Number Sense

Year 8

#MathsEveryoneCan

White Rose Maths

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Autumn	**Proportional Reasoning**						**Representations**					
	Ratio and scale		Multiplicative change		Multiplying and dividing fractions		Working in the Cartesian plane			Representing data		Tables & Probability
Spring	**Algebraic Techniques**						**Developing Number**					
	Brackets, equations and inequalities				Sequences	Indices	Fractions and percentages		Standard index form		Number sense	
Summer	**Developing Geometry**						**Reasoning with Data**					
	Angles in parallel lines and polygons		Area of trapezia and circles		Line symmetry and reflection		The data handling cycle				Measures of location	

Spring 2: Developing Number

Weeks 1 and 2: Fractions and Percentages

This block focuses on the relationships between fractions and percentages, including decimal equivalents, and using these to work out percentage increase and decrease. Students also explore expressing one number as a fraction and parentage of another. Both calculator and non-calculator methods are developed throughout to support students to choose efficient methods. Financial maths is developed through the contexts of e.g. profit, loss and interest The Higher strand also looks at finding the original value given a percentage or after a percentage change.

National Curriculum content covered includes:

- develop their use of formal mathematical knowledge to interpret and solve problems, including in financial mathematics
- work interchangeably with terminating decimals and their corresponding fractions
- define percentage as 'number of parts per hundred', interpret percentages and percentage changes as a fraction or a decimal, interpret these multiplicatively, express one quantity as a percentage of another, compare two quantities using percentages, and work with percentages greater than 100%
- interpret fractions and percentages as operators

Weeks 3 and 4: Standard index form

Higher strand students have already briefly looks at standard form in Year 7 and now this knowledge is introduced to all students, building from their earlier work on indices last term. The use of context is important to help students make sense of the need for the notation and its uses. The Higher strand includes a basic introduction to negative and fractional indices.

National Curriculum content covered includes:

- use integer powers and associated real roots (square, cube and higher), recognise powers of 2, 3, 4, 5 and distinguish between exact representations of roots and their decimal approximations
- interpret and compare numbers in standard form $A \times 10^n$, $1 \leq A < 10$, where n is a positive or negative integer or zero

Weeks 5 and 6: Number sense

This block provides a timely opportunity to revisit a lot of basic skills in a wide variety of contexts. Estimation is a key focus and the use of mental strategies will therefore be embedded throughout. We will also use conversion of metric units to revisit multiplying and dividing by 10, 100 and 1 000 in context. The Higher strand will extend this to look at the conversion of area and volume units, as well as having an extra step on the use of error notation. We also look explicitly at solving problems using the time and calendar as this area is sometimes neglected leaving gaps in student knowledge.

National Curriculum content covered includes:

- use standard units of mass, length, time, money and other measures, including with decimal quantities
- round numbers and measures to an appropriate degree of accuracy [for example, to a number of decimal places or significant figures]
- use approximation through rounding to estimate answers and calculate possible resulting errors expressed using inequality notation $a < x \leq b$
- use a calculator and other technologies to calculate results accurately and then interpret them appropriately

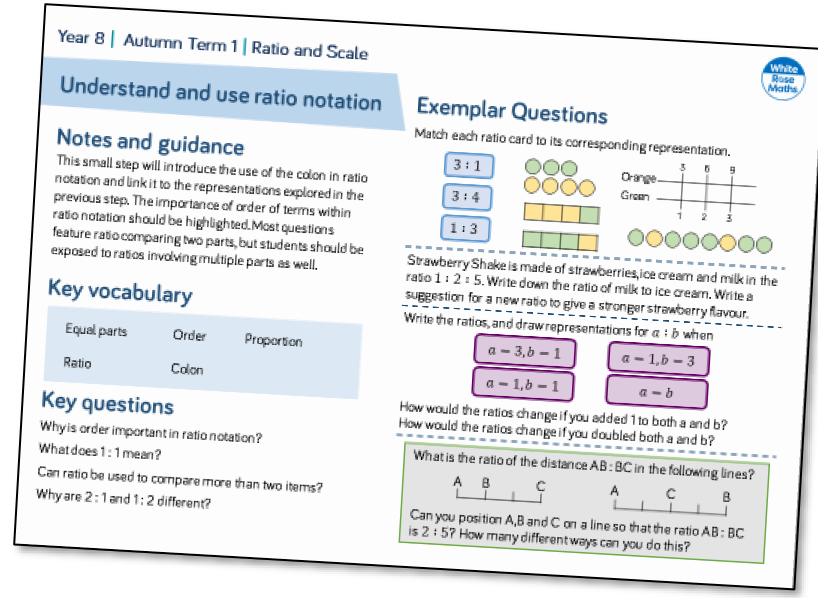
Why Small Steps?

We know that breaking the curriculum down into small manageable steps should help students to understand concepts better. Too often, we have noticed that teachers will try and cover too many concepts at once and this can lead to cognitive overload. We believe it is better to follow a "small steps" approach.

As a result, for each block of content in the scheme of learning we will provide a "small step" breakdown. ***It is not the intention that each small step should last a lesson – some will be a short step within a lesson, some will take longer than a lesson.*** We would encourage teachers to spend the appropriate amount of time on each step for their group, and to teach some of the steps alongside each other if necessary.

What We Provide

- Some ***brief guidance*** notes to help identify key teaching and learning points
- A list of ***key vocabulary*** that we would expect teachers to draw to students' attention when teaching the small step,
- A series of ***key questions*** to incorporate in lessons to aid mathematical thinking.
- A set of questions to help ***exemplify*** the small step concept that needs to be focussed on.


Year 8 | Autumn Term 1 | Ratio and Scale

Understand and use ratio notation

Notes and guidance

This small step will introduce the use of the colon in ratio notation and link it to the representations explored in the previous step. The importance of order of terms within ratio notation should be highlighted. Most questions feature ratio comparing two parts, but students should be exposed to ratios involving multiple parts as well.

Key vocabulary

Equal parts, Order, Proportion, Ratio, Colon

Key questions

Why is order important in ratio notation?
What does 1 : 1 mean?
Can ratio be used to compare more than two items?
Why are 2 : 1 and 1 : 2 different?

Exemplar Questions

Match each ratio card to its corresponding representation.

3 : 1, 3 : 4, 1 : 3

Strawberry Shake is made of strawberries, ice cream and milk in the ratio 1 : 2 : 5. Write down the ratio of milk to ice cream. Write a suggestion for a new ratio to give a stronger strawberry flavour.

Write the ratios, and draw representations for $a : b$ when

$a = 3, b = 1$; $a = 1, b = 3$; $a = 1, b = 1$; $a = b$

How would the ratios change if you added 1 to both a and b?
How would the ratios change if you doubled both a and b?

What is the ratio of the distance AB : BC in the following lines?

Can you position A, B and C on a line so that the ratio AB : BC is 2 : 5? How many different ways can you do this?

- These include reasoning and problem-solving questions that are fully integrated into the scheme of learning. Depending on the attainment of your students, you many wish to use some or all of these exemplars, which are in approximate order of difficulty. Particularly challenging questions are indicated with the symbol .
- For each block, we also provide ideas for key representations that will be useful for all students.

In many of the blocks of material, some of the small steps are in **bold**. These are content aimed at higher attaining students, but we would encourage teachers to use these with as many students as possible – if you feel your class can access any particular small step, then please include it in your planning.

Number Sense

Small Steps

- Round numbers to powers of 10, and 1 significant figure R
- Round numbers to a given number of decimal places
- Estimate the answer to a calculation
- **Understand and use error interval notation** H
- Calculate using the order of operations R
- Calculate with money
- Covert metric measures of length
- Convert metric units of weight and capacity

H denotes higher strand and not necessarily content for Higher Tier GCSE

R denotes "review step" – content should have been covered at KS3

Number Sense

Small Steps

- **Convert metric units of area** H
- **Convert metric units of volume** H
- Solve problems involving time and the calendar

H denotes higher strand and not necessarily content for Higher Tier GCSE

R denotes "review step" – content should have been covered at KS3

Round to powers of 10 and 1 sf

R

Notes and guidance

This small step revises and extends KS2 and Year 7 content.
It is important when rounding to avoid the phrase "round down" as this can lead to misconceptions. The use of number lines is very helpful to decide which number to round to, including when rounding to 1sf. Discussing when to round to a particular degree of accuracy is also useful.

Key vocabulary

Round	Significant	Power
Nearest	Integer	Number line

Key questions

How can you tell how many significant figures a number has? How do you identify the most significant?
What's the same and what's different about rounding to the nearest (e.g.) hundred or thousand?
Can 0 be an answer when rounding a number?

Exemplar Questions

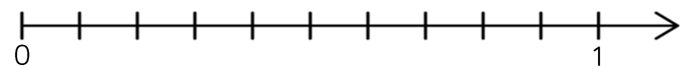
Round the numbers on the cards to the nearest hundred.

648 | 658 | 640.8 | 64.8 | 6.48

1648 | 8648 | 18 648 | 18 650.8

Would it better to round some of the numbers to a different degree of accuracy? Explain why or why not.

Show the approximate position of 0.392 on the number line.



Round 0.392 to the nearest integer.
Round 0.392 to one significant figure.

A newspaper reports a lottery win of £20 million.
The size of the win has been rounded to one significant figure.
What is the least possible size of the win?
What is the greatest possible size of the win?

Complete the statements using <, > or =

12 000 rounded to 1sf ◯ 9650 rounded to the nearest thousand

885 rounded to 1sf ◯ 799.9 rounded to the nearest hundred

24.6 rounded to 1sf ◯ 25.2 rounded to the nearest integer

White Rose Maths

Round to decimal places

Notes and guidance

Although rounding to decimal places is covered in KS2, it is not explicitly covered in our Year 7 scheme. Students may need reminding of the similarities and differences between rounding to decimal places and rounding to significant figures. It is useful to start by rounding to the nearest integer and then introducing one, two (and more only if appropriate) decimal places.

Key vocabulary

Round	Number line	Decimal point
Decimal place	Integer	Nearest

Key questions

How many figures does (e.g.) 36.514 have after the decimal point? To how many decimal places is it given?

What's the same and what's different about rounding (e.g.) 31.57 to 1 significant figure and rounding it to 1 decimal place?

Exemplar Questions

Amir and Rosie are rounding π to 1 decimal place.

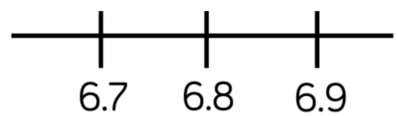
$\pi = 3.14159...$

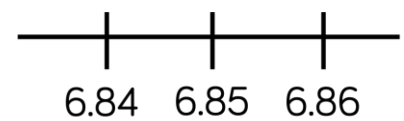
14 159 is much bigger than 5, so the answer is 3.2

π is less than half way between 3.1 and 3.2, so the answer is 3.1

Who do you agree with? Why?

Mark the position of 6.847 on these two number lines.





What is 6.847 rounded to 1 decimal place?
What is 6.847 rounded to 2 decimal places?

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e is an important number in advanced mathematics.

$e = 2.71821818...$

What is e rounded to the nearest integer?
What is e rounded to 1 decimal place? 2 decimal places? 3 decimal places? 4 decimal places? 5 decimal places?

Explain why rounding to one decimal place is the same as rounding to the nearest tenth.

Estimate the answer to a calculation

Notes and guidance

Students will learn to find the estimate to a calculation by rounding the numbers to 1 significant figure and performing the calculation on the simpler numbers obtained. It is worth exploring other strategies and considering whether you can tell if the estimate will be larger or smaller than the actual answer. Using all four operations and powers/roots is also recommended.

Key vocabulary

Significant figure	Estimate	Round
Over/underestimate	Root	Power

Key questions

Why is it useful to make an estimate before doing a calculation?

If both numbers you use when estimating the answer to a calculation are larger than the original numbers, will your estimate be an overestimate or underestimate?

Exemplar Questions

By rounding each number to the nearest integer, find estimates to the calculations.

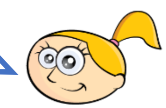
8.7 + 2.9 | 8.7 – 2.9 | 8.7 × 2.9 | 8.7 ÷ 2.9

Round 21.88 to 1 significant figure.
Use your answer to estimate the answer to these calculations.

21.88^2 | 21.88^3 | 600 ÷ 21.88

$\frac{21.88}{40} \approx 2$

$\frac{21.88}{40} \approx \frac{1}{2}$



Who do you agree with? Why?

I know $\sqrt{84}$ is greater than 9 and less than 10

Use your knowledge of square numbers to explain why Mo is correct.
Do you think $\sqrt{84}$ will be closer to 9 or 10? Why?

Estimate the answers to these calculations by rounding the numbers to 1 significant figure.

913 × 6.42 | 82.6 × 35.1 | 6.2 ÷ 1.9

In each case, explain if is it possible to tell if the estimate is an overestimate or an underestimate.

Error interval notation

H

Notes and guidance

This Higher strand step builds on the inequality notation covered earlier in the year to formally represent the upper and lower bounds of a single number that has been rounded to a given degree of accuracy. It is helpful to revise the notation first and to consider the similarities and differences in error intervals for discrete and continuous measures.

Key vocabulary

Round	Significant	Discrete
Continuous	Bound	Integer

Key questions

What is the smallest number that rounds to (e.g.) 16 to the nearest integer? Why isn't 16.4 the largest number that rounds to 16 to the nearest integer?
What's the difference between $<$ and $\leq$? How does this affect how we write error intervals?

Exemplar Questions

a is an integer.
For each of the cards, write down the possible values of a.

$9 \leq a \leq 12$ | $9 < a \leq 12$ | $9 < a < 12$ | $9 \leq a < 12$

$x = 4$ to the nearest integer.

x could be any number from 3.5 to 4.4

Annie is incorrect. Explain why.

Which of these inequalities represents the possible values of x?

$3.5 < x \leq 4.5$ | $3.5 \leq x \leq 4.5$ | $3.5 \leq x < 4.5$

When rounded to two decimal places a number is 7.24
Which of these could have been the original number?

7.234 | 7.244 | 7.2445 | 7.2454 | 7.2354

Write down the error interval for the number.

A number n, rounded to two significant figures is 3800
Write down the error interval for n.
How would the error interval change if n had been rounded to:

- three significant figures?
- four significant figures?

Use the order of operations R

Notes and guidance

Here we build on KS2 and Year 7 content to look at the order of operations in increasingly complex situations. It is useful to include formats involving fraction lines to represent division. Examples including roots as well as powers may be included. Comparing answers with those obtained from calculators is useful for both developing use of calculator skills as well as checking.

Key vocabulary

Operation	Order	Priority
Power	Root	Index/Indices

Key questions

Why do (e.g.) $11 + 7 - 4$ and $11 - 4 + 7$ have the same answer?

Which pairs of operations have equal priority in calculations?

Will (e.g.) $\sqrt{9} + \sqrt{16}$ and $\sqrt{9 + 16}$ have the same answer? Why or why not?

Exemplar Questions

$10 - 3 + 5$
$= 10 - 8$
$= 2$

$10 - 3 + 5$
$= 7 + 5$
$= 12$

Do you agree with Whitney or Dexter? Why?

Put these cards in order of their value, starting with the smallest

$3 + 4^2$	$(3 + 4)^2$	$3^2 + 4$	$3^2 + 4^2$

Without working out the calculations, which cards are equal in value?

$64 + \frac{38}{2}$	$\frac{1}{2} \times 64 + 38$	$(64 + 38) \div 2$	$\frac{64 + 38}{2}$
$38 \div 2 + 64$	$38 + 64 \div 2$	$64 + 38 \div 2$	

Which of these cards will have a negative value? How do you know?

$3 - 4 + 5$	$3 - 4 \times 5$	$3 \times 4 - 5$	$-3 \times (4 - 5)$

Add brackets to the calculations to make them correct.

$6 + 4 \times 7 - 3 = 22$ $\quad$ $6 + 4 \times 7 - 3 = 40$

$6 + 4 \times 7 - 3 = 67$

What is the value of $6 + 4 \times 7 - 3$ if there are no brackets?

Calculate with money

Notes and guidance

This small step provides a good opportunity to revisit other topics such as percentages, fractions and ratio in the context of money, and to maintain fluency with non-calculator methods as dependent on the needs of the class. Interpreting calculator displays can also be checked. It is a good opportunity to remind students of the vocabulary of financial mathematics.

Key vocabulary

Change	Deposit	Interest
Debit	Credit	Balance

Key questions

How do you use a calculator to find a percentage of an amount?
What's the difference between credit and debit?
How many decimal places should I round to when doing a calculation with money in pounds? What if the calculator shows an answer like 6.7 pounds?

Exemplar Questions

Ron buys a magazine for £2.95 and a drink for 75p
He finds the total cost on his calculator and the display shows:

77.95

Use estimation to prove that Ron's answer must be wrong.
What mistake did Ron make?
Find the change he should receive if he pays with a £10 note.

Are the chocolates actually half price? Explain why or why not.

Estimate the cost of buying a box of chocolates for each student in a class of 32

Find the difference between your estimate with the actual cost. Express the difference as a percentage of the actual cost.

Huan and Filip share some money in the ratio 5 : 2
How much money is there in total if:

- Huan gets £30?
- Filip gets £30?
- The difference between their shares is £30?

Eva has a bank balance of £84.35
She wants to pay a 20% deposit on a new tablet that costs £435
Can she afford the deposit and still be in credit in the bank?

Convert metric measures of length

Notes and guidance

This small step reviews and extends Year 7 content to look at more complex conversions. It provides a good context in which to revisit area formulae to help cement these in students' minds, and to look again at multiplication and division by powers of ten. It is useful to make connections with the prefixes kilo, milli etc. also used in the next step.

Key vocabulary

Metric	Metre	Prefix
Kilo	Milli	Centi

Key questions

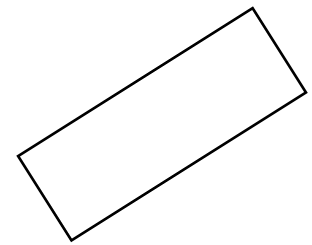
What is the difference between the prefixes kilo and milli?
Why do we need two prefixes that both mean 1 000?
How do you know whether to multiply or divide when converting metric units?
Why is (e.g.) 6.4 cm not equal to 6.40 mm?

Exemplar Questions

Use the facts that
1 m = 100 cm and
1 cm = 10 mm
to prove that Alex is wrong.

A rectangle has length 3 m and width 60 cm.
Work out:

- The perimeter of the rectangle in cm
- The perimeter of the rectangle in m
- The area of the rectangle in m^2
- The area of the rectangle in m^2



A circle has radius 85 cm.
Find the circumference of the circle, in metres, giving your answer to three significant figures.

By converting the measurements on the cards to metres, put these lengths in order of size starting with the smallest.

3.6 km | 36 cm | 360 cm | 36 km | 36 000 km

A parallelogram of base 2 m has the same area as a triangle of base 60 cm and perpendicular height 400 mm.
Work out the perpendicular height of the parallelogram.

Convert units of weight and capacity

Notes and guidance

This step emphasises the connections between conversions of all the metric units to establish the consistency of meaning of milli- kilo- etc. As well as performing the calculations, there is opportunity to discuss which unit is suitable to measure which item as many students may not be aware of this and see the activity as purely abstract.

Key vocabulary

Round   Significant

Key questions

What is the difference between multiplying an integer and a number with decimal places by 10/100/1 000?
What's the difference between a kilogram and a kilometre
How do you know whether to multiply or divide when converting metric units?

Exemplar Questions

What do all these have in common?

____ ml in a litre	____ mm in a metre	____ mg in a gram

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g   kg   mg   tonnes

What would be a sensible unit to measure the mass of each item?

- an ant
- a hamster
- a cow
- a lorry

List some other items that are suitable to measure with each unit.

Complete the statements using <, > or =

0.4 litres ____ 400 ml	40 g ____ 0.4 kg
0.04 tonnes ____ 4 kg	40 cl ____ 400 ml
40 kg ____ 40 000 g	4 cg ____ 0.4 g

Are these statements true or false? Correct any false statements.

x kg $\equiv 1000x$ g	y g $\equiv 10y$ cg	z cl $\equiv 10z$ ml
$a$cl $\equiv \frac{a}{10}$ litres	b g $\equiv \frac{b}{1000}$ kg	c ml $\equiv \frac{c}{10}$ cl

Convert metric units of area H

Notes and guidance

It is worth explicitly challenging the misconception that as 1 cm = 10 mm then 1 cm^2 = 10 mm^2. You can do this by exploring the area of a square of length 1 cm and comparing it to the area of a square of length 10 mm. Links could be made to previous steps including rounding when converting. This can be revisited later in the year when the area of a circle is first met.

Key vocabulary

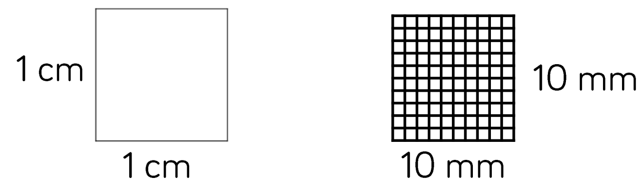
Area	Perpendicular	Units
Square units	Dimensions	

Key questions

Why is it that (e.g.) 1 $cm^2 \neq 10$ mm^2 ?
How do we find the area of a…? What happens to all the dimensions if we change them from (e.g.) m to cm?
Why can't we multiply 30 cm by 5 m without converting first?

Exemplar Questions

Explain how the diagrams show that 1 $cm^2 \neq 10$ mm^2



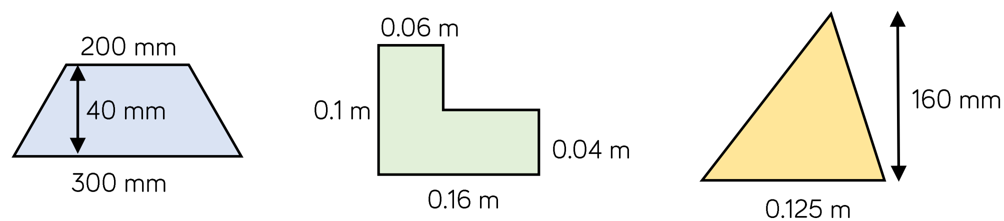
Put these areas in order of size starting with the smallest.

3.6 cm^2	306 mm^2	63 mm^2	330 mm^2
36 mm^2	630 mm^2	6.3 mm^2	36 cm^2

A rectangular playground measures 8 m by 17 m.
Find the area the playground giving your answer in m^2.
Now change the lengths to cm and work out the area the playground again, giving your answer in cm^2.
Use your answers to complete the statement.

1 m^2 = ____ cm^2

Show that the area of each shape is 100 cm^2.



Convert metric units of volume H

Notes and guidance

Volume has not yet been explicitly covered in KS3, but students following the Higher strand should be familiar with units of volume from KS2 and should also be confident in finding the volume of a cuboid. The large numbers created by volume conversion are a useful context on which to revisit numbers expressed in standard from.

Key vocabulary

Area	Perpendicular	Units
Cubic units	Dimensions	

Key questions

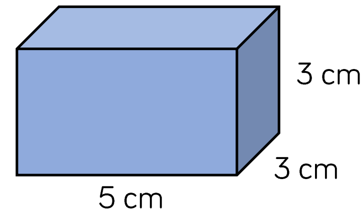
How do you calculate the volume of a cuboid/cube?

What happens to all the dimensions if we change them from (e.g.) m to cm?

Is there a connection between volume and cube numbers?

Exemplar Questions

Work out the volume of the cuboid, giving your answer in cm³.



Now change the lengths to mm and work out the volume of the cuboid, giving your answer in mm³.

Use your answers to complete the statement.

1 cm³ = ________ mm³

Which of these measures are equivalent to 1 m³?

Justify your answer.

- 100 cm³
- 10 000 cm³
- 1 000 000 cm³
- 1000 cm³
- 100 000 cm³

Complete the statements using $<$, $>$ or $=$

8 m³ ____ 800 000 cm³	8 cm³ ____ 8000 mm³
8 000 cm³ ____ 0.08 m³	800 mm³ ____ 0.08 cm³
8×10^7 cm³ ____ 80 m³	8×10^{-2} cm³ ____ 80 mm³

Time and the calendar

Notes and guidance

This topic is often regarded as 'common knowledge' but without explicit teaching/reminding, students are often prone to errors. Revisiting conversions in starters, or in other contexts, may be necessary to help students remember them. The use of an 'empty number line' to model calculating time differences is very helpful, emphasising that time is not a decimal quantity.

Key vocabulary

12-hour clock	24-hour clock	Week
Month	Year	Leap year

Key questions

To find the amount of time between (e.g.) 9:40 and 11:25, why can't you just do 11.25 – 9.40 on a calculator?
Which months have 30 days? How can you remember these?
How can you tell if a time is given in 12 or 24 hour clock?

Exemplar Questions

Three consecutive months in 2020 have a total of 91 days.
What might the months be?
How many possibilities can you find?
What are least and greatest possible totals of four consecutive months in 2020? Why might 2021 be different?

Feb 1st 2022 is a Tuesday.
What dates in January 2022 will be Tuesdays?

How many hours are there is one week?
It is believed that to become an expert at a skill takes around 10 000 hours of practice.
To the nearest week, how many weeks is 10 000 hours?
If you practised a skill for 3 hours a day every single day, how many years and months would it take to become an expert?

Investigate Dora's claim, assuming she count one number per second.
How long would it take to count to one billion at the same rate?

It would take me about 10 weeks to count to one million.

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21 : 50

? : ?

A film starts 9:50 pm and lasts $2\frac{3}{4}$ hours.
What time will the film will end?
How could a number line to solve the problem?