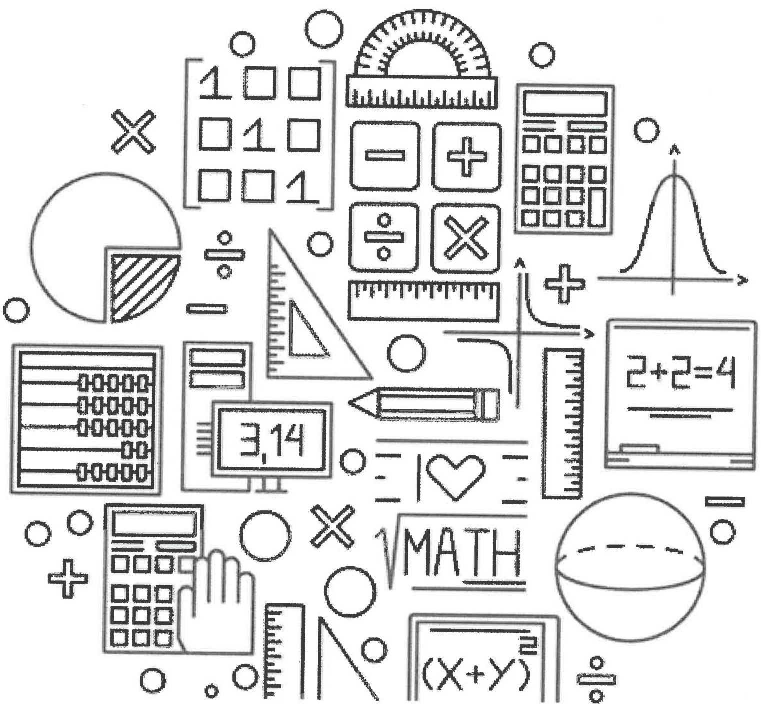
Madani Boys School

Mathematics

YEAR 8

KNOWLEDGE ORGANISER

YEAR 8	
WEEK	**HALF TERM 1**
3	Revision of Four Operations (whole / decimal)
4	Rounding (decimals places / significant figures)
5	Accuracy & Estimation
6	Basic Power Rules / Square Root / Cube Root
7	Prime Factor Trees / HCF / LCM
8	Introduction to Standard Form



YEAR 8 — DEVELOPING NUMBER…

Number Sense

What do I need to be able to do?

By the end of this unit you should be able to:

- Round numbers to powers of 10 and 1 sf
- Round numbers to any dp
- Estimate solutions
- Calculate using order of operations
- Calculate with money, units of measurement and time

Keywords

Significant: Place value of importance
Round: Making a number simpler but keeping its value close to what it was.
Decimal: Place holders after the decimal point.
Overestimate: Rounding up – gives a solution higher than the actual value
Underestimate: Rounding down – gives a solution lower than the actual value.
Metric: A system of measurement.
Balance: The amount of money in a bank account
Deposit: Putting money into a bank account.

Round to powers of 10 and 1 sig figure

R

If the number is halfway between we "**round up**"

5495 to the nearest 1000

5000 … 6000

5475 to the nearest 100

5400 … 5500

5475 to the nearest 10

5470 … 5480

370 to 1 significant figure is 400
37 to 1 significant figure is 40
3.7 to 1 significant figure is 4
0.37 to 1 significant figure is 0.4
0.00037 to 1 significant figure is 0.0004

Round to the first non-zero number

Round to decimal places

2.46192 ← Focus on the numbers after the decimal point

"To 1dp" – to one number after the decimal
"To 2dp" – to two numbers after the decimal

2.46192 (to 1dp) - Is this closer to 2.4 or 2.5

2.4 … 2.5

2.4 | 6192 This shows the number is closer to 2.5

2.46192 (to 2dp) - Is this closer to 2.46 or 2.47

2.46 … 2.47

2.46 | 192 This shows the number is closer to 2.46

Estimate the calculation

Round to 1 significant figure to estimate

4.2 + 6.7 ≈ 4 + 7 ≈ 11 This is an **overestimate** because the 6.7 was rounded up more

The equal sign changes to show it is an estimation

21.4 x 3.1 ≈ 20 x 3 ≈ 60 This is an **underestimate** because both values were rounded down

It is good to check all calculations with an estimate in all aspects of maths – it helps you identify calculation errors.

Order of operations

R

Brackets Operations in brackets are calculated first

Other operations e.g. powers, roots,

Multiplication/ Division

They are carried out in the order from left to right in the question

Addition/ Subtraction

They are carried out in the order from left to right in the question

Calculations with money

Debit - You have £0 or more in an account

Credit - You have less than £0 in an account

Money calculations are to 2dp

Using a calculator – ensure you are working in the correct units

£130 + 50p = 130 + 50 (in pence)
= 1.30 + 0.50 (in pounds)

£1 = 100p

Units are important: Useful Conversions

mm $\xrightarrow{\div 10}$ cm $\xrightarrow{\div 100}$ m $\xrightarrow{\div 1000}$ km

km $\xrightarrow{\times 1000}$ m $\xrightarrow{\times 100}$ cm $\xrightarrow{\times 10}$ mm

g $\xrightarrow{\div 1000}$ kg, kg $\xrightarrow{\times 1000}$ g

ml $\xrightarrow{\div 1000}$ L, L $\xrightarrow{\times 1000}$ ml

Metric measures of length

Kilo = 1000 x meter

Centi - $\frac{1}{100}$ x meter

Milli - $\frac{1}{1000}$ x meter

Units of weight/ capacity

Weight = g, kg, t
Capacity (volume of liquid) = ml, L

Time and the calendar

1 Year – the amount of time it takes Earth to go around the sun **365** (and a quarter) **days**
Leap Year – **366 days** (every 4 years)

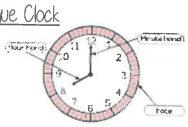
12 Months = one year = 52 weeks
31 days – Jan, March, May, July Aug, Oct, Dec
30 days – April, June, Sept, Nov
28 days – Feb (29 leap year)

1 week – 7 days
Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday

1 day – 24 hours
1 hour - 60 minutes
1 minute – 60 seconds

Use a number line for time calculations!

Analogue Clock



12-hour clock

- Use am (morning) and pm (afternoon)
- Only use hour times up to 12

Digital Clock (24-hour times)

24-hour clock

- 0-11 (morning hours)
- 12-23 (afternoon hours)

NUMBER SKILLS

What do I need to be able to do?

You should be able to:

- Understand properties of addition and subtraction
- Understand properties of multiplication and division
- Use formal methods of addition and subtraction for integers
- Use formal methods of multiplication and division for integers
- Add and subtract directed numbers
- Multiply and divide directed numbers
- Understand and use order of operations with positive and negative integers

Key Words

- Commutative: changing the order of operations does not change the result
- Associative: when you add or multiply you can do so regardless of how the numbers are grouped
- Inverse: the operation that undoes what was done by the previous operation
- Subtract: taking away one number from another
- Negative: a value less than zero
- Debit: money that leaves a bank account
- Credit: money that goes into a bank account
- Integer: a whole number
- Product: multiply terms
- Operation: a mathematical process

Addition

Addition is commutative

2 + 4 = 4 + 2

The order of addition doesn't change the result

Addition is associative

6 + (3 + 4) = (6 + 3) + 4

It doesn't matter how you group the numbers

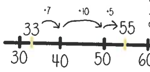
Formal written method:

	H	T	U
	3	4	2
+	1	4	9
	4	9	1
		1	

Remember the place value for each column!

Models to help with addition

- Number lines:



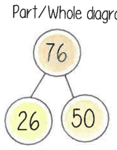
So we can say 33 + 7 + 10 + 5 = 55, or 33 + 22 = 55

- Bar models:

100	
47	53

So we can say 47 + 53 = 100

- Part/Whole diagrams:



So we can say 26 + 50 = 76

Subtraction

Subtraction is NOT commutative or associative

$12 - 8 \neq 8 - 12$

When you subtract, the order must stay the same.

Formal written method:

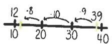
	H	T	U
	5	²3	¹2
−	2	1	6
	3	1	6

Remember 0 is a place holder!

	2	0	8
−	0	0	4

Models to help with addition

- Number lines:



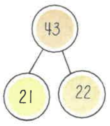
So we can say 39 - 9 - 10 - 8 = 12, or 9 - 27 = 12

- Bar models:

80	
24	56

So we can say 80 - 24 = 56 & 80 - 56 = 24

- Part/Whole diagrams:



So we can say 43 - 21 = 22 & 43 - 22 = 21

Written Methods for Multiplication

LONG MULTIPLICATION:

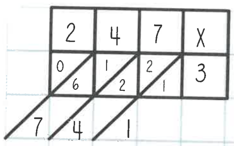
	2	4	7
x	₁	₂	3
	7	4	1

GRID METHOD:

X	200	40	7
3	600	120	21

600 + 120 + 21 = 741

GELOSIA:



REPEATED ADDITION:

	H	T	U
	2	4	7
	2	4	7
+	2	4	7
	7	4	1
	1	2	

Written Methods for Division

SHORT DIVISION:

	0	4	2
6	2	²5	¹2

	1	0	2
8	8	1	¹6

SHORT DIVISION with remainders

	1	2	5	5
2	2	5	¹1	0

Continue after the decimal point! If you start to get a repeating decimal, stop

LONG DIVISION:

	0	4	2	
6	2	5	2	
−	2	4	0	6 X 40
	0	1	2	
−	0	1	2	6 X 2
			0	

This method relies on you being comfortable with multiples of your divisor (in this case, 6)!

Calculations with Directed Numbers

Addition

2 + - 3

Remember, If I add a negative, I am adding something that will make it smaller, so it is the same as subtracting that number!

2 - 3 = -1

Subtraction

2 - - 3

Remember, If I subtract a negative, I am taking away the amount that was making it smaller, so it is the same as adding that number!

2 + 3 = 5

Generalisation.

+ - = -   - - = +

Multiplication

2 x - 3

'2 lots of -3'

= -6

-2 x -3

Think of this as the negative of 2 x -3

= 6

Division

Remember that multiplication and division are inverse operations.

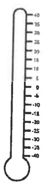
Eg 6 ÷ -3 = -2

-6 ÷ 2 = -3

Generalisation

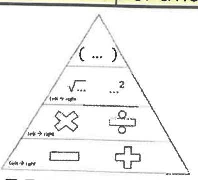
X	+	−
+	+	−
−	−	+

Models to help



It can be helpful to put calculations involving directed numbers into real life contexts Think about temperate or bank accounts when unsure

Order of Operations



Example 1

(4 x 7) + 3

So we need to evaluate the brackets first; 4x7 = 28

This is now 28 + 3 = 31

Example 2

$(6 + 4 - 3)^2 \times 4$

So we need to evaluate the brackets first and we work left to right; 6 + 4 - 3 = 7

This is now $7^2 \times 4 = 49 \times 4$

= 196

Example 3

4 - 8 x 2 + 12 ÷ 4

So first we do the multiplication/division left to right; 4 - 16 + 3

Now we do the addition/subtraction from left to right: -12 + 3 = -9

ESTIMATION

What do I need to be able to do?

You should be able to :

- Round numbers to an appropriate accuracy
- Truncate numbers to an appropriate accuracy
- Use inequality notation to identify the error interval due to rounding
- Estimate the value of a calculation

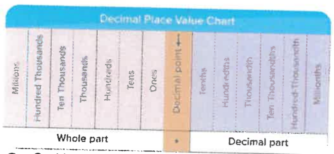
HIGHER TIER ONLY

- Find the greatest and least possible value of a calculation

Key Words

- Significant Figure: the digits in a number which are significant to the size of the number
- Error Interval: The range of values a number could have taken before rounding
- Estimation: finding a number close to the right answer
- Lower Bound: the smallest number that would round up to the estimated value
- Upper Bound: the smallest value that would round up to the next estimated value

Place Value



3 2 4 7 3 5 1 • 1 4 5

"Three million, two hundred and forty seven thousand, three hundred and fifty one point one four five"

Round to Powers of 10

2745 to the nearest 10

2740 — 2745 — 2750

If the number is half way between both, we round up

2745 to the nearest 100

2700 — 2745 — 2800

Look at the digit in the 'tens column', here we have a 4. Therefore we round down to 2700

2745 to the nearest 1000

2000 — 2745 — 3000

Look at the digit in the 'hundreds column', here we have a 7. Therefore we round up to 3000

Round to Decimal Places

"To 1 dp" means to one number after the decimal
"To 2 dp" means to two numbers after the decimal

Method 1

Round 7.46582 to 1 dp

7.4 — 7.46582 — 7.5

Round 7.46582 to 2 dp

7.46 — 7.46582 — 7.47

Method 2

Round 7.46582 to 1 dp

7.4|6582 6, so we round up to 7.5

Round 7.46582 to 2 dp

7.46|582 5, so we round up to 7.47

Round to Significant Figures

Start counting as soon as you get to a non-zero digit

Rounding to 1 significant figure (1 sf)

Round 1394 to 1 sf = 1000
Round 265 to 1 sf = 300
Round 32 to 1 sf = 30
Round 1.87 to 1 sf = 2
Round 0.439 to 1 sf = 0.4
Round 0.008722 to 1 sf = 0.009
Round 0.0005043 to 1 sf = 0.0005

Rounding to 2 significant figures (2 sf)

Round 1394 to 2 sf = 1400
Round 265 to 2 sf = 270
Round 32 to 2 sf = 32
Round 1.87 to 2 sf = 1.9
Round 0.439 to 2 sf = 0.44
Round 0.008722 to 2 sf = 0.0087
Round 0.0005043 to 2 sf = 0.00050

Truncation

Truncate 3.828 to 1 decimal place

3.8|2~~8~~ We ignore any digits after the first decimal place. So the answer is 3.8

Truncate 3.828 to 2 decimal places

3.82|~~8~~ We ignore any digits after the second decimal place. So the answer is 3.82 Notice that if we were to round 2.828 to 2 decimal places, we could get a different answer (3.83)

Truncate 3.828 to 1 significant figure

3|~~.828~~ We ignore any digits after the first significant figure. So the answer is 3

Truncate 3.828 to 3 significant figures

3.82|~~8~~ We ignore any digits after the third significant figure. So the answer is 3.82 Again notice that if we were to round this to 3 sf, the answer would be 3.83!

Truncate 0.0037281 to 3 significant figures

0.00372|81

0.00372

Error Intervals

If a number has been rounded, it is important to consider what possible values the exact value could have been. If we have a puppy that weighs 4kg to the nearest kg, it could actually weigh anything from 3.5kg to 4.5kg! To describe all the possible values that a rounded number could be, we use upper and lower bounds

A plant is 35cm tall, rounded to the nearest cm, what was the shortest and tallest height of the plant?

34cm — 35cm — 36cm

34.5cm 35.5cm

34.5cm ⩽ height < 35.5cm

A number was rounded to 3 decimal places to leave 0.673. What could the number be?

0.672 — 0.673 — 0.674

0.6725 0.6735

0.6725 ⩽ x < 0.6735

The speed of a train is 230 km/h truncated to 2 significant figures. What was the range for the true value of the speed?

230 — 240

235

Anything which starts with 23_ will be truncated to 230!

230 ⩽ speed < 240

Estimating Calculations

Estimate the value of 28 x 48

If we round both to 1 sf, this gives;
30 x 50 = 1500

Therefore 28 x 48 ≈ 1500

Estimate the value of (59.3 - 12.09) ÷ 23.4

We can approximate this sum to be (60 - 12) ÷ 20 = 2.5

Therefore,
(59.3 - 12.09) ÷ 23.4 ≈ 2.5

Estimate the value of $\frac{(4.2 \times 2.4)^2}{\sqrt{5}}$

We can estimate that (4.2 x 2.4) is approximately equal to 4 x 2 (8)

Now to deal with √5! We know that 4 is a square number and it is close to 5 so we can say that √5 is approximately equal to √4 (2)

The sum becomes $\frac{(4 \times 2)^2}{\sqrt{4}} = 32$

so $\frac{(4.2 \times 2.4)^2}{\sqrt{5}} \approx 32$

Using Error Intervals in Calculations

HIGHER TIER ONLY

A bag of peas has a mass of 700g (to the nearest 10g). Find the maximum mass of 5 bags of peas.

Maximum weight of one bag of peas:

690 — 700 — 710

695 705

= 705g

Therefore, the maximum weight of 5 bags of peas = 5 x 705 = 3525g

A = 30 (to the nearest whole number)
B = 11.5 (to the nearest 1 decimal place)
C = 300 (to the nearest 1 significant figure)

Error Interval for A 29.5 ⩽ A < 30.5
Error Interval for B 11.45 ⩽ B < 11.55
Error Interval for C 250 ⩽ C < 350

Calculate the maximum value of A + B

UB of A + UB of B 30.5 + 11.55 = 42.05

Calculate the minimum value of A x C

LB of A x LB of C 29.5 x 250 = 7375

Calculate the maximum value of C ÷ B

UB of C ÷ LB of B = 350 ÷ 11.45 = 30.7 (2dp)

FACTORS, MULTIPLES AND PRIMES

What do I need to be able to do?

You should be able to:

- Understand and use factors
- Understand and use multiples
- Recognise prime numbers
- Recognise square/triangular numbers
- Find common factors, including HCF
- Find common multiples, including LCM
- Express a number as the product of it's prime factors

Key Words

- Multiple: found by multiplying any number by a positive integer
- Factor: integers that multiply together to get another number
- Prime: an integer with only two factors (1 and itself)
- HCF: the highest common factor of two or more numbers
- LCM: the lowest common multiple of two or more numbers
- Product: multiply terms

Factors

A number can have many factors!

Example: what are the factors of 12?

- 1 x 12
- 2 x 6
- 3 x 4

So the factors of 12 are 1, 2, 3, 4, 6, 12

How to find factors

Be systematic! Always find your factor pairs and then write them in ascending order. This way you can be sure you've not missed any out!

Multiples

'The multiples of a number make up it's times table'

Eg. What are the multiples of 4?

4 x 1, 4 x 2, 4 x 3, 4 x 4 etc..

4, 8, 12, 16, 20...

This list never ends!

Is 15 a multiple of 3?

5	5	5

As I can share 15 into 3 equally sized parts, 15 is a multiple of 3!

3 x 5 = 15

NON-EXAMPLE

Why is 10 not a multiple of 4?

4 X 2.5 = 10 but 2.5 is not an interesting therefore 10 cannot be a multiple of 4!

Prime Numbers

- Always an integer
- Has only two factors; 1 and itself

Not in any other times tables apart from it's own

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

2 is the smallest, and only even, prime number

1 is not a prime number

A prime number has 2 factors, 1 and itself. 1 only has 1 factor (itself/1) therefore it isn't prime!

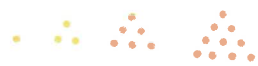
Square Numbers

They're called square numbers as, when arranged in an array they make a square!

1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225...

Square numbers have an odd number of factors.

Triangular Numbers



They're called triangular numbers as they make a triangle!

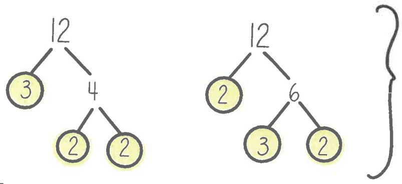
If you add two consecutive triangular numbers, you get a square number!

1, 3, 6, 10, 15, 21, 28, 36, 45, 55, 66, 78, 91, 105, 120...

Product of Prime Factors

Example 1

Write 12 as a product of it's prime factors



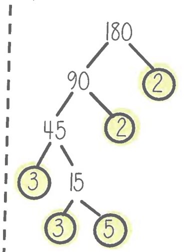
Both of these trees represent the same decomposition

$12 = 2 \times 2 \times 3$

$= 2^2 \times 3$

Example 2

Write 180 as a product of it's prime factors



$180 = 2 \times 2 \times 5 \times 3 \times 3$

$= 2^2 \times 3^2 \times 5$

Always try to write your final answer in ascending order using index notation!

Using prime factor decomposition

If we know that 12 written as a product of it's prime factors, how does that help us to write 36 as a product of it's prime factors?

We know $12 \times 3 = 36$ therefore we can multiply our answer by three and

$36 = 2 \times 2 \times 3 \times 3$

$= 2^2 \times 3^2$

What about 120?

Well 120 is 10 x 12 so we can say

$120 = 2 \times 2 \times 3 \times 10$

$= 2^3 \times 3 \times 5$

Remember $10 = 2 \times 5$

Lowest Common Multiple (LCM)

Example 1

What is the LCM of 6 and 8?

6 - 6, 12, 18, 24, 30

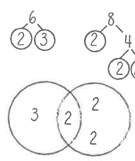
8 - 8, 16, 24, 32, 40

The first time their multiples match is 24 therefore:

the LCM of 6 and 8 is 24

Example 2

What is the LCM of 6 and 8?



We just multiply all of the numbers in the Venn diagram together to find the LCM!

LCM of 6 and 8 = 3 x 2 x 2 x 2

= 24

Example 3a

What is the LCM of 24 and 16?

Choose any factor of 24 and 16 (here we chose 2!)

then we divide 24 and 16 by 2!

Then repeat until we cannot take out any more common factors

	24	16
2	12	8
2	6	4
2	3	2

LCM of 16 and 24 = 2 x 2 x 2 x 3 x 2

= 48

Example 3b

What is the LCM of 12 and 15?

	12	15
3	4	5

LCM of 12 and 15 = 3 x 4 x 5

= 60

Highest Common Factor (HCF)

Example 1

What is the HCF of 6 and 8?

6 - 1, 2, 3, 6

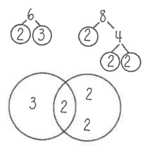
8 - 1, 2, 4, 8

The biggest number which is a factor of both 6 and 8 is 2, therefore

the HCF of 6 and 8 is 2

Example 2

What is the HCF of 6 and 8?



As we are looking for the highest common factor we are looking for the factors which the two numbers share These can be found in the overlap in the Venn diagram!

HCF of 6 and 8 = 2

Example 3a

What is the HCF of 24 and 16?

As we are taking out common factors here, we find the HCF by multiplying them!

	24	16
2	12	8
2	6	4
2	3	2

HCF of 16 and 24 = 2 x 2 x 2

= 8

Example 3b

What is the HCF of 12 and 15?

	12	15
3	4	5

HCF of 12 and 15 = 3

INDICES

What do I need to be able to do?

You should be able to:

- Add/subtract with indices
- Multiply expressions with indices
- Divide expressions with indices
- Know the addition law for indices
- Know the subtraction law for indices
- Be familiar with the key results
- Work with negative exponents

HIGHER TIER ONLY

- Work with fractional exponents

Key Words

- Base: the number that gets multiplied by a power
- Power: the number of times the number is used in a multiplication
- Exponent: power (see above)
- Index: power (see above)
- Coefficient: a number used to multiply a variable
- Variable: a letter which represents an unknown number
- Commutative: changing the order of the operations doesn't change the result

power/exponent/index

5^2 | coefficient $3d^4$

base

Addition Law for Indices

$$\boxed{a^m \times a^n = a^{m+n}}$$

Examples

- $2^2 \times 2^3 = 2 \times 2 \times 2 \times 2 \times 2 = \underline{2^5}$
- $k^4 \times k^2 = k \times k \times k \times k \times k \times k = \underline{k^6}$

Subtraction Law for Indices

$$\boxed{a^m \div a^n = a^{m-n}}$$

Examples

$5^3 \div 5 = \frac{5 \times 5 \times 5}{5} = \underline{5^2}$

$d^5 \div d^2 = \frac{d \times d \times d \times d \times d}{d \times d} = \underline{d^3}$

Further Examples

Remember it is best practice to write your variables in alphabetical order!

1. $4w \times 5z = 4 \times 5 \times w \times z = \underline{20wz}$

Multiply the coefficients together and then consider the variables!

2. $3a \times 4a^2 \times 2a$
$= 3 \times 4 \times 2 \times a \times a \times a \times a$
$= \underline{24a^4}$

Remember if there is no power written, it is to the power of 1

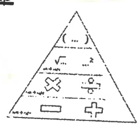
3. $(t^3)^2 = t^3 \times t^3$
$= t \times t \times t \times t \times t \times t$
$= \underline{t^6}$

Don't forget that if you square something, you multiply it by itself!

4. $3p^2 \times 4p^3 \div 6p^4 = \frac{3p^2 \times 4p^3}{6p^4}$
$= \frac{12p^5}{6p^4}$
$= \underline{2p}$

Don't forget about the order of operations!!

Using the subtraction law, 5-4=1



Spotting Patterns

$2^3 = 2 \times 2 \times 2 = 8$

$2^2 = 2 \times 2 = 4$

$2^1 = 2$

$2^0 = 1$

$2^{-1} = \frac{1}{2}$

$2^{-2} = \frac{1}{4} = \frac{1}{2^2}$

$2^{-3} = \frac{1}{8} = \frac{1}{2^3}$

Each time I add one to the power, I multiply by 2

Each time I take one from the power, I divide by 2

Therefore, 2 to the power of 0 is 1
Remember anything to the power 0 is 1

If we carry this on, we can even say what 2 to the power of a negative number is!

We can even spot that 2 to the power of -2 is the same as 1 over 2 to the power of 2 (or 2 squared!)

FRACTIONAL INDICES

HIGHER TIER ONLY

$$\boxed{a^{\frac{1}{m}} = \sqrt[m]{a}}$$

Examples

$25^{\frac{1}{2}} = \sqrt{25} = \underline{5}$ $\quad 8^{\frac{1}{3}} = \sqrt[3]{8} = \underline{2}$

$$\boxed{a^{\frac{n}{m}} = (\sqrt[m]{a})^n}$$

Examples

$25^{\frac{3}{2}} = (\sqrt[2]{25})^3 = 5^3 = \underline{125}$

Remember that this is the same as $(25^{\frac{1}{2}})^3$

Harder Examples

$(81x^2)^{\frac{1}{2}} = \sqrt{81x^2} = \underline{9x}$

$(9c^4)^{\frac{3}{2}} = (\sqrt{9c^4})^3 = (3c^2)^3 = \underline{27c^6}$

Remember this means we cube EVERYTHING inside the brackets

$(32f^{20})^{\frac{3}{5}} = (\sqrt[5]{32f^{20}})^3 = (2f^4)^3 = \underline{8f^{12}}$

It is really helpful to know the powers of 2;
2
4
8
16
32

Refer to the ladder on the right if you're struggling to spot the patterns!

Square and Cube Numbers

When working with indices, it is helpful to know your square and cube numbers!

SQUARE NUMBERS

1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225...

CUBE NUMBERS

1, 8, 27, 81, 125, 216, 343, 512...

You are expected to know these!

NEGATIVE FRACTIONAL INDICES

HIGHER TIER ONLY

EXAMPLE 1

$8^{-\frac{1}{3}} = \frac{1}{8^{\frac{1}{3}}}$

$= \underline{\frac{1}{2}}$

Remember this means the cube root of 8!

EXAMPLE 2

$25^{-\frac{3}{2}} = \frac{1}{25^{\frac{3}{2}}}$

$= \frac{1}{5^3}$

$= \underline{\frac{1}{125}}$

Remember this is the same as $(25^{\frac{1}{2}})^3$

EXAMPLE 3

$(343x^9)^{-\frac{2}{3}} \div x^3$

$= \frac{1}{(343x^9)^{\frac{2}{3}}} \div x^3$

$= \frac{1}{(7x^3)^2} \div x^3$

$= \frac{1}{49x^6} \times \frac{1}{x^3} = \underline{\frac{1}{49x^9}}$

Don't forget the order of operations!

Remember instead of dividing by x cubed, we can multiply by the reciprocal

KEY THINGS TO REMEMBER

$$\boxed{a^m \times a^n = a^{m+n}}$$

$$\boxed{a^m \div a^n = a^{m-n}}$$

$$\boxed{a^0 = 1}$$

$$\boxed{a^{-m} = \frac{1}{a^m}}$$

HIGHER TIER ONLY

$$\boxed{a^{\frac{1}{m}} = \sqrt[m]{a}}$$

$$\boxed{a^{\frac{n}{m}} = (\sqrt[m]{a})^n}$$

STANDARD FORM

What do I need to be able to do?

You should be able to :

- Write numbers in standard form
- Convert numbers written in standard form to ordinary numbers
- Order numbers in standard form
- Add/subtract numbers in standard form
- Multiply/divide numbers in standard form
- Use a calculator when working with standard form

Key Words

Standard Form: a system of writing very big or small numbers

Commutative: changing the order of operations doesn't change the result

Base: the number that gets multiplied by a power

Power: the number of times the number is used in a multiplication

Index: power (see above)

Exponent: power (see above)

Negative: a value below zero

Converting ordinary numbers into standard form

Any integer

$A \times 10^n$

Any number between 1 and 10

Examples

700	12500	0.00034
$= 7 \times 10 \times 10$	must be between 1 and 10 $= 1.25 \times 10 \times 10 \times 10 \times 10$	Remember a negative power doesn't make the answer negative, just closer to 0!
$= 7 \times 10^2$	$= 1.25 \times 10^4$	$= 3.4 \times 10^{-4}$

Converting standard form into ordinary numbers

Example 1	Example 2	Non-Examples
2×10^3	4.12×10^2	$12 \times 10^2 = 1200$ — must be between 1 and 10!
$= 2 \times 10 \times 10 \times 10$	$= 4.12 \times 10 \times 10$	$1.84 \times 10^{0.9} = 14.62$ — must be an integer!
$= 2000$	$= 412$	$6.4 \times 8^3 = 3276.8$ — must be a power of 10!

Index Laws Recap

$10^3 = 10 \times 10 \times 10 = 1000$

$10^2 = 10 \times 10 = 100$

$10^1 = 10$

$10^0 = 1$

$10^{-1} = \frac{1}{10}$

$10^{-2} = \frac{1}{100} = \frac{1}{10^2}$

$10\text{-}3 = \frac{1}{1000} = \frac{1}{10^3}$

+1, ×10, −1, ÷10

Each time I add one to the power, I multiply by 10

Each time I take one from the power, I divide by 10

Therefore, 10 to the power of 0 is 1. Remember anything to the power 0 is 1

If we carry this on, we can even say what 10 to the power of a negative number is!

We can even spot that 10 to the power of -2 is the same as 1 over 10 to the power of 2 (or 10 squared)

Ordering Numbers in Standard Form

10^4	10^3	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}

3.1×10^2	4.12×10^4	2×10^{-2}	3.281×10^3	2.4×10^{-2}
310	41200	0.02	3281	0.024

$2 \times 10^{-2} \rightarrow 2.4 \times 10^{-2} \rightarrow 3.1 \times 10^2 \rightarrow 3.281 \times 10^3 \rightarrow 4.12 \times 10^4$

Adding and Subtracting Numbers in Standard Form

$(2.1 \times 10^6) + (3.3 \times 10^3)$

Foolproof method: convert both numbers to ordinary numbers and then add

$(2.1 \times 10^6) + (3.3 \times 10^3)$

$2{,}100{,}000 + 3300$

$= 2{,}103{,}300$

$= 2.103 \times 10^6$

You should leave your answer in the form given in the question

$(7.32 \times 10^{-1}) - (2.8 \times 10^{-3})$

$0.732 - 0.0028$

$= 0.7292$

$= 7.292 \times 10^{-1}$

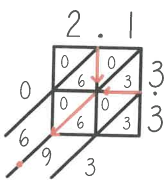
Remember, the best way to work out a subtraction is with column method!

$$\begin{array}{r} 0.7320 \\ -\ 0.0028 \\ \hline 0.7292 \end{array}$$

Multiplying and Dividing Numbers in Standard Form

$(2.1 \times 10^6) \times (3.3 \times 10^3)$

In multiplication and division problems, you can multiply the A values and the look at the powers of 10



$2.1 \times 3.3 \times 10^6 \times 10^3$

$= 6.93 \times 10^6 \times 10^3$

Remember $a^m \times a^n = a^{m+n}$

$= 6.93 \times 10^9$

$(2.8 \times 10^8) \div (7 \times 10^5)$

$\frac{2.8 \times 10^8}{7 \times 10^5} = \frac{0.4 \times 10^8}{10^5} = 0.4 \times 10^3$

Remember $a^m \div a^n = a^{m-n}$

BUT...

0.4×10^3 is not in standard form, as A is not a number between 1 and 10! So...

$0.4 \times 10^3 = 400$

$= 4 \times 10^2$

Using a Calculator

If we need to write 1.3×10^3 in our calculator;

You're going to need this button here!

Input 1.3 and then press $\times 10^x$

Then press 3 for the power.

Your calculator will often give you the solution to your sum, if it is suitably big/small, in standard form