into town	350
Sport		Visiting the arcade	150
Football club	650	Going to the beach	300
Rowing club	700	Cinema	400
Basketball training	350	Grandma's 70th birthday party	250
Roller Skating	550	**Family Chores**	
Trampolining	650	Food shop	750
Rugby training	400	Taking rubbish to the tip	400
Golf	450	Taking the car to the car wash	300
Swimming club	300	Collecting a parcel	250
Judo	450	Collecting prescriptions	200
Kick boxing	600	Taking sister to karate lessons	250

The numbers in the table relate to the total emission of CO2 per return journey. A journey can be made more than once during the month e.g. Riley can travel to school in the car for more than one day during the month.

Optional extras:

- Pupils could record how many times their family car is used over the course of a week. The teacher could challenge pupils to find out how much CO2 is emitted from their car per journey and calculate the total units of CO2 emitted in one week.
- Pupils could analyse the journeys they take in the car and decide which journeys could be made by public transport or an eco-friendly mode of transport such as a bicycle. What would the changes equate to as a fraction of their whole journeys?
- Pupils could research variations in car make and relative CO2 emissions. Why do some cars emit more greenhouse gases than others?
- Thinking of a month as 30 days, pupils could calculate (by scaling up one typical day's use of the family car) how many units of CO2 they use on average per month and per year. How could they reduce this figure?

Lesson Two

The Big Idea: To analyse energy bills and fuel costs in the context of fractions.		
Fluency Objectives To find fractions of amounts. To add fractions with different denominators.	**Reasoning Objectives** To apply knowledge of fractions to explain which reduction offers the best deal.	**Problem Solving Objectives** To solve problems related to energy costs and fractions.
Common Misconceptions Assumption that when multiplying a fraction by a whole number, the number will increase. Inaccuracies with which part of the fraction is the numerator or denominator.	**Key Vocabulary** Cost Tariff Consumption Smart meter Energy transfer Numerator Denominator Common denominator Parts Whole Fraction	**Resources required** Recent energy bills (anonymised)

Suggested Lesson Structure:

Stage 1: How much do pupils think the monthly gas and electricity bill is for an average sized house?

Answer: **£172.81** according to British Gas (2023)

This represents 1/12 of a year. What would the yearly bill be if we rounded the monthly bill to the nearest pound?

1 year											
£173	£173	£173	£173	£173	£173	£173	£173	£173	£173	£173	£173

Answer: **£2076**
Is this what pupils were expecting? Is this higher/lower than they thought?

Stage 2: How many pupils have a Smart Meter at home? Do they understand what it does?

Smart meters have been introduced to help us keep track of how much energy we are using. It can also help prevent customers receiving estimated bills as the smart meter will have accurate up to date readings, so customers are charged correctly for the energy they have used.

Pupils to consider:

Kyle and Daisy both have a smart meter. Last year, Kyle was paying £720 per year but since having a smart meter, his annual bill has decreased by 1/8. Last year, Daisy was paying £680 per year but since having a smart meter, her annual bill has decreased by 1/10.

Who is now paying the least for their energy use?

£720							
1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8

£680									
1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10

Teaching point: When teaching pupils to find a fraction of an amount ensure they are exposed to both ways in which the calculation can be presented:

1/8 of 720 and **1/8 x 720**

Both calculations are the same. By showing pupils both, this addresses the misconception that some pupils have that when multiplying, the number always gets bigger.

1/8 x £720 = £90

£720 – £90 = £630

1/10 x £680 = £68

£680 – £68 = £612

Daisy is paying the least.

Stage 3: Pupils are now given 3 scenarios to calculate which person is now paying less for their energy bills. Encourage pupils to show their method of calculating.

- Dave was paying £950 but his bill has reduced by 1/5.
  Amelia was paying £820 but her bill has reduced by 1/10.
  Who is now paying the least for their energy?

Teaching point: Additional explanation may be required when non-unit fractions are introduced (fractions where the numerator is not 1).

- Andy was paying £490 but his bill has decreased by 2/7.
  Scarlett was paying £640 but her bill has decreased by 3/8.
  Who is now paying the least for their energy?

- Felix was paying £1100 but his bill has decreased by 3/11.
  Beth was paying £810 but her bill has decreased by 2/9.
  Rita was paying £900 but her bill has decreased by 2/15
  Who is now paying the least for their energy?

Stage 4: Once understanding of the above has been secured, pupils will now move on to addition of fractions with different denominators.

An energy company are reviewing their annual customer survey. According to their database, on average customers have saved ¼ on their gas bill and 1/3 on their electricity bill by switching to a smart meter. What fraction of their total energy bill have they saved?

¼ + ⅓

These fractions have different denominators so cannot be added together. We must find a common denominator first. Check understanding of common denominator.

Pupils could use a manipulative such as fraction tiles or fraction towers to secure their understand-ing that ⅓ and ¼ are from different fraction families.

This representation shows how ¼ cannot be added to ⅓ as the sections of the bar model do not match up.

<table>
<tr><td colspan="12">1 whole</td></tr>
<tr><td colspan="3">¼</td><td colspan="3">¼</td><td colspan="3">¼</td><td colspan="3">¼</td></tr>
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<table>
<tr><td colspan="12">1 whole</td></tr>
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From the representation we can clearly see that ¼ is equivalent to 3/12 and 1/3 is equivalent to 4/12.

$$\frac{1}{4} + 1/3 = 3/12 + 4/12 = 7/12.$$

Therefore, the energy company's customers have saved 7/12 from their total energy bill.

Pupils to complete the following showing their methods of calculating:

- Gas Company A are making changes to their prices. To match other energy suppliers, they have decided to reduce their gas tariffs by 2/9 and reduce their electricity tariffs by 1/5. What is the total fraction that Gas Company A are reducing their tariffs by?
- Electricity Company B are analysing their accounts. On average last year, their customers saved 11/20 on their energy bills. Which combinations of fractions add together to make 11/20? (Pupils are expected to find more than one solution).

Optional extras:

- Pupils can have a conversation with someone at home about how much they are paying for their energy use per month and whether they have a smart meter installed.
- If pupils have a smart meter, ask them to record their energy use on a typical day. Then ask pupils to make one noticeable change e.g. turn off all lights when they leave a room and see what difference it makes to their energy use.
- If pupils are aware of what one month's energy costs, can they use the model at the beginning of the lesson to work out what their yearly bill would be?

Lesson Three

The Big Idea: To calculate differences between renewable and non-renewable energy using ratio and proportion.		
Fluency Objectives To understand the difference between ratio and proportion. To calculate ratio and proportion.	**Reasoning Objectives** To explain the link between ratio and proportion within the context of renewable and non-renewable energy.	**Problem Solving Objectives** Solve problems involving the relative sizes of 2 quantities where missing values can be found by using integer multiplication and division facts.
Common Misconceptions Some children may not understand the difference between ratio and proportion. Some pupils may not understand that a proportion is the same as a fraction or percentage.	**Key Vocabulary** Renewable Non-renewable Ratio Proportion Fraction Part Whole Percentage	**Resources required** Images of renewable and non-renewable energy sources. Multilink or unifix cubes

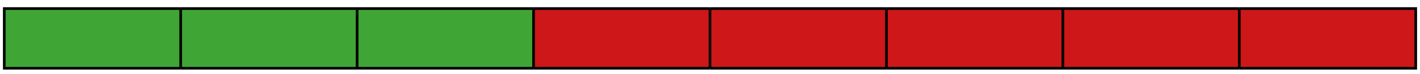
Suggested Lesson Structure:

Stage 1: Pupls to discuss in small groups different types of renewable energy (energy that can be replenished in a relatively short space of time) and non-renewable energy (energy that will eventually run out). Share ideas as a group.

Stage 2: Pupils will now explore the meaning behind ratio and proportion within the context of energy.

Teaching point: Let's assume renewable energy is being used nationally at a ratio of 3:5 compared to non-renewable. The ratio is a part-to-part comparison and specifies how many parts relate to renewable energy and how many parts relate to non-renewable energy. The proportion is a part to whole comparison and compares one section against the whole. In this example there are 8 parts in total, therefore the proportion of energy that is renewable is 3 out of 8 or 3/8.

3:5 (ratio)



	Renewable energy – 3/8 (proportion)
	Non-renewable energy 5/8 (proportion)

Using a manipulative such as multilink or unifix cubes, pupils now demonstrate their understanding of ratio by creating the following:

- Renewable energy to non-renewable energy with a ratio of 3:7
- Renewable energy to non-renewable energy with a ratio of 2:5
- Effectiveness of wind energy, solar energy and hydroelectric energy with a ratio of 3:6:4

In each instance, pupils should inform a partner of the proportion of each part e.g. for the ratio 3:7, the proportion of renewable energy is 3/10.

Stage 3: Pupils will now extend their knowledge of ratio and proportion by simplifying ratios. This is a good starting point if pupils have not been exposed to simplifying fractions yet. Pupils may benefit from using manipulatives for this task.

If the use of renewable energy nationally is increasing and the ratio compared to non-renewable energy is now considered to be 6:9, how else could this ratio be expressed? Explore idea that we need to find a common factor of both 6 and 9. Simplified form is 2:3.

Allow pupils to explore simplifying the following:

- Energy generated from wind power compared to solar energy can be expressed using the ratio 9:15. How else can this ratio be expressed?
- The rate of energy produced from hydroelectric power, solar panels and wind turbines can be expressed using the ratio 4:8:10. How else can this ratio be expressed?

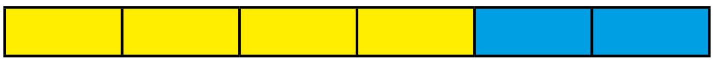
Stage 4: Pupils will now experience ratio and proportion in a problem-solving context.

Explore the following as a class:

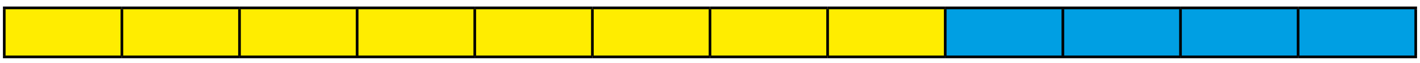
Coal fired power stations use 4 units of energy per minute compared to wind turbines which use 2 units of energy per minute. If wind turbines have used 12 units of energy, how many have coal fired power stations used?

(Pupils could once again use a manipulative such as multilink in 2 separate colours and continually increase both sides of the ratio)

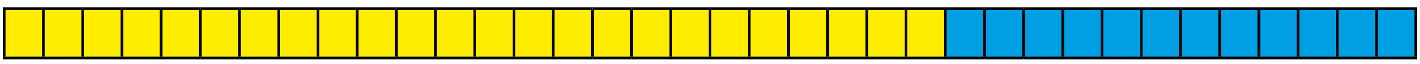
(yellow)	Coal fired power stations
(blue)	Wind turbines



4:2 as in the original question



8:4 (the ratio has been doubled)



24:12 (the ratio has increased by a scale factor of 6)

Answer: The coal fired power stations have used **24** units of energy.

Pupils complete the following:

- E.on gains 5 new customers per minute compared to Scottish Power who gain 3 new customers per minute. How many customers will both companies have gained after 8 minutes?

- The proportion of Government spending used on renewable energy is ¾ compare to non-renewable energy. What ratio can be used to express the relationship between Government spending on renewable and non-renewable energy? Explain how you know.

Optional extras:

- Pupils could compare the amount of money their family spends on gas : electricity and express this as a ratio in its simplest form.

- Pupils can research a ratio in their own home such as hours the lights are on : hours the lights are off and express this as a ratio and as two proportions.

- Pupils could help prepare a meal at home and express the time taken to prepare vs the time taken to consume as a ratio.

Lesson Four

The Big Idea: To express increases in current within a series circuit as a fraction.		
Fluency Objectives To calculate fractions of whole numbers.	**Reasoning Objectives** To explain how the bar model shows fractional increases in current.	**Problem Solving Objectives** To explain how the bar model shows fractional increases in current.
Common Misconceptions Some pupils may record fractional increases as mixed numbers instead of fractions e.g. 1 ½ instead of just ½.	**Key Vocabulary** Circuit Current Fraction Part Whole Decimal Equivalent Equivalence	**Resources required** Circuit equipment; cells, batteries, wires, bulbs, motors, buzzers, ammeters and a variety of electrical conductors. Cuisenaire to support bar modelling if pupils require it.

Suggested Lesson Structure:

Stage 1: Have the phrase 'electrical conductor' somewhere visible to pupils e.g. on a board or on A3 paper on their desks. Allow pupils to discuss what they think is meant by this phrase and share ideas as a class.

After this discussion, encourage pupils to make a simple series circuit in small groups. Ensure pupils are made aware of the precise meaning of a series circuit compared to a parallel circuit. Discuss the key elements of a series circuit. Where does the energy come from? How does the energy travel through the circuit? What is the scientific term for electrical energy within a circuit? (current).

Stage 2: Having already established that an electrical conductor will allow electrical current to pass through it, ensure pupils can explain this succinctly to a peer or write it down in their science book. Allow pupils time to experiment to see which materials around the classroom (and some which can be provided by the teacher e.g. metal spoons, paperclips etc…) are electrical conductors. Pupils can record these as a list or in a table within their books. After the experiment has been completed, ask pupils to make a conjecture about electrical conductors. Teachers may choose to use a vocabulary scaffold such as;

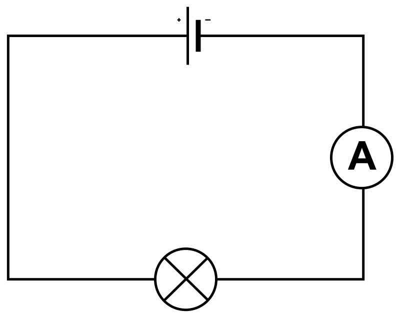
"My conjecture, based on the evidence from our experiment is …."

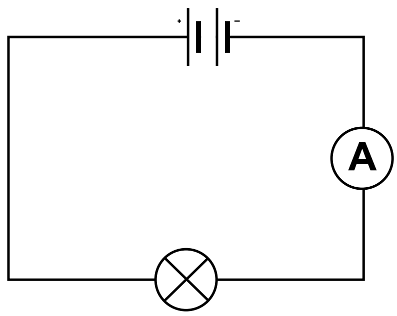
Stage 3: Do any pupils know how the current (energy) within a circuit is measured? (with an ammeter). Encourage pupils to use an ammeter to measure the current within a simple circuit. Discuss their recording compared to another group's. Next, encourage pupils to include an additional element to their circuit e.g. another cell (to make a battery) or an additional bulb. Discuss what happens to the current.

Teaching point: In a series circuit, the current is determined by how many energy sources are attached to the circuit. The current will only increase if additional energy sources (another cell) is added to the circuit. Maintaining the same quantity of cells but increasing a different component (such as a bulb) will decrease the current in a circuit. The current will also measure the same regardless of where the ammeter is placed within a circuit. Encourage pupils to come to this conclusion themselves by asking them to measure the current in more than one place within the circuit.

The remaining stages of the lesson focus on mathematical content. The numbers have been set to ensure the content is in line with age related expectations. Although pupils could use their ammeter readings from earlier in the lesson, they could be exposed to decimal numbers which are too advanced for pupils in Year 5/6 or Year 7/8 to convert to a fraction.

Stage 4: The teacher introduces two circuit diagrams to pupils.



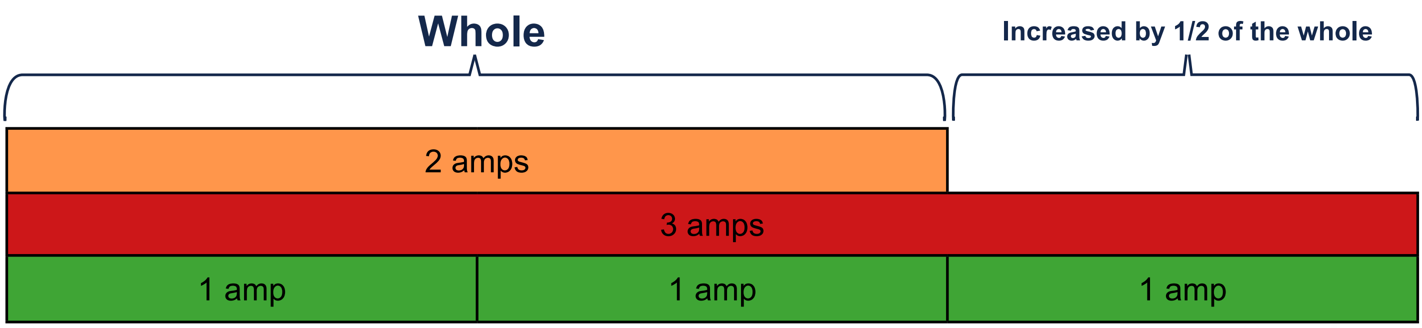


Firstly, what do pupils notice about the two diagrams? Which one will have more energy within the circuit?

Record the ammeter readings as 2 amps in the first series circuit and 3 amps in the second series circuit.

Ask pupils to express how much the current has increased within the second circuit.

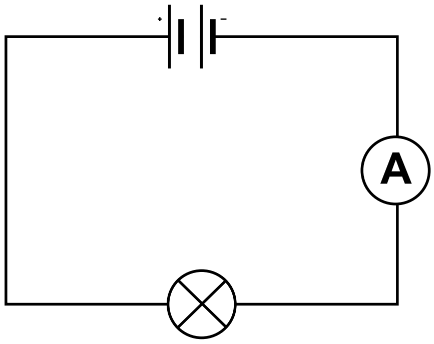
Record 1 somewhere visible to pupils. The current has increased by 1 amp from 2 amps to 3 amps. We are now going to express this as a fractional increase. The current has increased by 1 amp from 2 amps. Can pupils see a relationship between 1 amp and 2 amps? The current has increased by ½ because 1 is ½ of 2. A bar model representation is shown below which pupils may find useful.

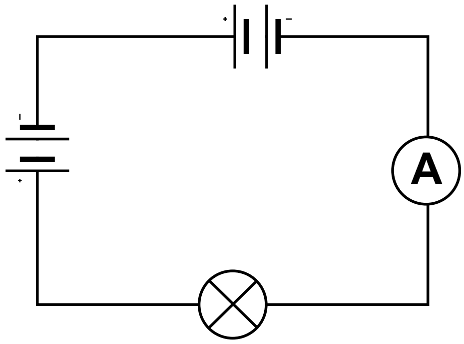


The teacher may choose to use the table below to record the findings.

Current in 1st series circuit	Current in 2nd series circuit	Difference in current	Expressed as a fraction	Conclusion
2 amps	3 amps	1 amp	½	The current increased by ½ because the reading increased by 1 amp from the original 2 amps.

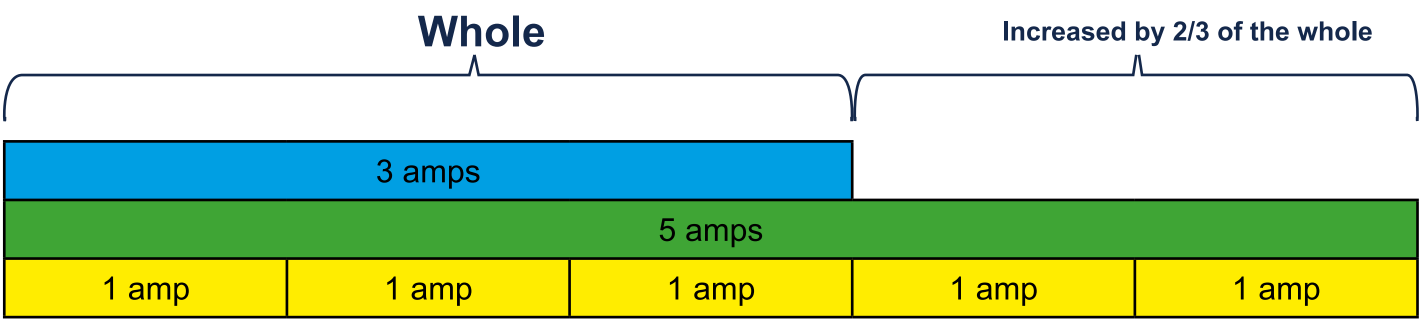
Pupils to discuss and record their thoughts for the next example:





On this occasion, the readings should be 3 amps for the first circuit diagram and 5 amps for the second circuit diagram. Allow pupils to discuss and form their own conclusion.

3 amps is the first reading, 5 amps is the second reading therefore the difference between the readings is 2 amps. The current has increased from 3 amps, by 2 amps resulting in an increase of 2/3 (2 amps more than the original 3 amps). Once again, a bar model representation is shown below which may add further exemplification for pupils.



Current in 1st series circuit	Current in 2nd series circuit	Difference in current	Expressed as a fraction	Conclusion
3 amps	5 amps	2 amp	2/3	The current increased by 2/3 because the reading increased by 2 amp from the original 3 amps.

Stage 5: Allow pupils to calculate the fractional increase of the following changes in current. The teacher may choose to ask pupils to draw circuit diagrams or a bar model in addition to the table format above.

1. The current in a circuit increasing from 3 amps to 4 amps.
2. The current in a circuit increasing from 4 amps to 6 amps. (Will pupils recognise the equivalence of 2/4 and 1/2?)
3. The current in a circuit increasing from 4 amps to 7 amps.
4. The current in a circuit increasing by 2/3. What could the ammeter readings have been both before and after the increase?

Optional extras:

- Pupils could create their own problems for a peer to solve, stating the current in the first circuit and the current in the second circuit.
- Pupils could solve further problems indicating the fractional increase (for example, ¾) and find as many different examples of ammeter readings that would fit with the increase.
- Pupils could be challenged to extend their thinking and see if they can record fractional decreases e.g. from 5 amps to 3 amps would be a reduction of 2/5.

Lesson Five

The Big Idea: To order fractional reductions in volume in the context of glacial ice sheets.		
Fluency Objectives To compare fractions including fractions greater than 1.	**Reasoning Objectives** To explain how to compare and order fractions with different denominators.	**Problem Solving Objectives** To solve problems involving comparing and ordering fractions.
Common Misconceptions Fractions are larger when the denominator is a bigger number e.g. 3/8 is bigger than 3/4 because 8 is larger than 4.	**Key Vocabulary** Fraction Common denominator Comparison Smallest Largest Volume	**Resources required** Images of glacial ice sheets melting. Cuisenaire to support bar modelling if pupils require it.

Suggested lesson structure:

Stage 1: What do pupils already know about climate change? Pupils note down ideas in small groups ready to feed back to the class.

According to NASA, 'the planet's average surface temperature has risen about 1.62 degrees Fahrenheit (0.9 degrees Celsius) since the late 19th century, a change driven largely by increased carbon dioxide and other human-made emissions into the atmosphere.'

https://climate.nasa.gov/evidence/

Pupils look back at previous lessons and make a list of what they believe constitutes 'human-made emissions'. Make a whole class list which can be visible for the remainder of the lesson.
Our man-made production of energy is causing these changes in our climate. Non-renewable energy is more damaging to our environment than renewable sources of energy.

Stage 2: Introduce the concept of glacial ice sheets. Teachers may want to play this short video to pupils as it explains what glacial ice sheets are and discusses how the melting of these is affecting planet Earth. https://www.nationalgeographic.com/environment/global-warming/big-thaw/

Assess prior knowledge of the meaning of 'volume.'

Pose an example using an image like the one above.

"There are two glacial sheets which have an identical volume of 14,000m3. Over the past decade, glacial sheet A has reduced in size by 2/3 whilst glacial sheet B has reduced in size by 3/4. Which glacial sheet has been reduced by the most?"

Teaching point: For a problem such as the one above, pupils are required to compare 2/3 and 3/4. A common misconception is that fractions with larger denominators are bigger than those with smaller denominators. To compare fractions, pupils should understand that we need to find a common denominator. This can be represented using Cuisenaire rods or a bar model as shown below.

1 whole											
¼			**¼**			**¼**			**¼**		
⅓				**⅓**				**⅓**			
1/12	**1/12**	**1/12**	**1/12**	**1/12**	**1/12**	**1/12**	**1/12**	**1/12**	**1/12**	**1/12**	**1/12**

Teaching point: Using the bar model above, or a manipulative such as fraction towers or fraction strips may aid children in their conceptual understanding and enable them to see that ¾ is larger than 2/3. Although manipulatives and the bar model representation make this comparison explicit, it is advisable to extend pupils to find a common denominator because they will be exposed to fractions in future learning where manipulatives may not be useful e.g. 7/16.

Finding a common denominator involves finding the lowest common multiple of 3 and 4. In this case, the lowest common multiple is 12.

2/3 = 8/12
3/4 = 9/12

Therefore, glacial ice sheet B, which has reduced in volume by 3/4, has reduced by the most. Teachers can encourage pupils to work out the new volume as an extension to the original task.

Stage 3: Pupils can now consolidate their knowledge by exploring further related examples such as those below:

- There are two glacial sheets which have an identical volume of 16,500m3. Over the past decade, glacial sheet A has reduced in size by 3/5 whilst glacial sheet B has reduced in size by 2/3. Which glacial sheet has been reduced by the most?
- There are three glacial sheets which have an identical volume of 18,000m3. Over the past decade, glacial sheet A has reduced in size by 3/4, glacial sheet B has reduced in size by 1/3 and glacial ice sheet C has reduced in size by 5/6. Which glacial sheet has been reduced by the most?

The next stage builds on the skills of finding a common denominator and encourages learners to order fractions including fractions greater than 1.

Stage 4: Encourage pupils to make the connection between glacial ice sheets melting and ocean levels rising. The following problems are now set in the context of ocean levels rising.

"The Arctic Ocean has increased in volume over the past decade by 4/5. The North Sea has increased in volume over the past decade by 1 ½ and the Norwegian Sea has increased in volume by 1 1/3. Order the fractional increases from smallest to largest."

Teaching point: Pupils should be encouraged to examine the three fractions and decide how to order them. We still need to find a common denominator as was evident in the previous examples. The lowest common multiple of 2, 3 and 5 is 30. Therefore, our common denominator in this case will be 30. Some pupils may find it easier to convert the mixed number fractions into improper fractions for comparison and ordering purposes.

4/5 = 24/30
1 ½ = 1 15/30 or 45/30
1 1/3 = 1 10/30 = 40/30

As a result, if we order the fractions from smallest to largest we get:

4/5 **1 1/3** **1 ½**

Stage 5: Pupils are now to be encouraged to complete further ordering examples using a template such as the one below:

"The Southern Ocean has increased in volume over the past decade by 1 ¼. The Labrador Sea has increased in volume over the past decade by 1 2/5 and the Greenland Sea has increased in volume by 1 3/10. Order the fractional increases from smallest to largest."

Denotes values that can be changed.

Optional extras:
- Pupils can be further extended by using both mixed number fractions and improper fractions within problems.
- Pupils could be encouraged to research an approximate value by which sea levels have increased and express this as a fractional increase if they can.
- Pupils could be given a value for the volume of water within seas or oceans and be challenged to calculate the new volume after the fractional increases.

Lesson Six

The Big Idea: To analyse, using percentages, the financial implications of investing in renewable energy.		
Fluency Objectives To calculate percentages of whole numbers.	**Reasoning Objectives** To compare percentages of whole numbers and use reasoning vocabulary to justify which results in a greater value.	**Problem Solving Objectives** To solve problems involving the calculation of percentages.
Common Misconceptions There is only one way to calculate percentages; by finding 10% and adjusting accordingly. Multiplying a percentage by a whole number will increase the value of the number.	**Key Vocabulary** Comparison Percentage Part Whole Half Quarter	**Resources required** Bead strings

Stage 1: *This stage may not be necessary depending on pupil's prior knowledge of percentages.*

Each child or pair needs access to a bead string. This activity is designed to reinforce the idea that percentages represent part of a whole. Pupils are expected to make the link between fractions and percentages although may need explicit explanation.

Assume the bead string goes from 0% to 100%. Ask the pupils to show various percentages (35%, 73% 2% etc…). If pupils are highly successful, certain percentages could be discussed in terms of their fractional equivalent e.g. 50%, 40%, 75% etc…

Next, assume the bead string goes from 0 to a whole number of the teacher's choice. Ask pupils to show a percentage on their bead string and estimate the amount. This helps to develop pupil's conceptual understanding and will give clear indication to the teacher whether pupils fully understand that a percentage is a part of a whole.

Discuss estimates using key questions:

- What strategies have pupils used?
- Who do we think is closest?
- How did the bead string help us?
- How could this percentage be recorded as a fraction?

Repeat this task for as many times as is necessary.

Stage 2: This stage builds on pupil's conceptual understanding and shows how percentages can be plotted on a number line to aid calculation skills.

Show a percentage calculation written in two ways.

For example: 35% x 120 and 35% of 120.

Ask pupils to discuss the difference. Reinforce the idea that there is no difference in the calculations. They can be written in either format but mean the same.

Show pupils a number line from 0 – 120 and ask them to discuss where 35% would go? Some pupils may choose to use the bead strings to help them.

0 120

Teaching point: Some pupils may find it useful to mark 50% and 25% before marking 35%.

0 35% 120

Discuss estimates of the value of 35% of 120 before showing pupils 2 ways of calculating.

Pupils can either:

- Find 25% or ¼ of 120 (30) and then add 10% (12) resulting in 42.
- Find 10% (12) and multiply this by 3, therefore finding 30% (36). Then find 5% by halving the value of 10% (½ of 12 is 6). By adding 36 and 6 we achieve 42 as our final answer.

Teaching point: This is a key opportunity to discuss which method is most efficient. By using our number sense in the first example, we only needed to complete 2 calculations to find the answer compared to 4 calculations in the second example. Encourage pupils to use their number sense in future examples to avoid completing multiple, unnecessary calculations.

Stage 3: This stage incorporates finding percentages and learning about renewable energy sources.

Discuss with pupils what the term 'renewable energy' means. Hopefully pupils will have retained information discussed during lesson two of this sequence.

According to Energy UK, renewable energy uses natural energy to make electricity. Examples include wind, wave, marine, hydro, biomass and solar.
https://www.energy-uk.org.uk/energy-industry/renewable-generation.html

Not only are renewable energy sources a more sustainable choice for our planet but it can help us save money on energy bills.

The examples used in the following calculations have been fabricated and do not represent actual energy saving figures.

Share example with pupils:

By installing solar panels in an average home, some homeowners could save 25% on their energy bills. If an average household spends £1300 per year on electricity, how much would they save by installing solar panels?

Therefore, the calculation needed is 25% x 1300 or 25% of 1300. Discuss efficient methods and ensure pupils understand the amount that customers will save is £325.

Pupils can now explore the following example in small groups or independently.

A farmer has invested in 5 wind turbines to go on his fields. Each wind turbine saves the farmer 8% on his energy bills. If the farmer currently pays £1550 for his energy, how much will he save once the wind turbines have been installed?

Teaching point: Pupils could choose to find 8% and then multiply this value by 5. Pupils could also choose to multiply 8% by 5 first and then find 40% of 1550. Both methods result in the same answer although once again, this could encourage discussion about which method is most efficient.

Stage 4: A combination or all the following questions can be given to pupils to answer once the teacher is confident pupils understand how to calculate percentages accurately.

- By installing solar panels, Fin is likely to save an average of 13% on his annual bill of £650. His friend Sam has also installed solar panels and is likely to save an average of 27% on his annual bill of £850. After the deductions, who will be paying the least for their energy?
- Reducing a £450 energy bill by 16% results in a lower cost than reducing a £500 energy bill by 20%. True or false?
- Two rival companies using wave energy are competing to secure a deal with the Coastguard. Currently, the Coastguard pays £3600 per year for their energy. Company A is promising a 30% reduction in the cost of energy whereas Company B is promising a saving of £900 per year. Which company is offering the cheapest deal?
- A farmer has noticed that her energy bill last year was £4000 but since installing wind turbines on her farm, her energy bill is now £3000. How could this reduction be recorded as a percentage?

Optional extras:

- Pupils could investigate how much their family could save by the investment of a renewable energy source such as solar panels.
- Complete a whole class project about renewable energy and which investment would be most advantageous for the school to make.