

Mathematics

Key Stage 3

1 Book



TeeJay Maths
ADDING FUN TO LEARNING

National Curriculum Key Stage 3 - Book 1

- This book covers the first third of the **KS3** course, as laid out in the **National Curriculum England Framework Document**.
- There are no A and B exercises. The book covers approximately a third of the Key Stage 3 course and could be used by pupils in Year 7 or earlier. All of the exercises are important !
- The book follows on directly from **TeeJay's Year 6 Book** and includes revision and consolidation of the Upper Key Stage 2 course.
- This **KS3 Book 1** contains a 9 page "**Chapter Zero**" which primarily revises topics covered in Key Stage 2 and can be used as a diagnostic tool. This could be followed by **TeeJay's** diagnostic assessments * of the work covered in our Year 5-6 books.
- It also contains a **Chapter 21**, which revises every topic from our **KS3 Book 1** course, prior to an end of year assessment.
- Non-calculator skills are emphasised and encouraged throughout the book.
- Each chapter has a "**Revisit - Review - Revise**" exercise as a summary.
- **Homework***, mirroring exercise by exercise the topics in this book, is available as a photocopiable pack.
- **TeeJay's Assessment Pack*** for our **KS3 Book 1**, is also available as a photocopiable pack, and can be used topic by topic or combined to form a series of Cumulative Tests. It also contains a series of longer assessments covering the Outcomes as laid out in the **National Curriculum England Framework Document** (Sept 2013).

We make no apologies for the multiplicity of colours used throughout the book, both for text and in diagrams - we feel it helps brighten up the pages !!

T Strang, J Geddes, J Cairns

(June 2017)

* Available for purchase separately.

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CHAPTER 2

Integers

Negative Numbers in Context

The set of **Positive** and **Negative Whole** numbers, along with **Zero** is called the set of **Integers**.

Examples of Integers :- -8, -25, 17, 76, 0, -14, 4003, -3067.

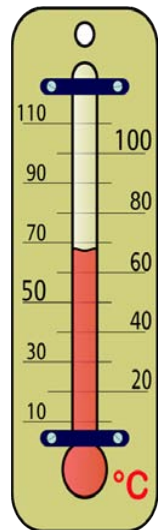
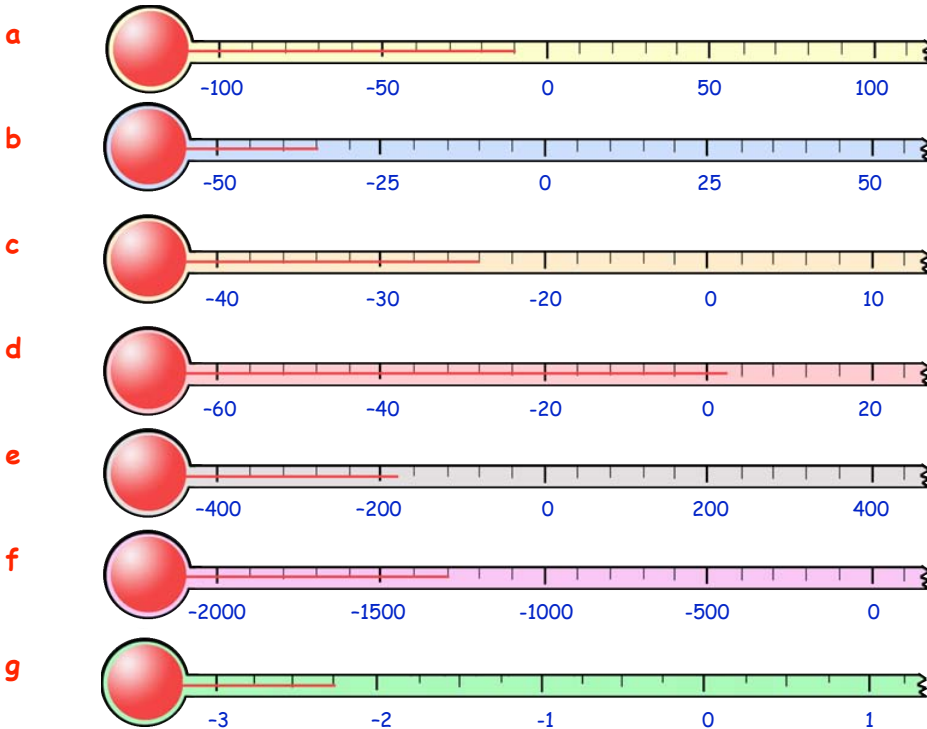
* **Note** 2.5 , $\frac{1}{2}$, $-5\frac{2}{3}$, -3.25 , -213.8 etc. are **not** integers.

Discuss why each of the above is not an integer.

Be able to work with positive & negative numbers in the real world.

Exercise 1 Mainly Revision

1. What **temperature**, in $^{\circ}\text{C}$ is shown on each of these thermometers ?



2. List each of these in order, starting with the warmest :-

a 52°C , -39°C , 110°C , -9°C

b -25°C , -43°C , 0°C , -11°C , 2°C

c -2.3°C , 1.9°C , -2.8°C , -0.9°C , 0.1°C , -1.7°C , 1.6°C , -0.2°C , -1.1°C . (not integers)

If you have savings in a bank, the bank records this with a positive (+) sign.

If you are overdrawn (i.e. owe the bank money), they record this with a negative (-) sign.

(Discuss "in the **red**" and "in the **black**").

If Gerry has $\pounds 100$ in his bank account, the bank computer will show this as :-

+\pounds 100.

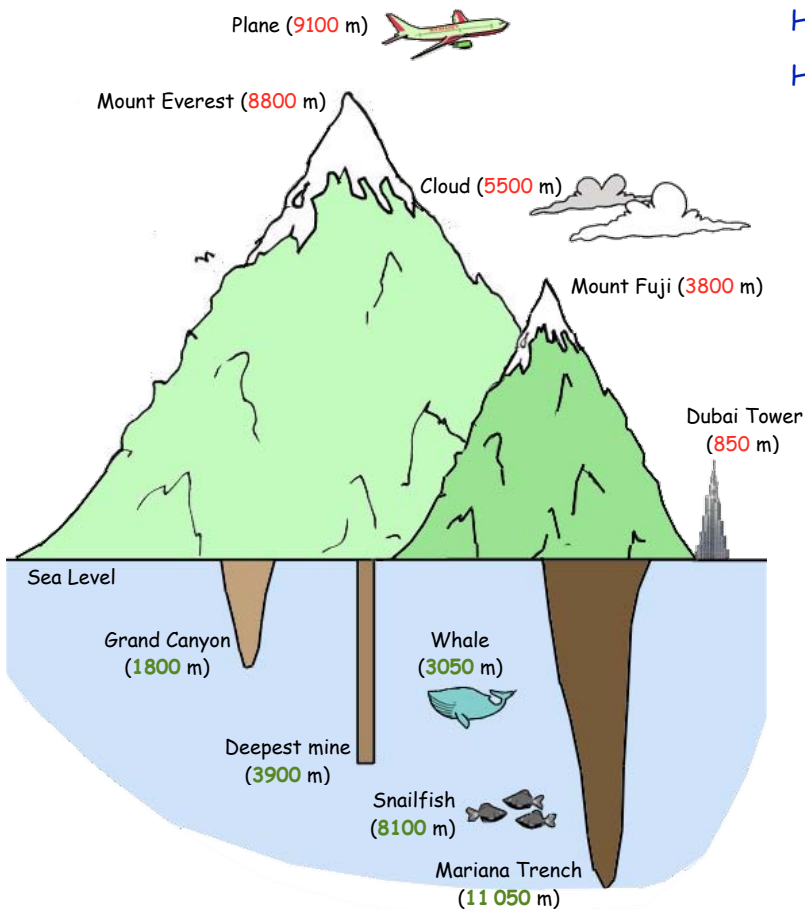
Mary is **overdrawn** by $\pounds 50$. The computer will show this as :-

-\pounds 50.

3. a Sammi's account shows **£1250**. What does this balance mean ?
- b George's account shows **-£39.50**. What does this balance mean ?
- c Alfie had £75 in his account, but withdrew £112.00.
What will his balance now show on the bank computer ?
- d Billy's balance last week was **-£220**, but he paid in £95.
What's his new balance and how much more will he need to pay in to clear his **overdraft** ?
- e Liz's bank balance showed **£305**.
She bought an iPhone for £395 and a bluetooth speaker for £115, using her debit card.
How will her new balance show up on the bank computer ?



4. Positive and negative numbers are used to describe heights above or below sea-level.



Heights **above** sea level are **positive (+)**.

Heights **below** sea level are **negative (-)**.

Use "+" or "-" to describe the heights (depths) of the following :-

- the trans-Atlantic plane
 - the deepest whales dive to
 - the Burj Khalifa tower in Dubai
 - the Grand Canyon in Arizona USA
 - the height of Mount Everest
 - the depth of the deepest mine
 - the height of the clouds
 - the depth of the Mariana Trench
 - the height of Mount Fuji (Japan)
 - the depth that Snailfish swim at.
5. How many metres is :-
- Mount Everest above Mount Fuji
 - the Snailfish below the foot of the mine
 - the top of Mount Fuji above the foot of the Grand Canyon
 - the lowest recorded depth of a whale below the trans-Atlantic plane
 - the clouds above the whale
 - the mine below the top of Mount Everest
 - the base of the Mariana Trench below the top of the Burj Khalifa tower in Dubai ?

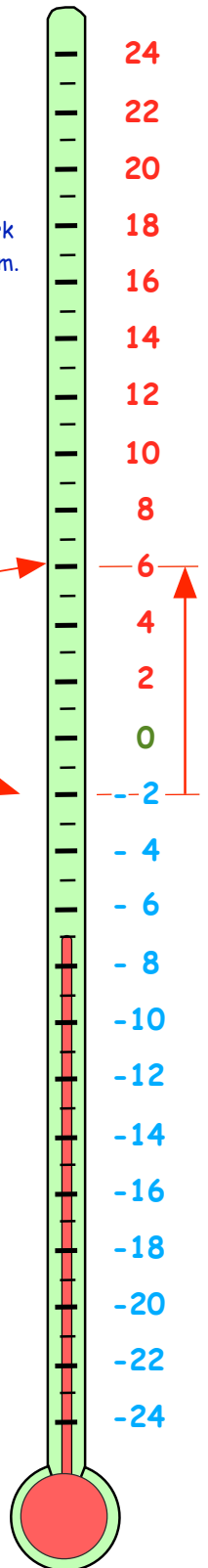
6. Picturing a thermometer in your head, or better still, sketching one, is a useful way of doing calculations involving negative numbers or integers in general.

Copy the thermometer shown opposite and use it to help you do the following :-

Find the temperature that is :-

- | | | | |
|---|----------------------|---|----------------------|
| a | 3°C up from 8°C | b | 15°C up from 0°C |
| c | 35°C up from 52°C | d | 7°C down from 11°C |
| e | 12°C down from 12°C | f | 6°C up from -2°C |
| g | 20°C down from -10°C | h | 45°C up from -25°C |
| i | 17°C down from 3°C | j | 115°C down from 0°C |
| k | 57°C down from -23°C | l | 65°C down from -30°C |
| m | 11°C up from -25°C | n | 42°C up from -50°C. |

Do **not** mark this diagram.



7. Look carefully at your thermometer.

Can you see that 6°C is 8°C up from -2°C?

Copy and complete these in the same way :-

- | | | | |
|---|---------------------------|---|-----------------------------|
| a | 17°C is from 11°C | b | 5°C is from 19°C |
| c | 0°C is from 32°C | d | 25°C is from -25°C |
| e | -11°C is from 0°C | f | 7°C is from -3°C |
| g | -45°C is from -34°C | h | -15°C is from 16°C |
| i | 89°C is from -1°C | j | -105°C is from -75°C. |

8. The temperature in my basement is -8°C.

The attic in my house is 27° warmer.

What is the temperature in the attic ?



- 9.



As a miner descends a mine shaft, the temperature falls **steadily** by 6°C for every 50 metres of descent.

At ground level, the temperature is 17°C.

What is the temperature at a depth of :-

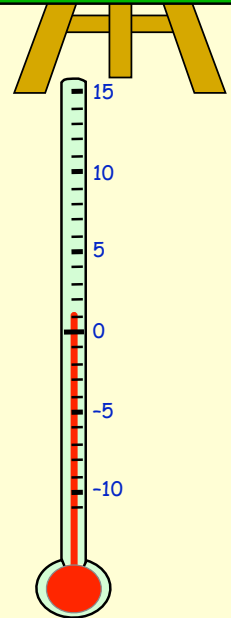
- | | | | |
|---|------------|---|--------------|
| a | 100 metres | b | 150 metres |
| c | 300 metres | d | 350 metres ? |

Adding and Subtracting Integers

When **adding** and **subtracting** integers, consider a thermometer and use the following **two step** method :-

- Example 1 :-** To find $(-1) + 3 \Rightarrow$
- picture the **first** number (-1)
 - then move **(up)** by 3 $\Rightarrow 2$
- Example 2 :-** To find $5 - 7 \Rightarrow$
- picture the **first** number (5)
 - then move **(down)** by 7 $\Rightarrow -2$
- Example 3 :-** To find $4 + (-7) \Rightarrow$
- picture the **first** number (4)
 - then move **(down)** by 7 $\Rightarrow -3$
- Example 4 :-** To find $(-5) + (-8) \Rightarrow$
- picture the **first** number (-5)
 - then move **(down)** by 8 $\Rightarrow -13$

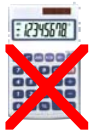
Be able to add & subtract positive and negative numbers.



- So the basic rule is this :-
- if you **add on a (+) number** you move **up**.
 - if you **add on a (-) number** or **subtract a number** you move **down**.

Exercise 2

Draw a thermometer to help you.



1. Write each question first, then the answer :-

- | | | | |
|-----------------|-------------------|------------------|---------------------------------|
| a $4 + 5$ | b $7 + 9$ | c $0 + 11$ | d $8 + (-2)$ |
| e $6 + (-1)$ | f $8 + (-8)$ | g $3 + (-6)$ | h $5 + (-9)$ |
| i $0 + (-7)$ | j $(-5) + 8$ | k $(-10) + 10$ | l $(-4) + 11$ |
| m $(-9) + 7$ | n $(-10) + 6$ | o $5 + (-10)$ | p $(-8) + (-7)$ |
| q $(-9) + (-9)$ | r $(-16) + (-14)$ | s $(-43) + 15$ | t $(-33) + (-20)$ |
| u $(-40) + 10$ | v $(-55) + (-25)$ | w $300 + (-155)$ | x $(-7 \cdot 1) + (-3 \cdot 2)$ |

2. Again, use your thermometer to help here :-

(Remember :- $5 - 6$ means "start at 5, then move **down** by 6" $\Rightarrow -1$).

- | | | | |
|-----------------|------------------|-------------------|------------------------------|
| a $10 - 9$ | b $11 - 11$ | c $33 - 19$ | d $5 - 8$ |
| e $1 - 9$ | f $2 - 15$ | g $0 - 17$ | h $(-2) - 3$ |
| i $(-5) - 2$ | j $(-11) - 5$ | k $(-3) - 20$ | l $0 - 20$ |
| m $15 - 35$ | n $(-11) - 29$ | o $100 - 200$ | p $(-47) - 25$ |
| q $0 - 126$ | r $(-130) - 130$ | s $70 - 210$ | t $(-7 \cdot 5) - 8 \cdot 5$ |
| u $10 - 20 + 5$ | v $(-3) + 2 - 6$ | w $(-8) - 8 + 10$ | x $(-7) + (-8) + 15$ |

Subtracting Negative Numbers

Be able to recognise and use the double negative method.

When asked the answer to $7 - (-3)$, the obvious answer is 4. **Wrong!!**

Think of a simpler question :-

$9 - 3$ means "how far is it from 3 up to 9?"
 \Rightarrow by counting, we can see the answer is 6.

This means that the question :-

$7 - (-3)$ means "how far is it from -3 up to 7?"
 \Rightarrow by counting, we see the answer is **10** (not 4).

Notice that $7 + 3$ also gives **10**.

A rule for **Double Negatives** :- "Two Negatives make a Positive"

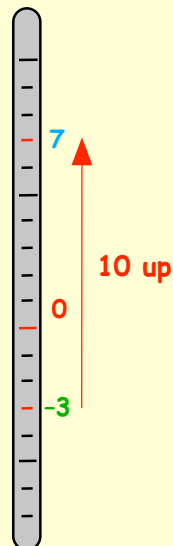
Examples :-

$$\begin{aligned} 5 - (-3) \\ = 5 + 3 \\ = 8 \end{aligned}$$

$$\begin{aligned} 15 - (-6) \\ = 15 + 6 \\ = 21 \end{aligned}$$

$$\begin{aligned} (-1) - (-8) \\ = -1 + 8 \\ = 7 \end{aligned}$$

$$\begin{aligned} -2 - (-7) + 1 \\ = -2 + 7 + 1 \\ = 6 \end{aligned}$$



Exercise 3



1. Copy and complete the following :-

a $6 - (-4) = 6 + 4 = \dots$

b $10 - (-8) = 10 + 8 = \dots$

c $7 - (-2) = 7 + \dots = \dots$

d $20 - (-10) = 20 + \dots = \dots$

e $15 - (-8) = \dots + \dots = \dots$

f $9 - (-9) = \dots + \dots = \dots$

2. Show all the required steps in answering the following :-

a $8 - (-9)$

b $11 - (-12)$

c $0 - (-12)$

d $5 - (-14)$

e $19 - (-12)$

f $35 - (-15)$

g $13 - (-13)$

h $200 - (-300)$

i $16 - (-24)$

j $2.5 - (-5.5)$

k $5.9 - (-2.1)$

l $\frac{1}{2} - (-\frac{1}{2})$

m $(-1) - (-4)$

n $(-2) - (-8)$

o $(-9) - (-11)$

p $(-8) - (-6)$

q $(-1) - (-3)$

r $(-14) - (-6)$

s $(-23) - (-23)$

t $(-40) - (-80)$

u $(-27) - (-7)$

v $(-4.5) - (-5.5)$

w $(-0.6) - (-0.7)$

x $\frac{1}{3} - (-\frac{1}{3}) + \frac{1}{3}$.

3. Which calculations in Question 2 do NOT involve integers?

4. Find :-

a $\frac{1}{8} + \frac{1}{8} + (-\frac{1}{8}) - (-\frac{1}{8}) + (-\frac{1}{8})$

b $1 - \frac{4}{5} + (-\frac{3}{5}) - (-\frac{2}{5}) + (-\frac{1}{5}) - \frac{4}{5}$.

Multiplication and Division of Integers

Be able to
× and ÷
positive and
negative numbers.

Since $5 \times 8 = 40$, then obviously $5 \times (-8)$ cannot also be 40.

$5 \times (-8)$ means "5 lots of -8" = $(-8) + (-8) + (-8) + (-8) + (-8) = -40$.

Examples :-

$2 \times (-3) = -6$

$9 \times (-5) = -45$

$(-10) \times 4 = -40$

$(-7) \times 7 = -49$

Similarly :- Since $20 \div 2 = 10$, then obviously $(-20) \div 2$ cannot also be 10.

$(-20) \div 2 = -20$ shared by 2" = **-10**.

Examples :-

$(-18) \div 3 = -6$

$(-28) \div 7 = -4$

$(-50) \div 10 = -5$

$(-81) \div 9 = -9$

$2 \times (-10)$



Exercise 4



1. Copy each of the following and find the answers :-

a $3 \times (-4)$

b $5 \times (-6)$

c $2 \times (-8)$

d $8 \times (-8)$

e $(-9) \times 6$

f $(-10) \times 4$

g $(-11) \times 4$

h $(-8) \times 7$

i $9 \times (-5)$

j $7 \times (-4)$

k $4 \times (-20)$

l $10 \times (-10)$

m $15 \times (-1)$

n $(-30) \times 3$

o $(-5) \times 20$

p $(-80) \times 5$.

2. Copy each of the following and find the answers :-

a $(-18) \div 6$

b $(-25) \div 5$

c $(-49) \div 7$

d $(-45) \div 9$

e $(-14) \div 2$

f $(-60) \div 10$

g $(-55) \div 5$

h $(-36) \div 4$

i $(-7) \div 7$

j $(-19) \div 1$

k $(-63) \div 7$

l $(-200) \div 10$.

3. Work out :-

a $(3 \times 8) \div 6$

b $(4 \times (-10)) \div 5$

c $3 \times (-1) \times 7$

d $5 \times (-2) \times 8$

e $4 \times (-9) \div 6$

f $(-8) \times 6 \div 4$

g $6 \times (-4) \div 3$

h $20 \times (-10) \div 5$.

4. Find the following :- (hint :- work out the bit in brackets first)

a $(7 + (-4)) \times 5$

b $6 \times (5 - 8)$

c $((-11) + 3) \times 2$

d $((-4) - 10) \div 2$

e $10 \times (12 - 15)$

f $(12 - 3) \times (-5)$

g $((-6) - 5) \times 4$

h $(8 + (-14)) \div 3$

i $((-19) - 11) \div 5$.

5. a What do you think the answer to $40 \div (-5)$ will be? 8 or -8?

b If you think 8, check if $8 \times (-5)$ really takes you back to the original 40.

c If it doesn't, then the answer must be!

Note :- $18 \div (-3) = -6$ (not 6) (since $6 \times (-3) \neq 18$) $21 \div (-7) = -3$ (not 3) (since $3 \times (-7) = -21$).

In other words, if you divide two integers, where one of them is **positive** and one of them is **negative** \Rightarrow the answer is always **negative**.

6. Write each of the following and find the answers :-

- | | | | | | | | |
|---|----------------|---|-----------------|---|-----------------|---|-----------------|
| a | $20 \div (-5)$ | b | $24 \div (-6)$ | c | $18 \div (-9)$ | d | $25 \div (-5)$ |
| e | $36 \div (-4)$ | f | $40 \div (-8)$ | g | $7 \div (-1)$ | h | $42 \div (-3)$ |
| i | $96 \div (-8)$ | j | $100 \div (-5)$ | k | $120 \div (-6)$ | l | $49 \div (-7)$ |
| m | $1 \div (-1)$ | n | $7 \div (-2)$ | o | $30 \div (-4)$ | p | $3 \div (-6)$. |

The **DOUBLE NEGATIVE** again :-

Remember :- Since $2 \times (-5) = -10 \Rightarrow (-2) \times (-5)$ cannot also be -10 !

\Rightarrow The only other possibility is that $(-2) \times (-5) = +10$.

RULE 1 :- "When **two negatives** are **multiplied** \Rightarrow the answer is **positive**"

Examples :- $(-4) \times (-6) = 24$ $(-5) \times (-8) = 40$ $(-8) \times (-10) = 80$

RULE 2 :- "When **two negatives** are **divided** \Rightarrow the answer is **positive**"

Examples :- $(-21) \div (-3) = 7$ $(-32) \div (-8) = 4$ $(-48) \div (-6) = 8$

7. Write each of the following and find the answer :-

- | | | | | | | | |
|---|--------------------|---|---------------------|---|---------------------|---|-------------------------|
| a | $(-2) \times (-4)$ | b | $(-5) \times (-3)$ | c | $(-6) \times (-9)$ | d | $(-7) \times (-4)$ |
| e | $(-6) \times (-8)$ | f | $(-5) \times (-5)$ | g | $(-13) \times (-1)$ | h | $(-10) \times (-8)$ |
| i | $(-9) \times (-9)$ | j | $(-20) \times (-4)$ | k | $(-3) \times (-60)$ | l | $(-200) \times (-30)$. |

Copy each of these questions and set down the steps in each one to find the answer :-

8. a $(-15) \div (-5)$ b $(-21) \div (-3)$ c $(-32) \div (-4)$ d $(-18) \div (-2)$
e $(-45) \div (-9)$ f $(-32) \div (-8)$ g $(-54) \div (-9)$ h $(-80) \div (-2)$
i $(-63) \div (-7)$ j $(-150) \div (-5)$ k $(-800) \div (-10)$ l $(-147) \div (-3)$.
9. a $(3 \times (-8)) \div 6$ b $((-4) \times (-10)) \div 5$ c $3 \times (-4) \times (-5)$ d $5 \times (-8) \div (-4)$
e $(-6) \times (-6) \div (-4)$ f $(-10) \times 6 \div (-2)$ g $(5 + (-9)) \times (-7)$ h $(-8) \times (1 - 9)$
i $((-19) + (-2)) \div (-3)$ j $(-1) \times (-6) \times (-7)$ k $(-2) \times (-5) \times (-9)$ l $(-4) \times (-5) \times (-10)$
m $(-1)^2$ n $(-2)^2$ o $(-8)^2$ p $(-20)^2$
q $(-1)^3 (= -1 \times -1 \times -1)$ r $(-2)^4$ s $(-1)^7$ t $(-1)^{101}$.

Exercise 5

Mixed Exercise



1. Find :-

- | | | | | | | | |
|---|--------------------|---|--------------------|---|---------------------|---|---------------------|
| a | $6 - 9$ | b | $-3 - 7$ | c | $-2 + 10$ | d | $-6 - 24$ |
| e | $11 + (-2)$ | f | $-7 + (-8)$ | g | $7 - (-3)$ | h | $9 - (-1)$ |
| i | $-5 - (-5)$ | j | $108 + (-148)$ | k | $-108 - (-109)$ | l | $-3 + (-3) + (-3)$ |
| m | $-9 + (-2) - (-5)$ | n | $-3 - (-3) + (-9)$ | o | $-12 - (-8) - (-1)$ | p | $-7 + (-8) - (-15)$ |

2. Work out :-

- | | | | | | |
|---|------------------------|---|--------------------------|---|------------------------|
| a | $2 + (-3) + 5 + (-8)$ | b | $15 - (-9) + (-23) - 10$ | c | $125 + (-130) - (-65)$ |
| d | $-2 - (-3) - 5 - (-8)$ | e | $15 + (-9) - (-23) + 10$ | f | $-125 - (-130) - 65$ |

3. Find :-

- | | | | | | | | |
|---|--------------------------|---|----------------------------|---|--------------------------------|---|---------------------------|
| a | $5 \times (-2)$ | b | $(-3) \times 8$ | c | $(-2) \times (-7)$ | d | $(-8) \times (-10)$ |
| e | $12 \div (-3)$ | f | $(-20) \div 4$ | g | $(-10) \div (-2)$ | h | $(-24) \div (-6)$ |
| i | $5 \times (-2) \times 3$ | j | $(-30) \div 6 \times (-2)$ | k | $(-1) \times (-2) \times (-3)$ | l | $(-4) \times 1 \div (-8)$ |

4. Work out :-

- | | | | | | |
|---|--------------------------------------|---|-----------------------------------|---|--|
| a | $5 \times (-1) \times (-3)$ | b | $12 \div (-2) \times (-9)$ | c | $(-1) \times (-1) \times (-1) \times (-1)$ |
| d | $-3 \times (-8) \div (-4) \div (-2)$ | e | $-4 \times (-9) \div (-6) \div 6$ | f | $(-6) \times (-5) \div (-10) - (-3)$ |

5. The balance in Marjory's bank account was £1000.

- She withdrew £230 on Monday,
- She deposited £85 on Tuesday,
- She withdrew £899 on Wednesday,
- She deposited £30 on Thursday.



Explain why she was contacted by her unhappy bank manager on the Friday.

6. a



Last winter, the temperature in a Norwegian village was recorded every evening at 10 pm for a period of 5 days.

The readings were :-

-17°C , 3°C , -2°C , -5°C , -9°C .

Find the **average*** temperature for the 5 days.

* To find the average of 5 numbers, add them together and divide your answer by 5.

b The temperature in a village in Sweden was also being recorded at the same time.

The readings there were :- -9°C , 1°C , -19°C , 0°C , 2°C .

Which country had the village that was, on **average**, warmer ?

Explain with working.





1. Archie's bank balance at the end of last month was **£1405**.

After his monthly £1985 wage was paid in, he spent £2500 on a new bathroom suite in his house.

How will his new balance show up on his online bank statement ?



- 2.



The temperature of the sand on a beach was 38°C .

The sea water's temperature was -12°C .

How many degrees cooler was the water compared to the sand ?

3. Show all the required steps in answering the following :-

a	$11 + (-9)$	b	$-14 + 13$	c	$-7 + (-13)$	d	$200 + (-210)$
e	$7 - 18$	f	$-21 - 9$	g	$-4 + 7 - 12$	h	$-19 + (-8) - 3$
i	$3 - (-4)$	j	$100 - (-90)$	k	$(-5) - (-14)$	l	$(-2 \cdot 7) - (-1 \cdot 7)$
m	$(-0 \cdot 6) - (-1 \cdot 8) - 1 \cdot 2$	n	$3 - (-\frac{1}{4}) + \frac{3}{4} - (-2\frac{1}{2})$				

4. Write each of the following and find the answers :-

a	$4 \times (-3)$	b	$(-5) \times 9$	c	$(-3) \times (-6)$	d	$(-11) \times (-5)$
e	$15 \div (-5)$	f	$(-30) \div 6$	g	$(-21) \div (-3)$	h	$(-45) \div (-9)$
i	$4 \times (-5) \times 2$	j	$(-40) \div 8 \times (-3)$	k	$(-3) \times (-2) \times (-1)$	l	$(-6) \times 2 \div (-3)$
m	$(-21) \times (-11) \times 0$	n	$(-2) \times (-2) - (-2)$	o	$(-30) \div (-6) \times (-2)$	p	$(-1) + (-2) \times (-3)$

5. Find the following :- (Remember **BOMDAS**).

a	$5 - (-1) \times (-3)$	b	$(-3) \times (-8) + (-4) \div (-2)$	c	$(-1) \times (-1) - (-1) \times (-1)$
d	$(-9)^2$	e	$(-2)^5 \div (-4)^2$	f	$(-1)^3 + (-1)^2 - (-3)^2$

6. To aid recovery from his injuries, Scruffy had to spend five minutes each day over a period of six days in an extremely cold room.

The temperature of the air on each of these days was :-

-3°C , -7°C , -5°C , -3°C , -5°C and -10°C .

What was the average temperature of the room ?

