KING EDWARD VI
HANDSWORTH GRAMMAR
SCHOOL FOR BOYS

KING EDWARD VI
ACADEMY TRUST
BIRMINGHAM

Year 9

2025 Mathematics 2026

Unit 15 Booklet – Part 1

HGS Maths

Tasks

Dr Frost Course

Name: _____

Class: _____

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Unit 15 Booklet – Part 2

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1 Percentages with Multipliers

Worked Example	Your Turn
Write down the multiplier: To find 20%	Write down the multiplier: To find 30% …
To increase by 20%	To increase by 30%
To decrease by 20%	To decrease by 30%

Dr Frost 219a, 219c and 221a

Worked Example	Your Turn
Write down the multiplier: To find 12.5%	Write down the multiplier: To find 0.5%
To increase by 12.5%	To increase by 0.5%
To decrease by 12.5%	To decrease by 0.5%

Worked Example	Your Turn
Find 7% of 493.8	Find 2% of 34.32

Dr Frost 219b and 219d

Worked Example	Your Turn
Awa is putting money into a new savings account. Each month they deposit $\$130$. After 7 months they get an interest payment of 9% of the total amount in the account. Work out how much interest Awa is paid.	Mateo is putting money into a new savings account. Each month they deposit $\$330$. After 11 months they get an interest payment of 3% of the total amount in the account. Work out how much interest Mateo is paid.

Worked Example	Your Turn
There are 900 elephants in a wildlife sanctuary. Each elephant is either an Asian elephant or an African elephant. 68% of the elephants are Asian elephant. 75% of the Asian elephants are male. Work out how many of the Asian elephants are male.	There are 360 rhino in a conservation area. Each rhino is either a white rhino or a black rhino. 25% of the rhino are white rhino. 30% of the white rhino are male. Work out how many of the white rhinos are female.

Worked Example	Your Turn
a) Increase 461.7 by 17% b) Decrease 461.7 by 17%	a) Increase 295.6 by 18% b) Decrease 295.6 by 18%

Fill in the Gaps

Original Amount	%	Increase/ Decrease	Multiplier	Calculation	New Amount
£50	25%	*Increase*	1.25	£50 × 1.25	£62.50
£70	20%	*Increase*	1.2		
£85	18%	*Increase*	1.18		
£125	76%	*Increase*			
£64	11%	*Increase*			
£27	53%	*Increase*			
£220	6%	*Increase*			
£45	2%	*Increase*			
£36	15%	*Decrease*	0.85	£36 × 0.85	£30.60
£218	22%	*Decrease*	0.78		
£35	30%	*Decrease*	0.7		
£60	20%	*Decrease*			
£95	25%	*Decrease*			
£78	11%	*Decrease*			
£110	8%	*Decrease*			
£24	7%		1.07		
£92			1.23		
£48			0.73		
£13			0.94		

Fill in the Gaps

Increasing & Decreasing by a Percentage 

Q	Whole	Increase or Decrease	Change		Decimal Multiplier		Result
			As a percentage	As a decimal	Calculation to Find		
A	400	+	20%	0.2	1 + 0.2	1.2	
B	300	+	80%				
C	800	+		0.15			
D	700	+				1.12	
E	900	+	3%				
F	600	–	30%				
G	200				1 – 0.15		
H	1400					0.35	
I	500					0.93	
J	250						500
K	700					2.35	
L	140	+	0.5%				
M	550	+	14.5%				
O	820	–	0.5%				
P	1600	–	32.8%				
Q	86	–	5.75%				

Worked Example	Your Turn
A herd of 4950 moose lives in Forest A. 800 of the moose move to Forest B. After two years, the population of each forest has changed. The population of moose that remained in Forest A has decreased by 28%, and the population of moose in Forest B has increased by 27%. Calculate how many more moose there are in Forest A than in Forest B.	A colony of 1550 bats lives in Cave A. 250 of the bats move to Cave B. After six years, the population of each cave has changed. The population of bats that remained in Cave A has decreased by 29%, and the population of bats in Cave B has increased by 6%. Calculate how many more bats there are in Cave A than in Cave B.

Worked Example

Quinn is going to take a course of 12 piano lessons.
Piano lessons cost £60 each.
There are two offers

Offer A
Buy 11 lessons, get the 12th free

Offer B
9% off all lessons

Which offer should Quinn choose?

Your Turn

Connor wants to lease a car for a year.
A car dealership offers two options:

Option A
Buy the car for £ 9500 Sell it back to us for £8500 after 12 months

Option B
Get 16% off the monthly rental price of £ 115

Which option costs Connor less over the whole year?

Worked Example	Your Turn
93% of a number is 273.42 Find the number.	89% of a quantity is 359.56 Find the quantity.

Worked Example	Your Turn
The price of a jumper is increased by 74% and now is $\$581.16$. Find the original price.	The price of a jumper is increased by 68% and now is $\$717.36$. Find the original price.

Worked Example	Your Turn
The price of a wardrobe is decreased by 29% and now is $\$93.01$. Find the original price.	The price of a wardrobe is decreased by 57% and now is $\$95.03$. Find the original price.

Worked Example	Your Turn
In a 24% sale, the price of a shirt is reduced by $\$68.88$. Find the original price of the shirt.	In a 3% sale, the price of a phone is reduced by $\$2.82$. Find the original price of the phone.

Worked Example	Your Turn
Joe invests some money in a savings account. His investment increases by 17.5%. Joe now has $\$7050$ in his account. Work out the total increase in his account balance.	A clothes shop has a sale. In the sale, normal prices are reduced by 16%. The price of a pair of jeans is $€63$ in the sale. Work out how much the pair of jeans has been reduced by.

Worked Example	Your Turn
Kaitlyn records the number of muskox in an arctic nature reserve. She notes that there are 6 fewer than last year. This represents a 15% decrease from the previous year. Calculate how many muskox Kaitlyn recorded this year.	Lottie invests some money in the stock market. Her investment increases by 17.5%. Given that her account balance is €630 higher, work out how much her investment is now worth.

Fill in the Gaps

Question	Percentage Increase/ Decrease	Multiplier	Calculation	Original Amount
After an increase of 10%, the price of a computer is £275. What was its original price?	10% *Increase*	1.1	$£275 \div 1.1$	$£250$
After an 8% pay rise, Omar earns £10.26 per hour. What was his hourly pay before the increase?	8% *Increase*	1.08		
A shirt is reduced by 20% to £20 in a sale. What was its original price?	20% *Decrease*	0.8	$£20 \div 0.8$	$£25$
The population of a village decreases by 16% to 1260. What was the population before the decrease?	16% *Decrease*	0.84		
A TV costs £258.42 including 18% tax. What was the price of the TV before the tax was added?	18% *Increase*			
A painting is sold for £729, making a profit of 35%. What was the original cost of the painting?				
In a sale, a coat is reduced by 33% to £43.55. What was its original price of the coat?				
A puppy increases in weight by 7.5% to 3.87 kg. What was the previous weight of the puppy?				
			$£92 \div 1.15$	
			$528 \div 0.88$	

Worked Example	Your Turn
The price of a computer increases from £452 to £619.24. Determine the percentage change.	The price of a train ticket decreases from £294 to £244.02. Determine the percentage change.

Dr Frost 215a and 215d

Worked Example	Your Turn
Jonathan wants to check the balance of his bank account. He estimates that he has a balance of £600. His actual balance is £451. Calculate the percentage error in his estimate.	Oliver wants to check the balance of his bank account. He estimates that he has a balance of £10000. His actual balance is £7740. Calculate the percentage error in his estimate.

Worked Example	Your Turn
Last month Lyna bought 150 mobile phones at a cost of £500 each. She sold all of the phones for £655 each. Lyna paid a delivery cost of £6.75 for each one she sold. Lyna has to repair and re-deliver any faulty phones she sells. This costs her £75 for each one. Last month 16 phones were faulty. Calculate her percentage profit for the month.	Last month John bought 400 robotic vacuum cleaners at a cost of £1200 each. He sold all of the vacuum cleaners for £1620 each. John paid a delivery cost of £13.75 for each one he sold. John has to repair and re-deliver any faulty vacuum cleaners he sells. This costs him £516 for each one. Last month 24 vacuum cleaners were faulty. Calculate his percentage profit for the month.

Dr Frost 215b and 215c

Round your answers to 1 decimal place where necessary.

Question	Actual Change	Original Amount	Calculation	Percentage Change
A population of butterflies grows from 500 to 562. What is the percentage change?	62	500	$\frac{62}{500} \times 100$	
Ayesha buys a bike for £3000 and sells it for £3200. What is her percentage profit?	£200	£3000		
Hassan's savings increased from £150 to £167.50. Find the percentage increase.	£17.50			
Leia buys a painting for $700 and sells it for $642. Work out her percentage loss.	$58			
Tony's wages increase from £14.25 per hour to £15.85 per hour. What is the percentage increase?				
Eric buys a laptop for £550 and after 1 year it is worth £325. What is the percentage loss in its value?				
The population of a town increases from 56500 to 58900. What is the percentage growth?				
The price of a book is reduced from £7.99 to £6.49. Find the percentage decrease.				
Noah buys an antique clock for £45 and sells it for £150. Find his percentage profit.				
			$\frac{1.65}{7.50} \times 100$	
			$\frac{4}{30} \times 100$	

Fill in the gaps in the table.
The first one is done already.

	old price	new price	$\frac{\text{new price}}{\text{old price}}$	what's happened?
1	£34.00	£50.00	1.47	47% increase
2	£6.50	£7.20		
3	£8.50	£8.10		
4	£241.00			41% decrease
5	£78.20			4% increase
6	£1.60		1.24	
7	£852.10		0.30	
8	£29.00			32% decrease
9	£43.80			90% increase
10	£329.35	£400.00		
11	£22.00	£10.00		
12		£179.00	0.90	10% decrease
13		£4.00	1.15	15% increase
14		£11.00		16% increase
15		£11.11		8% decrease
16		£2.00		33% decrease
17		£1,499.00		17% increase
18		£8.50	1.09	
19	£8.00			10% decrease
20		£543.00		17% decrease

Fill in the Gaps

	Amount (**A**)	Percentage (**P%**)	**P%** of **A**	**A** increased by **P%**	**A** decreased by **P%**
1.	320	10 %	32	352	288
2.	320	25 %			
3.	320	2.5 %			
4.	320	1.25 %			
5.	80	1.25 %			
6.	400	1.25 %			
7.	125		5		
8.		4 %	10		
9.	250		20		
10.	625	16 %			
11.	1859	16 %			
12.	1234	16 %			
13.	609		97.44		
14.	84			97.44	
15.	116				97.44
16.	116	160 %			
17.	116				-116
18.	348	66⅔ %			

	Amount (**A**)	Percentage (**P%**)	**P%** of **A**	**A** increased by **P%**	**A** decreased by **P%**
19.		10 %		88	
20.	80		12		
21.		80 %	12		
22.			12	52	
23.			12		48
24.			12		-2
25.		5 %	12		
26.			12	13	
27.	10			13	
28.		25 %		13	
29.				13	12
30.	15				12
31.		25 %			12
32.			68		12
33.				468	12
34.		97.5 %			12
35.		2.5 %			468
36.				328	312

Fill in the Gaps

	Amount (**A**)	Percentage (**P%**)	**P%** of **A**	**A** increased by **P%**	**A** decreased by **P%**
1.		64 %	377 856		
2.		64 %		377 856	
3.		64 %			377 856
4.		42 %			
5.		42 %			
6.		42 %			
7.			313 344		
8.				313 344	
9.					313 344
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					

a) Complete rows 1-3.
Why was 377 856 chosen for those rows?

b) What number could be used in rows 4-6 to have the same effect?
Use that number to complete those rows.

c) What percentage could be used in rows 7-9 to have the same effect?
Use that percentage to complete those rows.

d) Find composite numbers for **A** and **P** such that **P**% of **A** is a prime number.
Use such pairs to complete rows 10-12.

e) Find composite numbers for **A** and **P** such that **A** increased by **P**% is a prime number.
Use such pairs to complete rows 13-15.

f) Find composite numbers for **A** and **P** such that **A** decreased by **P**% is a prime number.
Use such pairs to complete rows 16-18.

Fill in the Gaps

	Question	New %	Multiplier	Calculation	Answer
a	Increase 15 by 54%	154%	1.54	1.54×15	
b	Decrease 30 by 23%	77%	0.77	$\times 30$	
c	Increase 14 by 65%	165%		$\times$	
d	Decrease 35 by 34%			$\times$	
e	Increase 22 by	105%		$\times$	
f	Decrease by		0.7	$\times 33$	
g	Increase by			1.1×21	
h	by			0.55×42	
i	by			1.155×20	
j	Decrease 25 by 7.6%			$\times$	
k	Decrease 24 by 3.75%			$\times$	
l	Increase 12 by 92.5%			$\times$	
m	28 by			$\times$	23.1
n	by 47.5%			$\times$	23.1

Extra Notes

2 Simple and Compound Interest

Simple Interest

Worked Example	Your Turn
Mr Bansal invests £850 into a savings account. Mr Bansal gets 3.75% per year simple interest. Work out the total interest Mr Bansal will get after 12 years.	Mr Dhillow invests £2810 into a savings account. Mr Dhillow gets 4.75% per year simple interest. Work out the total interest Mr Dhillow will get after 12 years.

Worked Example	Your Turn
Juan invests £4790 for 7 years in a bank account paying simple interest. At the end of 7 years, the amount in the bank account is £5762.37 Calculate the annual rate of interest.	Zara invests £4210 for 6 years in a bank account paying simple interest. At the end of 6 years, the amount in the bank account is £4538.38 Calculate the annual rate of interest.

Dr Frost 219g

Fill in the Gaps

Fill in the blanks. All amounts are in USD.

Initial amount	Interest Rate	Amount earned per year	Interest earned over 5 years	Total after 5 years
100	10%	10	50	150
100	1%	1		
100	2%			
100	4%			
200	4%			
600	4%			
600		600		
500	0.5%			
250				256.25

Repeated Percentage Change

Worked Example	Your Turn
Write down the multiplier to increase by 20% then decrease by 20%	Write down the multiplier to decrease by 30% then increase by 30%

Fill in the Gaps

Section 1: Complete the table

Repeated percentage change

1st percentage change	1st percentage multiplier	2nd percentage change	2nd percentage multiplier	Overall percentage change	Overall percentage multiplier
30% increase	× 1.3	15% increase	× 1.15	49.5% increase	× 1.495
15% increase		30% increase			
20% increase		25% increase			
5% increase		40% increase			
7.5% increase			× 1.375		
	× 1.06		× 1.39		
	× 1.2				× 1.68
		50% increase		68% increase	
10% decrease		10% decrease			
20% decrease		20% decrease			
30% decrease		30% decrease			
30% decrease		30% increase			
30% increase		10% decrease			
	×0.85				× 1.19
			×0.92	35.6% decrease	

Worked Example	Your Turn
A television costs £500. The price is increased by 10%. A month later the price is decreased by 10%. What is the final price of the television? How much less is the television now?	A television costs £400. The price is decreased by 10%. A month later the price is increased by 10%. What is the final price of the television? How much less is the television now?

Fill in the Gaps

Q	Original amount	Percentage change 1	Percentage change 2	Overall percentage change	New amount
1	£200	Increase by 20%	Decrease by 20%		
2	£200	Decrease by 20%	Increase by 20%		
3	£200	Decrease by 20%			£200
4	£200	Decrease by 20%	Decrease by 20%		
5	£200	Increase by 20%	Increase by 20%		
6		Increase by 20%	Increase by 50%		£288
7		Increase by 20%		Increase by 50%	£288
8		Decrease by 20%	Decrease by 37.5%		£288
9	£576	Decrease by 20%		Increase by 50%	
10	£576	Increase by 20%		Decrease by 50%	
11	£576	Decrease by 50%			£576
12	£576	Increase by 50%	Decrease by 100%		

Compound Interest

Worked Example	Your Turn
Mr Bansal buys a car for £17150 which depreciates in value at a rate of 4% per year. Work out how much Mr Bansal's car will be worth in 14 years.	Mr Dhillow buys a car for £14680 which appreciates in value at a rate of 1.25% per year. Work out how much Mr Dhillow's car will be worth in 17 years.

Dr Frost 359b and 359c

Worked Example	Your Turn
A person invests £400 at 5% compound interest per annum. How much interest has been earned after 3 years?	A person invests £400 at 3% compound interest per annum. How much interest has been earned after 5 years?

Worked Example	Your Turn
Holly buys a watch for £815. It decreased in value by 3% per year for 3 years, then increased in value by 3.5% per year for 5 years. Find the new value of the watch.	Joe buys a laptop for £665. It increased in value by 5.5% per year for 3 years, then decreased in value by 8.5% per year for 5 years. Find the new value of the laptop.

Dr Frost 359d

Worked Example	Your Turn
Krishna invests £4000 in a bank account earning 7% interest for 3 years. The total in his account at the end of 3 years is calculated below. $4000 \times 1.07 \times 1.07 \times 1.07 = 4900.17$ Does his account pay simple or compound interest?	Jake invests £800 in a bank account earning 5% interest for 4 years. The interest over the 4 years is calculated below. $800 \times 0.05 \times 4 = 160$ Does his account pay simple or compound interest?

Dr Frost 359a

Worked Example

Hassan is planning on investing €3000 into a savings account for 3 years. He is presented with the two options below.

Account A	Account B
Pays variable interest. 7% in the first year, 6% in the second year, 5% in the third year.	Pays a fixed sum of €167 per year.

Determine which account will give Hassan the best value after 3 years.

Your Turn

Annabelle is planning on investing £8000 into a savings account for 4 years. She is presented with the two options below.

Account A	Account B
Pays compound interest of 2% per year.	Pays simple interest of 3% per year.

Determine which account will give Annabelle the best value after 4 years.

Dr Frost 359f

Worked Example	Your Turn
During the last year, the internet speed in a neighbourhood increased by 15% and later decreased by 10%. Determine the overall percentage increase. Give your answer correct to 1 decimal place.	During the last year, the number of otters in a river decreased by 10% and later increased by 8%. Determine the overall percentage decrease. Give your answer correct to 1 decimal place.

Dr Frost 359g

Worked Example	Your Turn
Pari invested €1200 into an account paying r% simple interest. Paul invested €1200 into an account paying 5% compound interest. After 2 years, Pari and Paul's accounts both contain the same amount of money. Calculate r Give your answer correct to 2 decimal places.	Viraj invested €$17{,}000$ into an account paying r% simple interest. Raphaël invested €17000 into an account paying 5% compound interest. After 4 years, Viraj and Raphaël's accounts both contain the same amount of money. Calculate r Give your answer correct to 2 decimal places.

Worked Example	Your Turn
Chloé measures the population of rabbits in a country park to be 4000 She then sees the population increase by $r\%$ one year, then 4% the year after, and 2% the year after that. Chloé recalculates the population of rabbits to be 4286 Determine r Give your answer correct to 2 decimal places.	Omar invests €500 into a savings account paying compound interest for 3 years. For the first two years, the account pays $r\%$ per year. For the third year, the account pays 2%. After the three years, Omar's account has €562.28 Determine r Give your answer correct to the nearest whole number.

Worked Example	Your Turn
Felicia buys a new car. The value of the car will depreciate by 1.75% each year and after 3 years it is worth £3645. Work out how much Felicia brought the car for.	Darron brought a boat 12 years ago. It depreciated in value at a rate of 4.75% per year and is now worth £980. How much did Darron pay for the boat?

Dr Frost 361c

Worked Example	Your Turn
Claire invests £10775 into an account that pays $x\%$ compound interest per annum. After 9 years Claire has £12276 in the account. Find the value of x, giving your answer to 2 decimal places	Felicia invests £14525 into an account that pay $x\%$ compound interest per annum. After 8 years Felicia has £18543 in the account. Find the value of x, giving your answer to 2 decimal places.

Worked Example	Your Turn
Gael invests £14000 into a savings account for 4 years. The account pays compound interest at a rate of $n\%$ per year for the first year. At the end of the first year, the value of Gael's account is £14560 Over the next 3 years, the account pays compound interest at a rate of $\frac{n}{2}\%$ Determine the value of Gael's account at the end of the 4 years.	Elena invests \$$1100$ into a savings account for 5 years. The account pays compound interest at a rate of $n\%$ per year for the first 3 years. At the end of the first 3 years, the value of Elena's account is \$$1424.53$ Over the next 2 years, the account pays compound interest at a rate of $\frac{n}{3}\%$ Determine the value of Elena's account at the end of the 5 years.

Dr Frost 361e

Fill in the Gaps

Fill in the blanks. All amounts are in USD.

Initial amount	Interest Rate	Amount earned in year 1	Interest earned over 5 years	Total after 5 years
100	10%	10	161.05	261.05
100	1%	1	105.01	
100	2%	2		
100	4%			
200				
600				
600				
500				
500				

Fill in the Gaps

	Start Amount	Annual Interest %	Multiplier	Period	£ Interest Total	Final Amount
1	£4,000	2%	0.02	3 years		
2	£4,000	4%		3 years		
3	£4,000	1.2%		3 years		
4	£2,500	3.25%		2 years		
5	£3,000			4 years	£600	
6	£2,500			3 years	£116.25	
7	£1,200			2 years		£1573.80
8		2.44%		3 years	£439.20	

Fill in the Gaps

Compound Growth & Decay

$original \times multiplier^{years} = final$

	Original Quantity	Yearly Growth Rate	Multiplier (M)	Years	Formula	Rearranged Formula (unknown as subject)	Final Quantity
a	400	+30%	1.3	2	$400 \times 1.3^2 = final$	x	
b	400	+3%		2	$\times 1.03^2 = final$	x	
c	400	+12%		3		x	
d	600		1.05	4		x	
e	400	−20%			$400 \times 0.8^2 = final$	x	
f	400	−2%		2		x	
g					$400 \times 0.88^3 = final$	x	
h	600	−33%		4		x	
i		+20%			$original \times 1.2^2 = 720$	$original = 720 \div 1.2^2$	720
j		+8%			$original \times 1.08^3 =$		755
k			0.6	2			800
l		−15%		3			430
m	800			2	$800 \times M^2 = 968$	$M = \sqrt[2]{968 \div 800}$	968
n	500			3			630

Fill in the Gaps

Q	Yearly percentage change	Original Amount	Amount after 5 years	Amount after 10 years
1	100%	£1		
2	50%	£1		
3	5%	£1		
4	-50%	£2,048		
5	25%		£20	
6	-25%		£20	
7	7%		£1	
8	100%			£2,048
9	5%			£100
10	100%			£2,048
11		£20	£30	
12		£1	£5	
13		£1	£10	
14			£50	£100
15		£4		£64

Worked Example	Your Turn
Amir invests £450 for n years into a savings account. Amir was paid 4.25% per annum compound interest. At the end of the n years Amir had £840.14 in the savings account. Work out the value of n.	Alice invests £1575 for n years into a savings account. Alice was paid 3.75% per annum compound interest. At the end of the n years Alice had £3810.62 in the savings account. Work out the value of n.

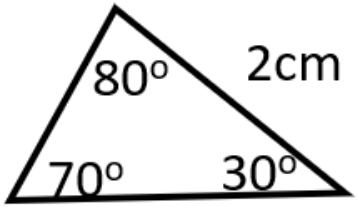
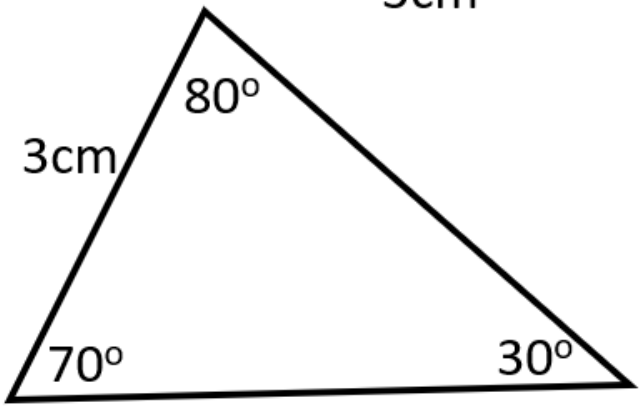
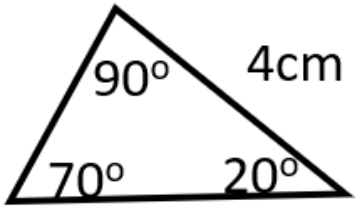
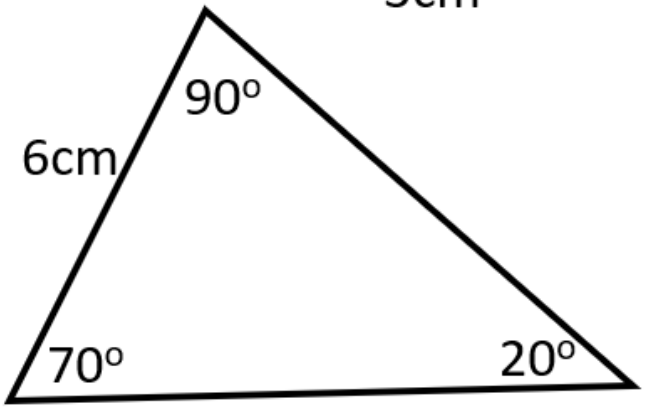
Worked Example	Your Turn
Alex invests some money into an account that pays 0.25% compound interest per annum. Work out after how many years Alex will have doubled the investment.	Amelia invests some money into an account that pays 0.5% compound interest per annum. Work out after how many years Amelia will have trebled the investment.

Fill in the Gaps

Original Amount	Interest Rate	Multiplier	Number of Years	Calculation	Final Amount
£100	5%	1.05	10	100×1.05^{10}	£162.89
£100	4%	1.04	10		
£200	6%		8		
£250	3%		6		
£1200	6%		5		
£700	2.5%		3		
£500	1.5%		7		
£250		1.06	4		
£325		1.025	5		
				$£400 \times 1.03^{6}$	
				$£7000 \times 1.02^{3}$	
£400	5%				£510.51
£250	3%				£326.19
£600			8		£703
		1.025	6		£347.91
	6.5%		4		£932.69

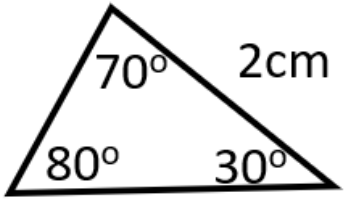
Extra Notes

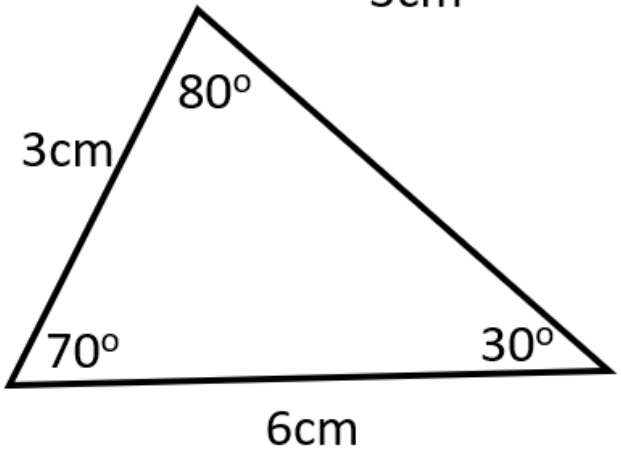
3 Similarity with Length

Worked Example	Your Turn
What is the scale factor? Find the missing lengths.  3cm  6cm	What is the scale factor? Find the missing lengths.  3cm  9cm

Worked Example

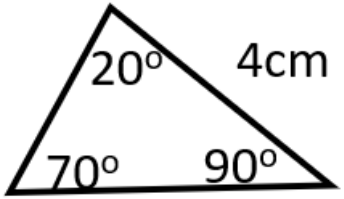
What is the scale factor? Find the missing lengths.

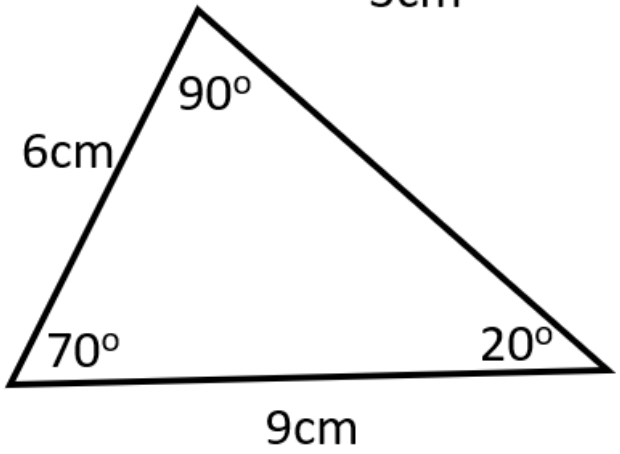




Your Turn

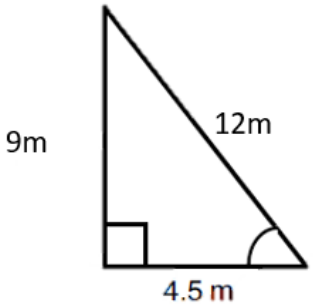
What is the scale factor? Find the missing lengths.

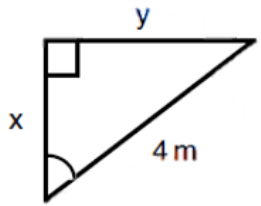




Worked Example

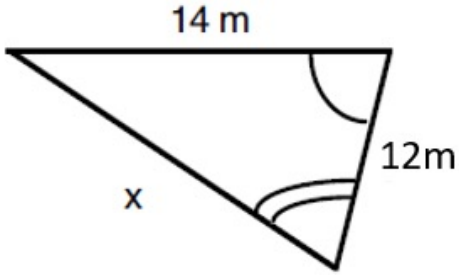
What is the scale factor? Find the missing lengths.

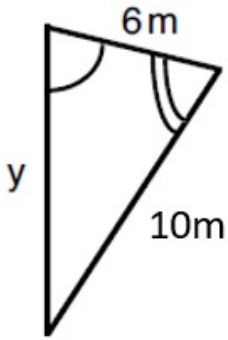




Your Turn

What is the scale factor? Find the missing lengths.



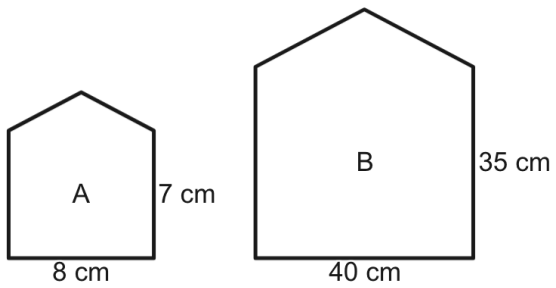


Dr Frost 292a

Worked Example

The diagram below shows two similar shapes A and B

Diagram NOT drawn to scale

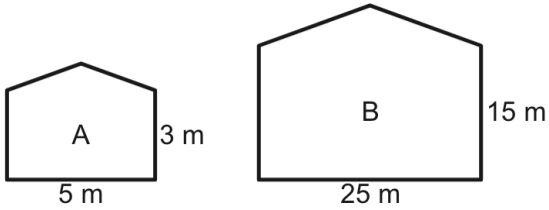


The perimeter of shape A is 34 cm
Calculate the perimeter of shape B

Your Turn

The diagram below shows two similar shapes A and B

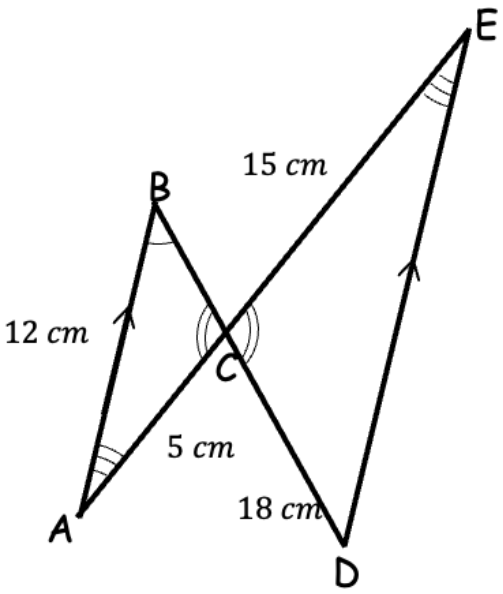
Diagram NOT drawn to scale



The perimeter of shape A is 18.5 m
Calculate the perimeter of shape B

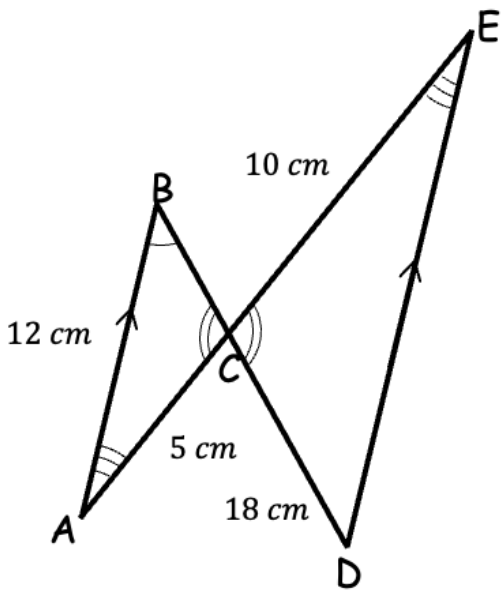
Worked Example

Calculate the missing lengths



Your Turn

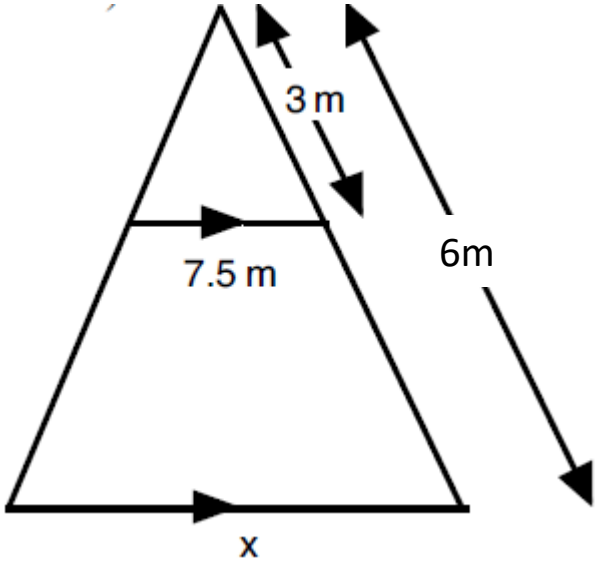
Calculate the missing lengths



Dr Frost 292b

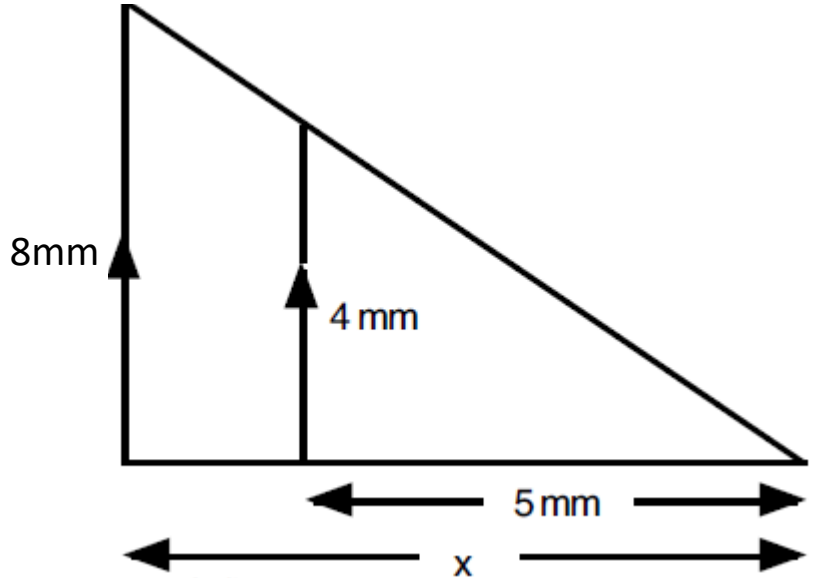
Worked Example

Find the length of every missing side



Your Turn

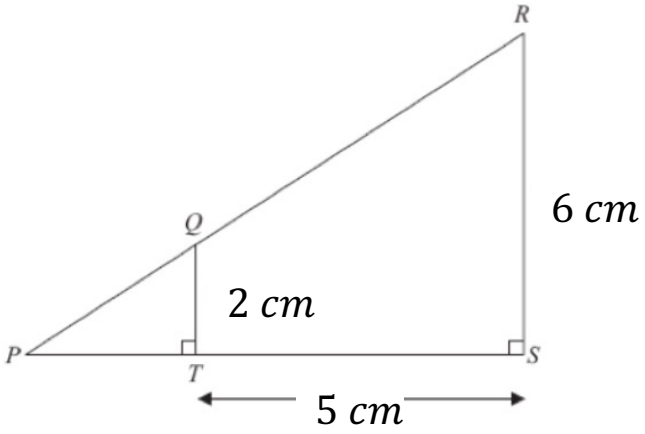
Find the length of every missing side



Dr Frost 292c

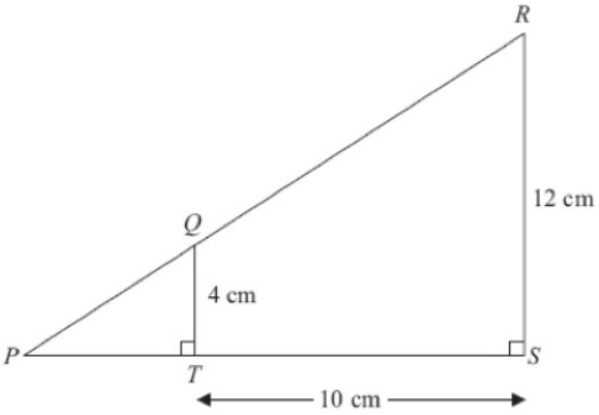
Worked Example

Calculate the length of PT



Your Turn

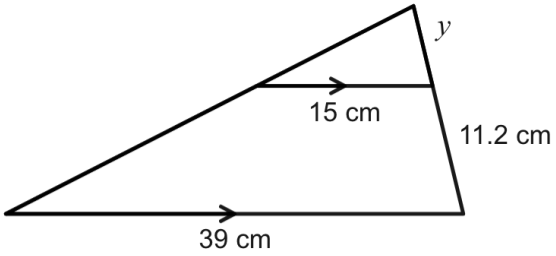
Calculate the length of PT



Dr Frost 292f

Worked Example

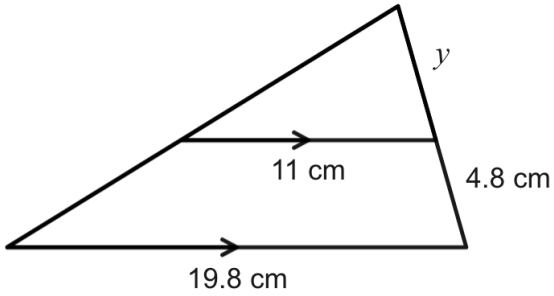
The triangles are similar.



Calculate the value of y

Your Turn

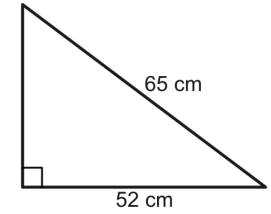
The triangles are similar.

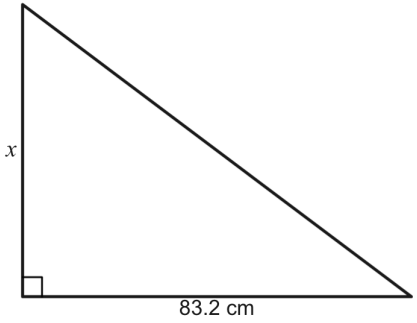


Calculate the value of y

Worked Example

The diagram below shows two similar triangles in the same orientation.

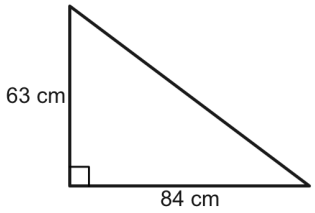


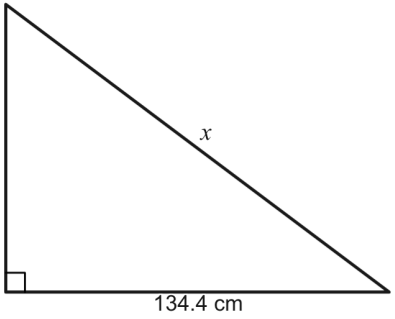


Determine the value of x
Give your answer correct to 1 decimal place.

Your Turn

The diagram below shows two similar triangles in the same orientation.



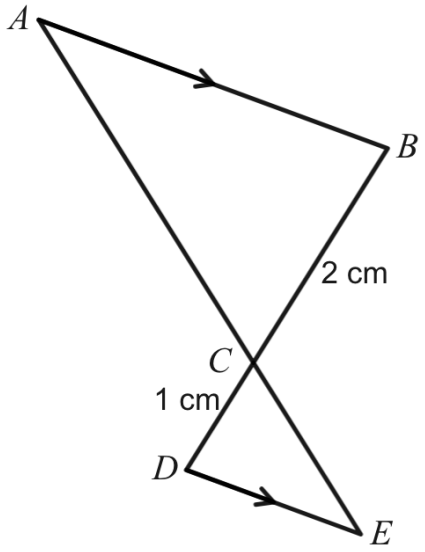


Determine the value of x
Give your answer correct to 1 decimal place.

Worked Example

In the diagram ACE and BCD are straight lines.
AB is parallel to DE

Triangles ABC and CDE are mathematically similar.



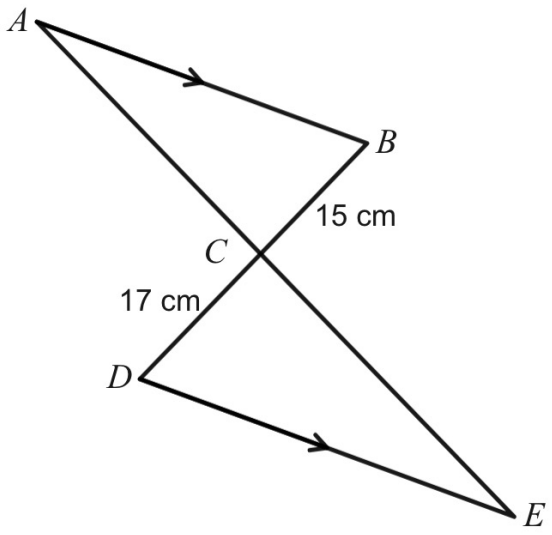
The length AE is 4.8 cm

Calculate the length of AC
Give your answer correct to 1 decimal place.

Your Turn

In the diagram ACE and BCD are straight lines.
AB is parallel to DE

Triangles ABC and CDE are mathematically similar.



The length AC is 31.5 cm

Calculate the length of CE
Give your answer correct to 1 decimal place.

Extra Notes

4 Right-Angled Trigonometry

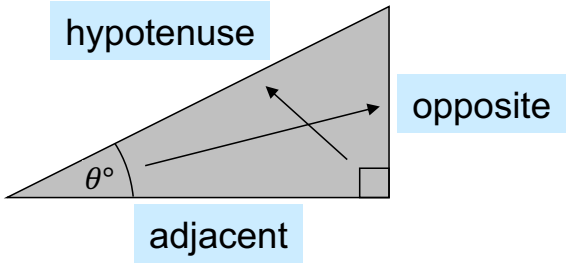
Worked Example	Your Turn
Find 'x'. Give your solution to 2 decimal places if required. a) $sin(60) = \frac{x}{5}$ b) $\cos(45) = \frac{5}{x}$	Find 'x'. Give your solution to 2 decimal places if required. a) $tan(60) = \frac{x}{4}$ b) $sin(45) = \frac{4}{x}$

Trigonometric Functions

A function $f(x)$ takes an input x and outputs a value y. A trigonometric function takes an angle $\theta°$ and outputs a ratio of sides.

For any right-angled triangle we always label the longest side as the hypotenuse (H). For the purposes of trigonometry, we label the other two sides relative to one of the non-right angles.

In order to understand and use some other rules connecting the sides & angle of right-angled triangles, we introduce a system for labelling the three sides:

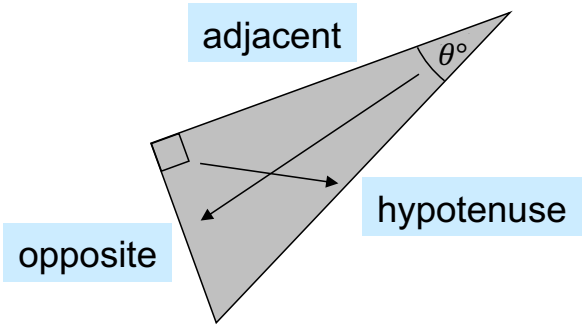


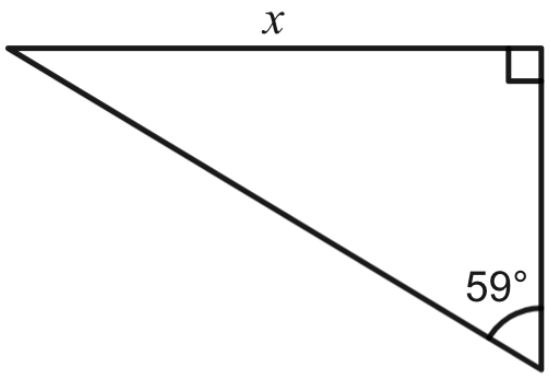
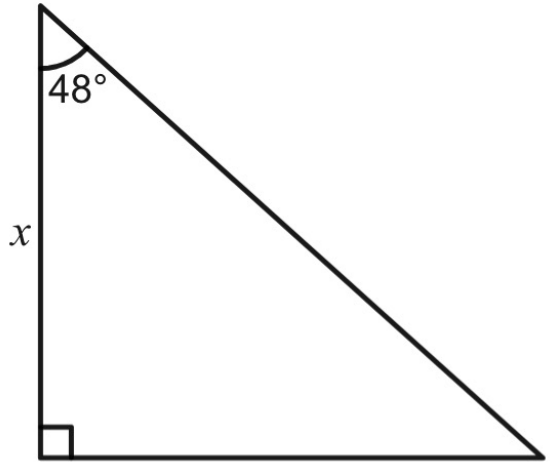
The **hypotenuse** is the longest side, always opposite the right-angle

The **opposite** is always across from the angle θ

The **adjacent** is the remaining side, next to the angle θ

You must be able to correctly recognise the hypotenuse, opposite and adjacent side for any given right-angled triangle and angle



Worked Example	Your Turn
Describe the side marked x relative to the given angle. 	Describe the side marked x relative to the given angle. 

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Trigonometric Functions

A function $f(x)$ takes an input x and outputs a value y. A trigonometric function takes an angle θ° and outputs a ratio of sides.

The three sides of right-angled triangles are:
O – Opposite
A – Adjacent
H – Hypotenuse

The next section considers the **ratios** between the hypotenuse, opposite and adjacent, relative to angle θ, in a right-angled triangle.

The ratio of the opposite to the hypotenuse is called **sine**

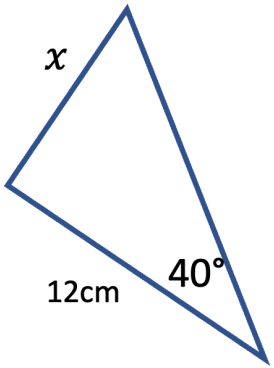
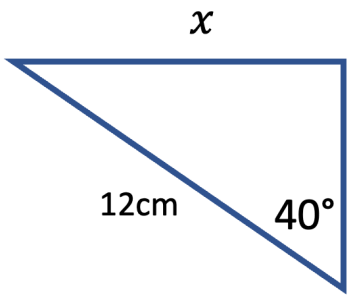
The ratio of the adjacent to the hypotenuse is called **cosine**

The ratio of the opposite to the adjacent is called **tangent**

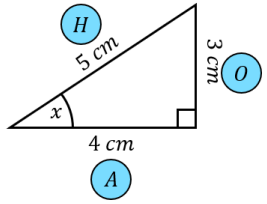
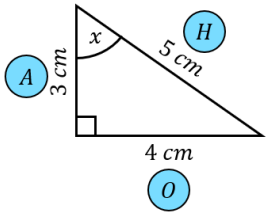
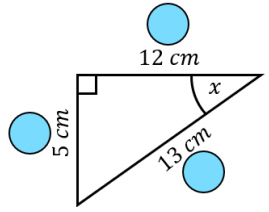
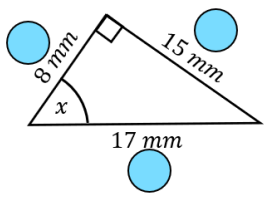
These are abbreviated as **sin**, **cos** and **tan**

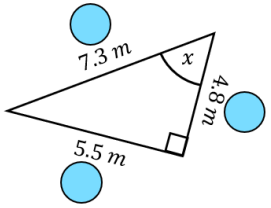
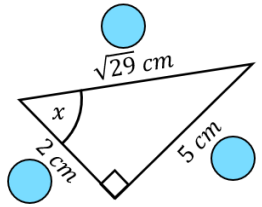
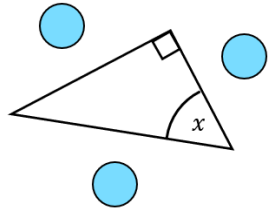
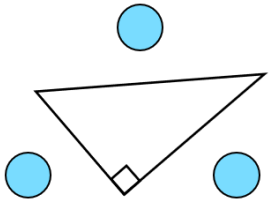
$$\sin\theta = \frac{O}{H} \qquad \cos\theta = \frac{A}{H} \qquad \tan\theta = \frac{O}{A}$$

This is commonly given the acronym: **SOHCAHTOA**

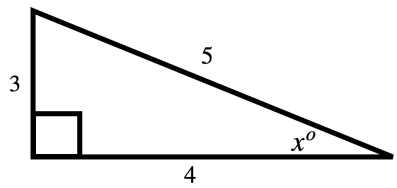
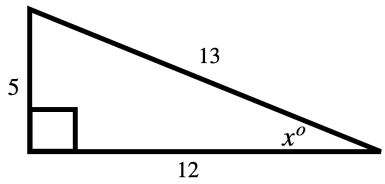
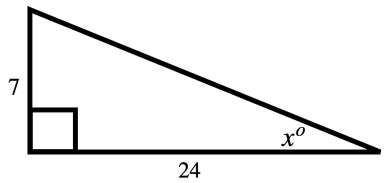
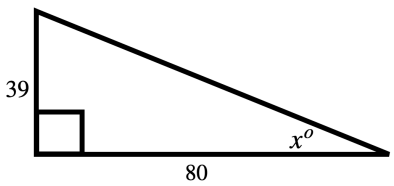
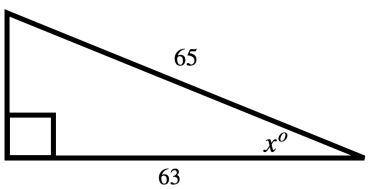
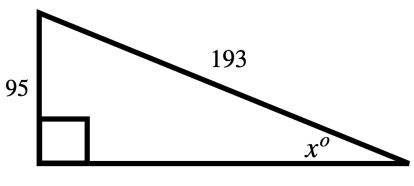
Worked Example	Your Turn
Choose the correct ratio to calculate side x  	Choose the correct ratio to calculate side x 

Fill in the Gaps

Labelled diagram	Sine Ratio	Cosine Ratio	Tangent Ratio
	$\sin x = \frac{3}{5}$	$\cos x = \frac{4}{5}$	$\tan x = \frac{\square}{\square}$
	$\sin x = \frac{\square}{\square}$	$\cos x = \frac{\square}{\square}$	$\tan x = \frac{\square}{\square}$
	$\sin x = \frac{\square}{\square}$	$\cos x = \frac{\square}{\square}$	$\tan x = \frac{\square}{\square}$
	$\sin x = \frac{\square}{\square}$	$\cos x = \frac{\square}{\square}$	$\tan x = \frac{\square}{\square}$

Labelled diagram	Sine Ratio	Cosine Ratio	Tangent Ratio
	$\sin x = \frac{\square}{\square}$	$\cos x = \frac{\square}{\square}$	$\tan x = \frac{\square}{\square}$
	$\sin x = \frac{\square}{\square}$	$\cos x = \frac{\square}{\square}$	$\tan x = \frac{\square}{\square}$
	$\sin x = \frac{\square}{\square}$	$\cos x = \frac{\square}{\square}$	$\tan x = \frac{9.9}{2}$
	$\sin x = \frac{4}{7}$	$\cos x = \frac{\square}{\square}$	$\tan x = \frac{\square}{\square}$

For each triangle, write down the value of each trigonometric ratio:

Triangle	$sinx^o$	$cosx^o$	$tanx^o$
			
			
			
			
			
			

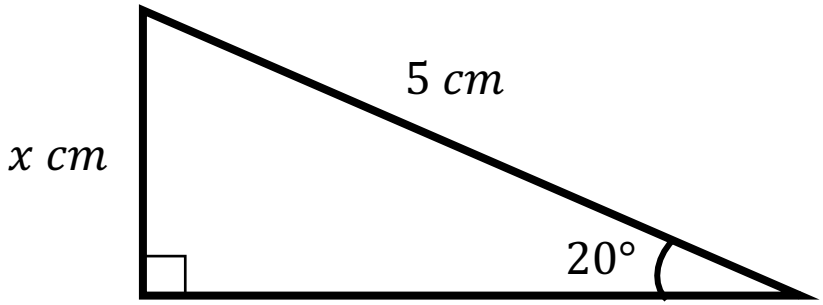
Diagrams not drawn to scale

Complete the table:

Triangle	$sinx^o$	$cosx^o$	$tanx^o$
	$\frac{5}{13}$		
	$\frac{15}{17}$		
		$\frac{3}{5}$	
			$\frac{4}{3}$
			$\frac{12}{5}$
		$\frac{2}{3}$	
			$\frac{1}{7}$
	$\frac{1}{\sqrt{3}}$		

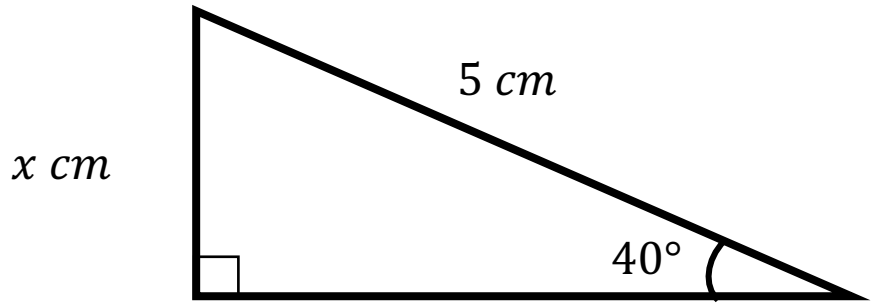
Worked Example

Calculate x. Round your answer to 1 decimal place.



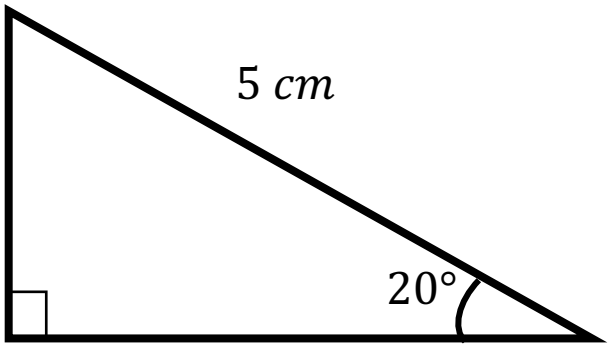
Your Turn

Calculate x. Round your answer to 1 decimal place.



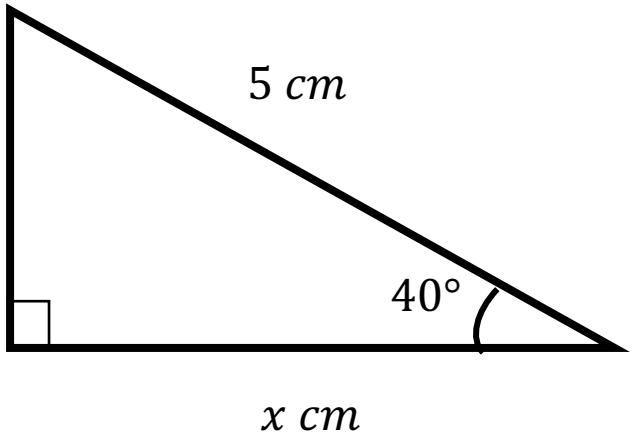
Worked Example

Calculate x. Round your answer to 1 decimal place.



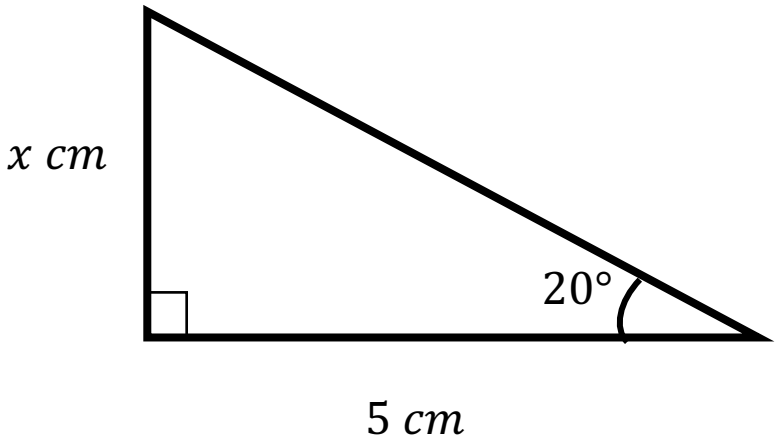
Your Turn

Calculate x. Round your answer to 1 decimal place.



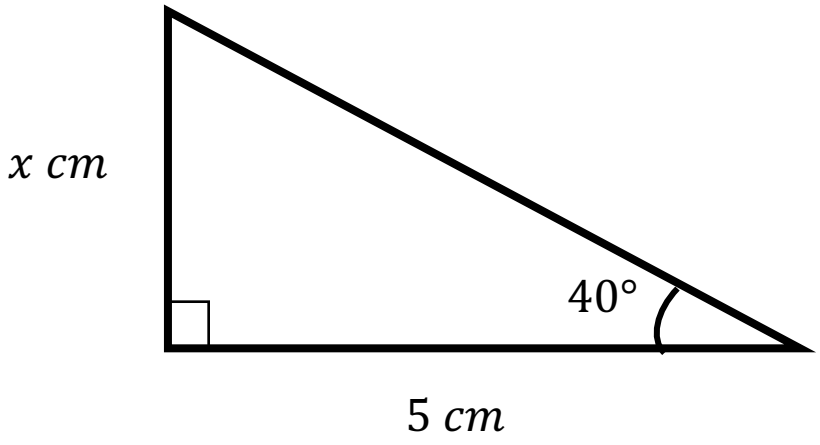
Worked Example

Calculate x. Round your answer to 1 decimal place.



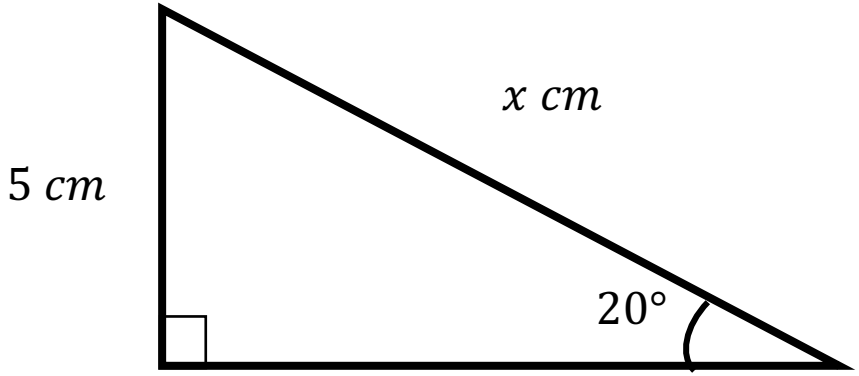
Your Turn

Calculate x. Round your answer to 1 decimal place.



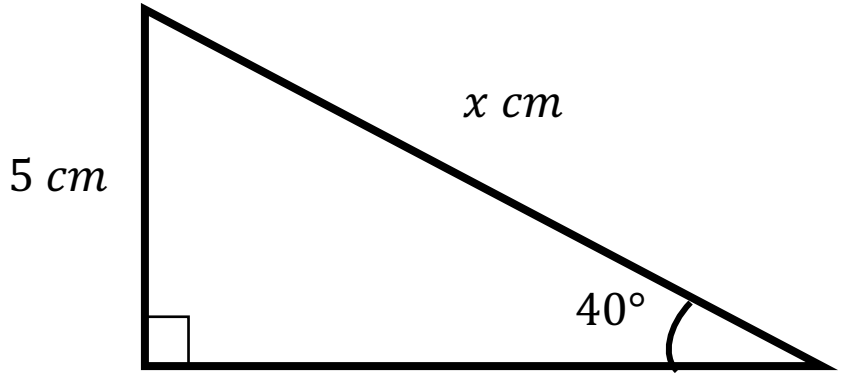
Worked Example

Calculate x. Round your answer to 1 decimal place.



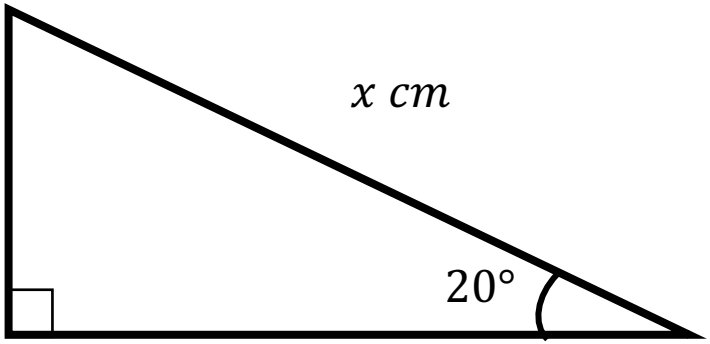
Your Turn

Calculate x. Round your answer to 1 decimal place.



Worked Example

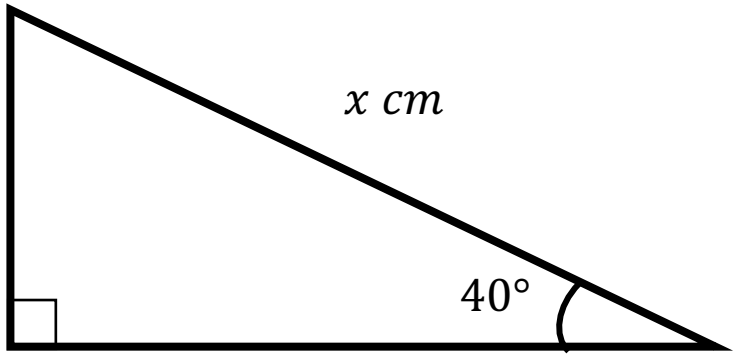
Calculate x. Round your answer to 1 decimal place.



$5\ cm$

Your Turn

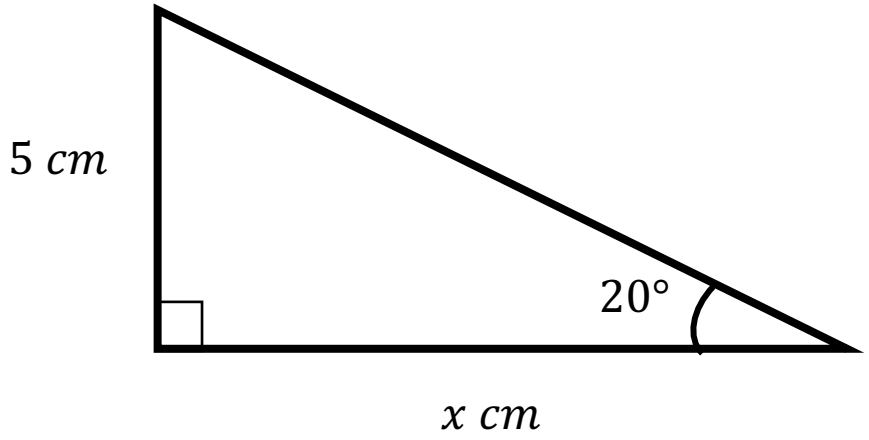
Calculate x. Round your answer to 1 decimal place.



$5\ cm$

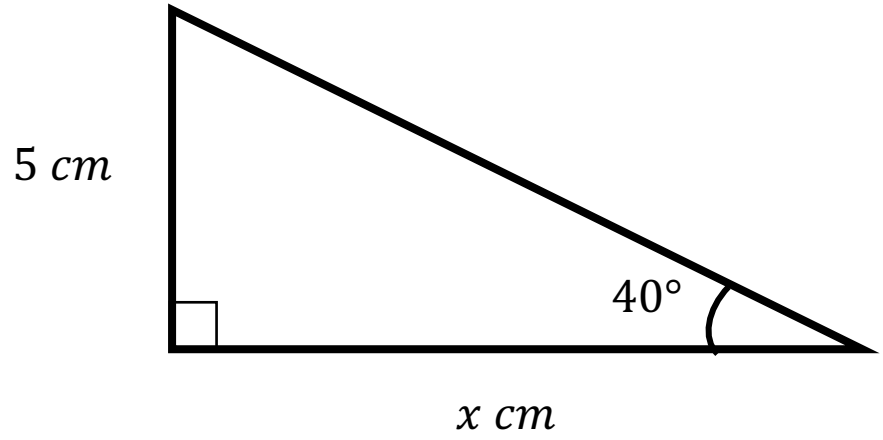
Worked Example

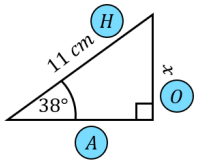
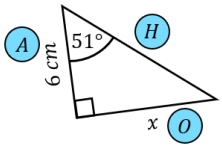
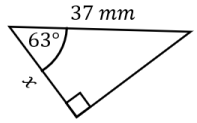
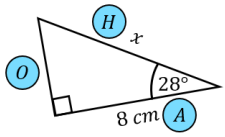
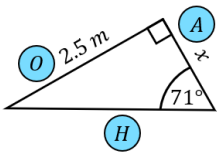
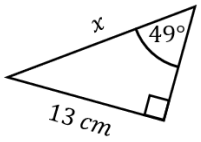
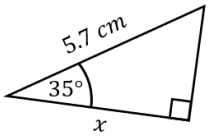
Calculate x. Round your answer to 1 decimal place.



Your Turn

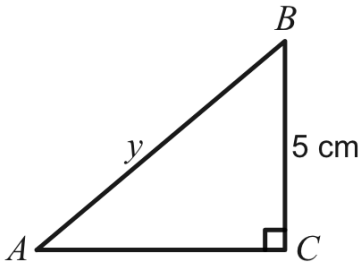
Calculate x. Round your answer to 1 decimal place.



Labelled diagram	Choose ratio	Substitute into formula	Rearrange formula	Answer (1dp)
	sin	$\sin 38 = \frac{x}{11}$	$x = 11 \times \sin 38$	
	tan			
				
	cos	$\cos 28 = \frac{8}{x}$	$x = \frac{8}{\cos 28}$	
	tan			
				
				
		$\tan 68 = \frac{7}{x}$		

Worked Example

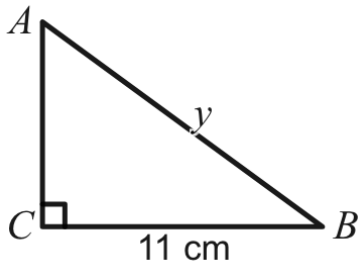
Given that $\text{Angle } A : \text{Angle } B = 4 : 5$
determine the value of y in the diagram.



Give your answer correct to 1 decimal place.

Your Turn

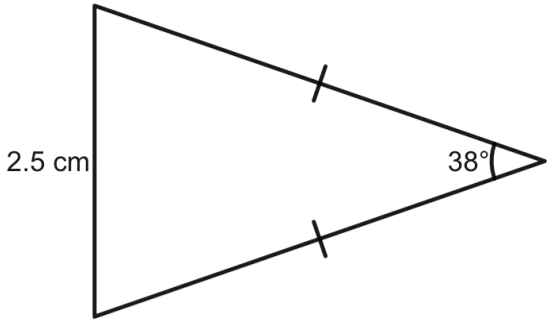
Given that $\text{Angle } A : \text{Angle } B = 3 : 2$
determine the value of y in the diagram.



Give your answer correct to 1 decimal place.

Worked Example

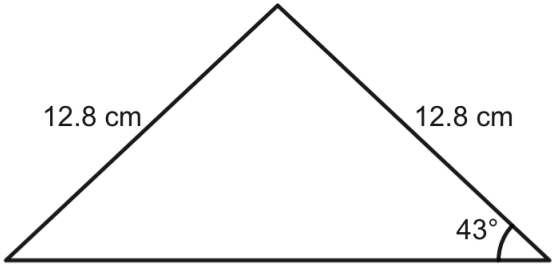
Work out the perimeter of the following isosceles triangle.



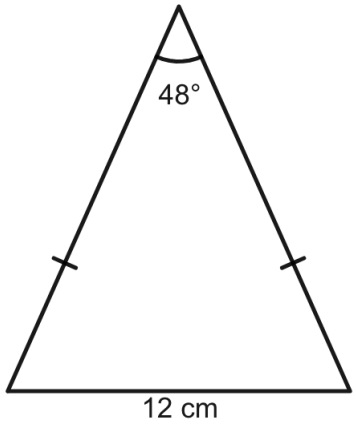
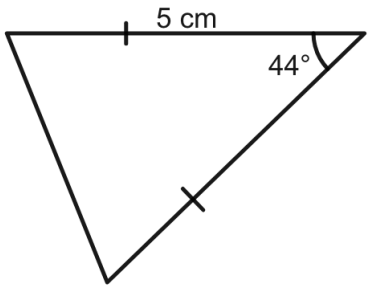
Give your answer correct to 1 decimal place.

Your Turn

Work out the perimeter of the following isosceles triangle.

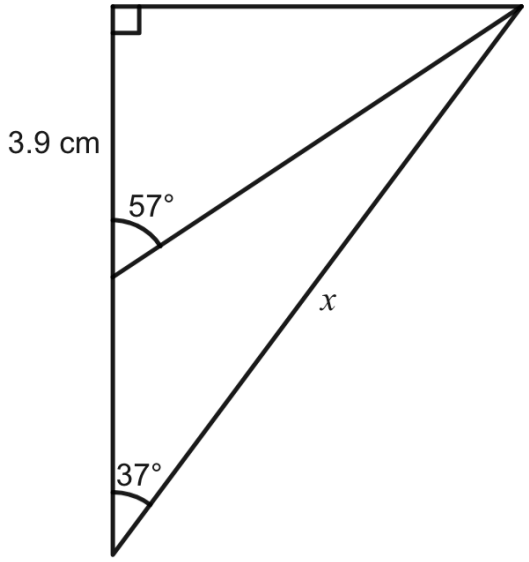


Give your answer correct to 1 decimal place.

Worked Example	Your Turn
Determine the area of the isosceles triangle in the diagram.  Give your answer correct to 1 decimal place.	Determine the area of the isosceles triangle in the diagram.  Give your answer correct to 1 decimal place.

Worked Example

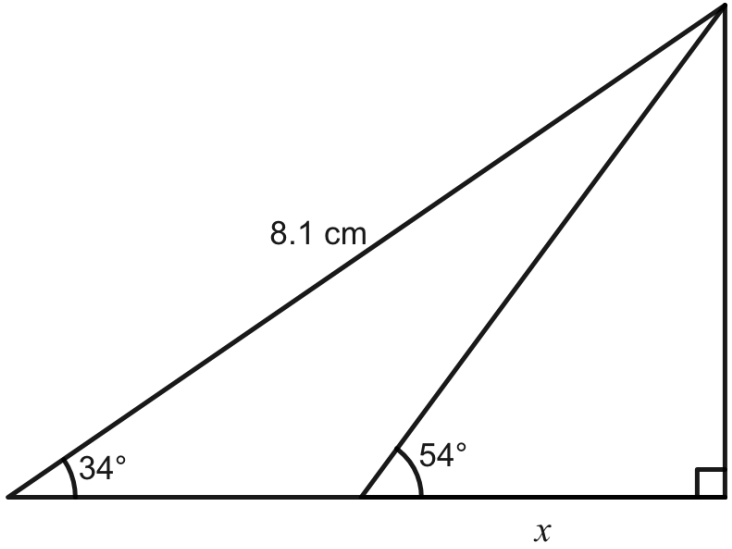
Work out the value of x



Give your answer correct to 1 decimal place.

Your Turn

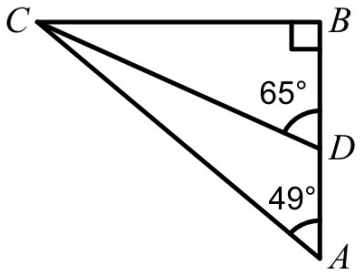
Work out the value of x



Give your answer correct to 1 decimal place.

Worked Example

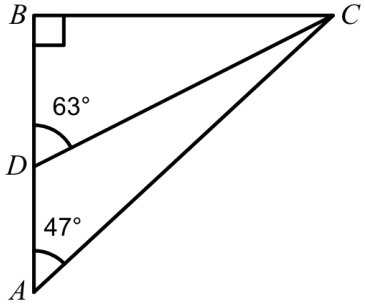
Given that $BC = 20$ cm, find the length of AD



Give your answer correct to 1 decimal place.

Your Turn

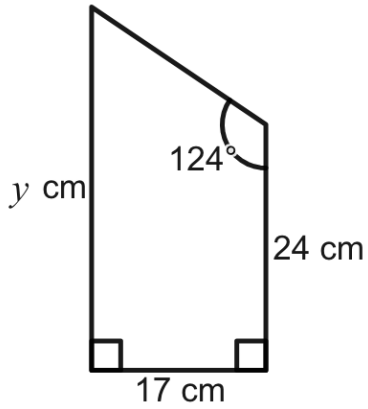
Given that $CD = 24$ cm, find the length of AD



Give your answer correct to 1 decimal place.

Worked Example

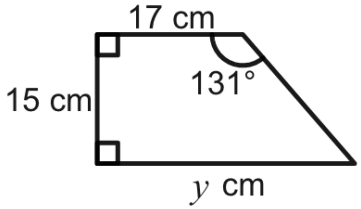
The diagram shows a trapezium.



Determine the length of the edge labelled y.
Give your answer correct to 1 decimal place.

Your Turn

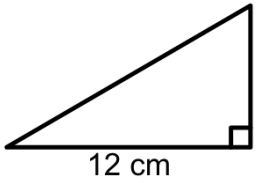
The diagram shows a trapezium.



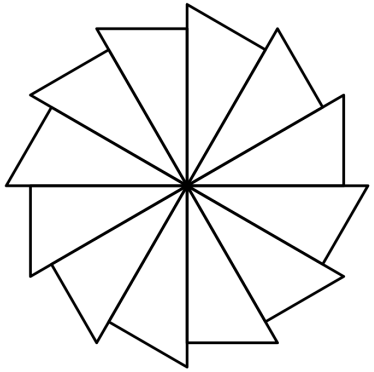
Determine the length of the edge labelled y.
Give your answer correct to 1 decimal place.

Worked Example

A shape is to be made from 12 triangles. The diagram below shows the triangle to be used.



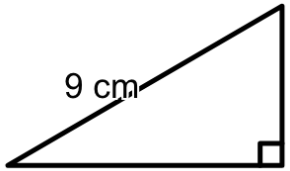
The triangles are arranged as shown in the diagram below.



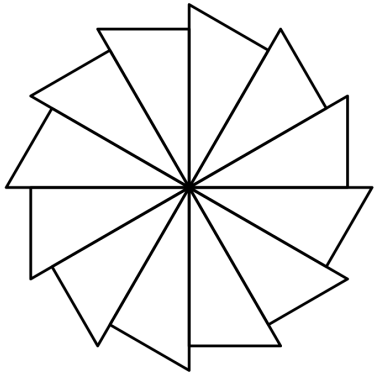
Find the perimeter of the shape.
Give your answer correct to 1 decimal place.

Your Turn

A shape is to be made from 9 triangles. The diagram below shows the triangle to be used.



The triangles are arranged as shown in the diagram below.



Find the perimeter of the shape.
Give your answer correct to 1 decimal place.

Inverse Trigonometric Functions

We have met the idea that if $f(x) = y$ then $f^{-1}(y) = x$

The trigonometric functions sin, cos and tan are all functions where the input is an angle giving an output which is a ratio of sides.

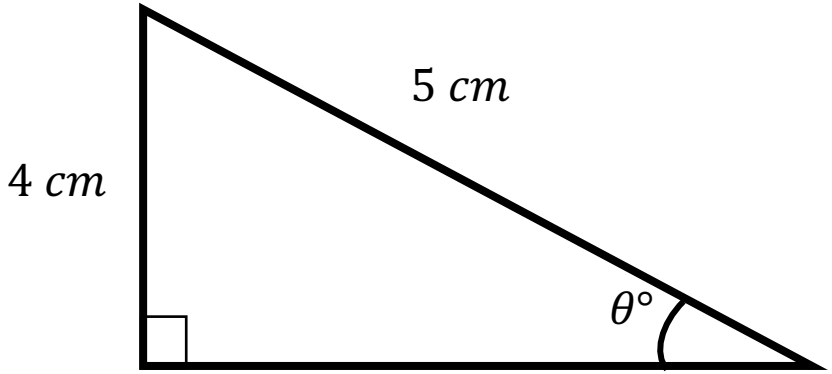
The inverse of these functions therefore does this in reverse.

If $\sin(30°) = 0.5$ then $\sin^{-1}(0.5) = 30°$
If $\cos(60°) = 0.5$ then $\cos^{-1}(0.5) = 60°$
If $\tan(45°) = 1$ then $\tan^{-1}(1) = 45°$

Worked Example	Your Turn
Find 'x'. Give your solution to 2 decimal places. $sin(x) = \frac{2}{3}$	Find 'x'. Give your solution to 2 decimal places. $cos(x) = \frac{2}{3}$

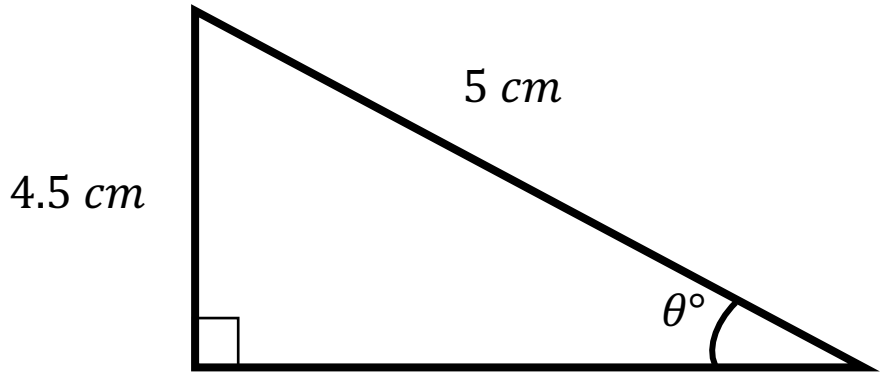
Worked Example

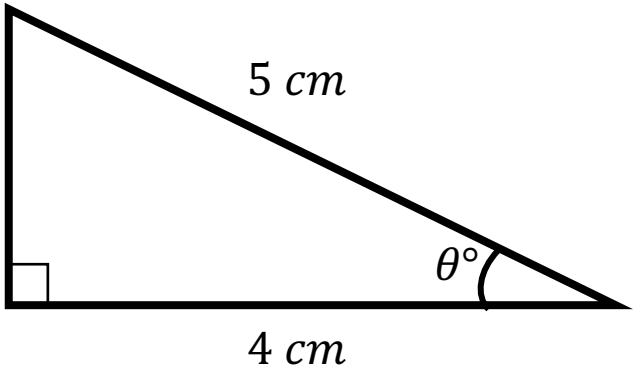
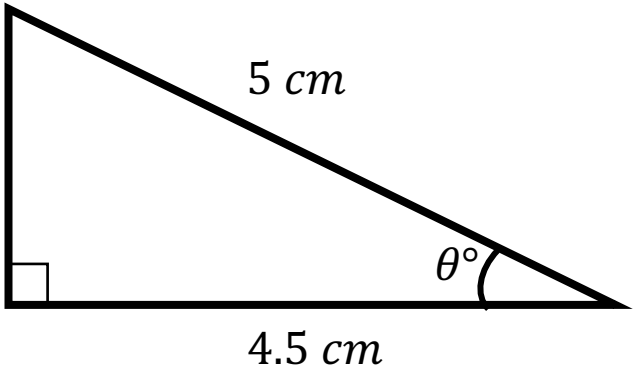
Calculate θ. Round your answer to 1 decimal place.



Your Turn

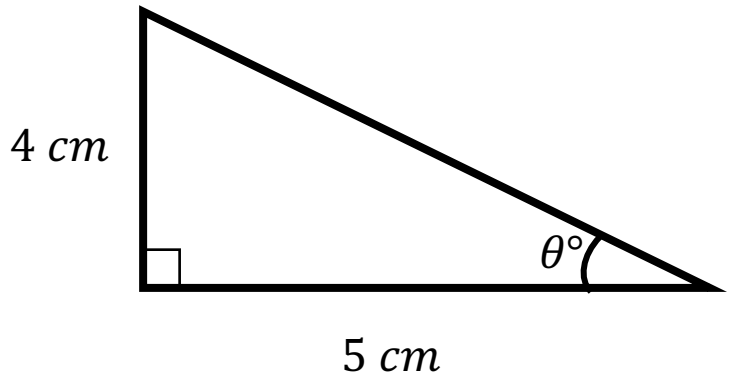
Calculate θ. Round your answer to 1 decimal place.



Worked Example	Your Turn
Calculate θ. Round your answer to 1 decimal place.  	Calculate θ. Round your answer to 1 decimal place. 

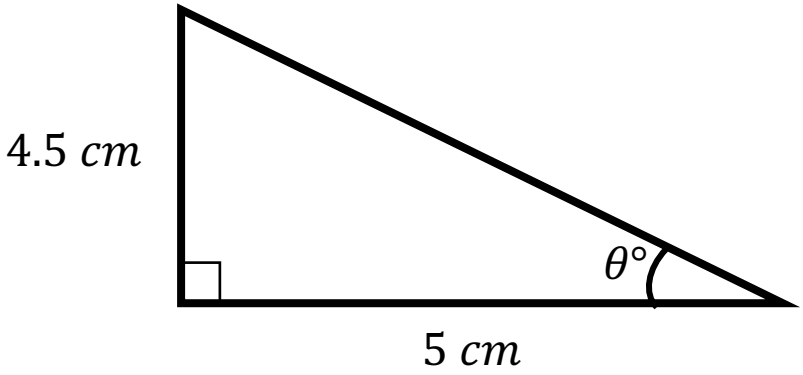
Worked Example

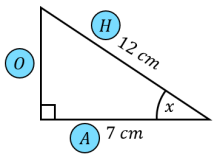
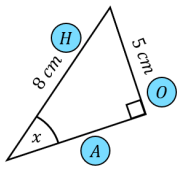
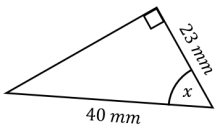
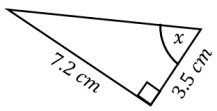
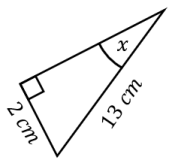
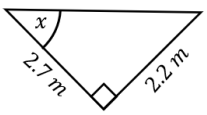
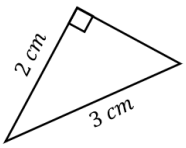
Calculate θ. Round your answer to 1 decimal place.



Your Turn

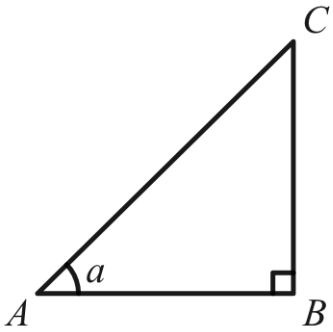
Calculate θ. Round your answer to 1 decimal place.



Labelled diagram	Choose ratio	Substitute into formula	Rearrange formula	Answer (1dp)
	cos	$\cos x = \frac{7}{12}$	$x = \cos^{-1}\left(\frac{7}{12}\right)$	
	sin			
				
				
				
				
		$\cos x = \frac{2}{3}$		
			$x = \tan^{-1}\left(\frac{15}{11}\right)$	

Worked Example

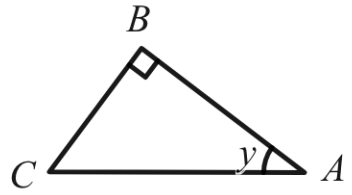
Given that the length of BC is 70% of the length of AC, find the value of a.



Give your answer correct to 1 decimal place.

Your Turn

Given that the length of BC is 75% of the length of AB, find the value of y.



Give your answer correct to 1 decimal place.

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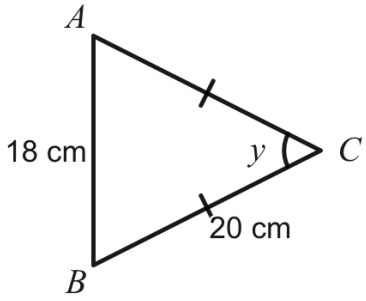
Worked Example

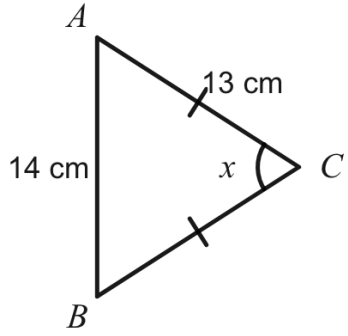
Work out the value of y.



Give your answer correct to 1 decimal place.

Your Turn

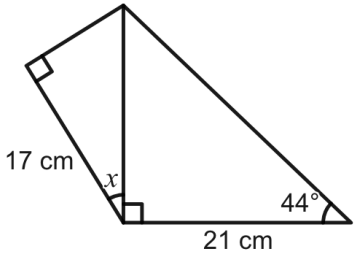
Work out the value of x.



Give your answer correct to 1 decimal place.

Worked Example

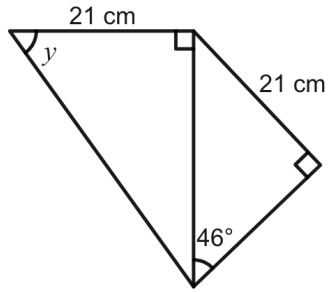
Work out the value of x.



Give your answer correct to 1 decimal place.

Your Turn

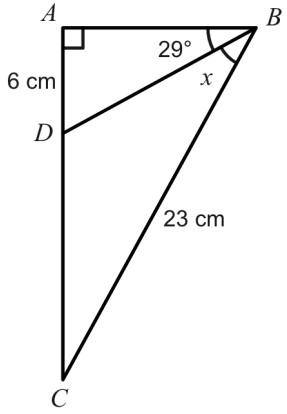
Work out the value of y.



Give your answer correct to 1 decimal place.

Worked Example

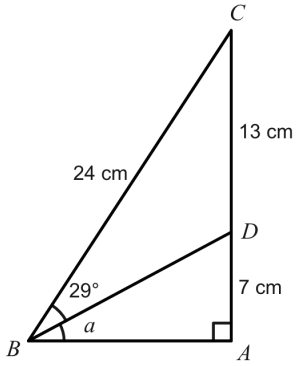
Work out the value of x.



Give your answer correct to 1 decimal place.

Your Turn

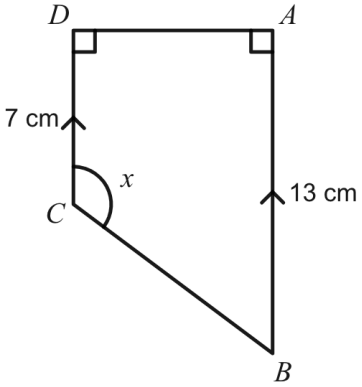
Work out the value of a.



Give your answer correct to 1 decimal place.

Worked Example

$ABCD$ is a trapezium with area 80 cm².

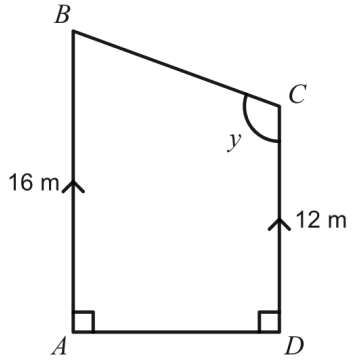


Work out the value of x.

Give your answer correct to 1 decimal place.

Your Turn

$ABCD$ is a trapezium with area 154 m².

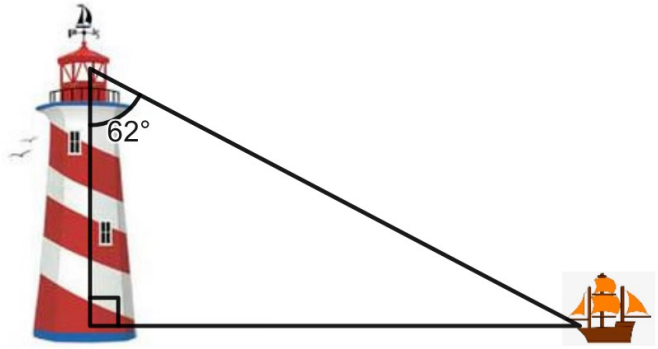


Work out the value of y.

Give your answer correct to 1 decimal place.

Worked Example

The diagram below shows a lighthouse and a boat.

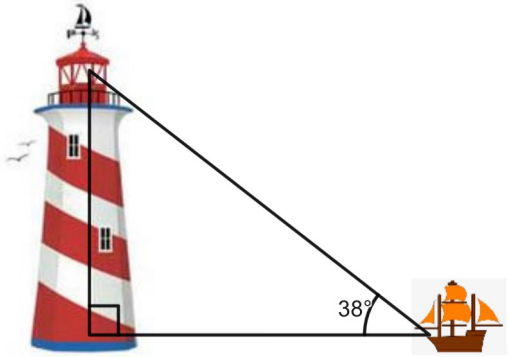


The lighthouse keeper notes that from looking straight down, the boat is at an angle of $62°$

Write down the angle of depression of the boat from the lighthouse.

Your Turn

The diagram below shows a lighthouse and a boat.

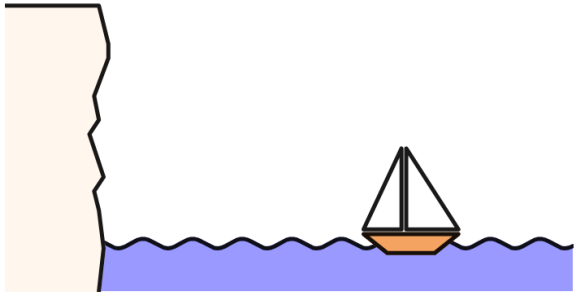


The captain of the boat can see the light of the lighthouse by looking upwards at an angle of $38°$

Write down the angle of depression of the boat from the lighthouse.

Worked Example

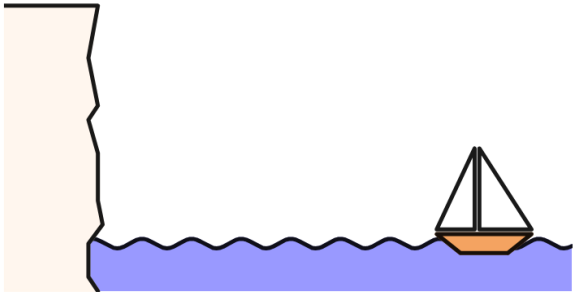
Talula is on a boat 93 metres away from the foot of a vertical cliff. The height of the cliff is 87 metres.



Calculate the angle of depression of the boat from the top of the cliff.

Your Turn

Levi is on a boat 59 metres away from the foot of a vertical cliff. The boat is also 73 metres from the top of the cliff.



Calculate the angle of elevation of the top of the cliff from Levi's position.

Worked Example	Your Turn
The horizontal distance between a telegraph pole and a point P on the ground is 22 m and the angle of elevation is $60°$ from the point P to the top of the telegraph pole. Find the distance between the top of the telegraph pole and the point P. Give your answer correct to 1 decimal place.	The horizontal distance between a clock tower and a point P on the ground is 9 m and the angle of elevation is $34°$ from the point P to the top of the clock tower. Find the distance between the top of the clock tower and the point P. Give your answer correct to 1 decimal place.

Pythagoras' Theorem or Trigonometry

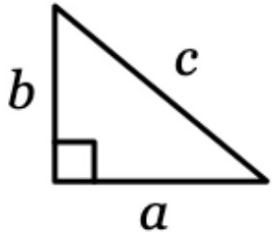
Right-angled?

Yes

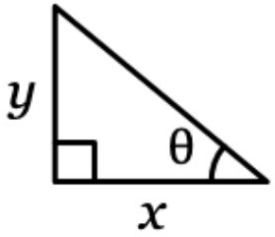
No

Involves **3** sides?

Involves **2** sides and **1** angle?



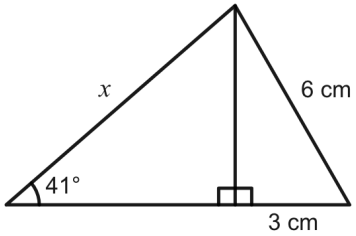
Pythagoras' Theorem



$S^{O}_{H}\ C^{A}_{H}\ T^{O}_{A}$

Worked Example

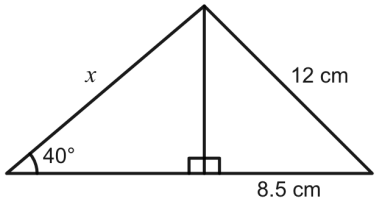
Work out the value of x.



Give your answer correct to 1 decimal place.

Your Turn

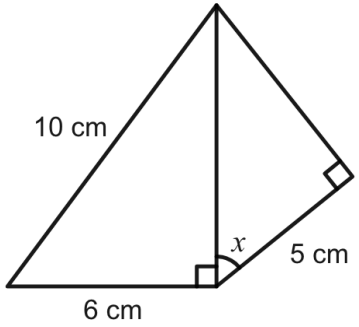
Work out the value of x.



Give your answer correct to 1 decimal place.

Worked Example

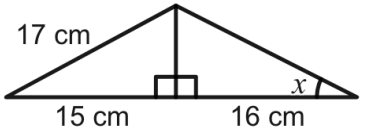
Work out the value of x.



Give your answer correct to 1 decimal place.

Your Turn

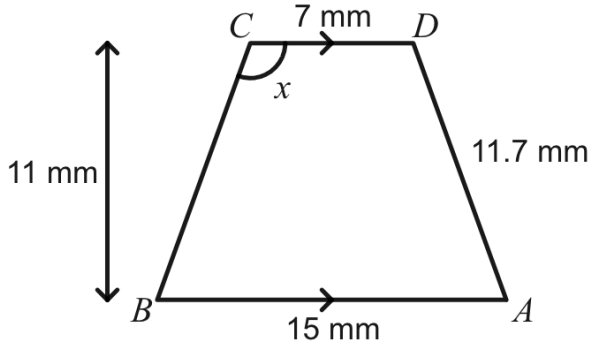
Work out the value of x.



Give your answer correct to 1 decimal place.

Worked Example

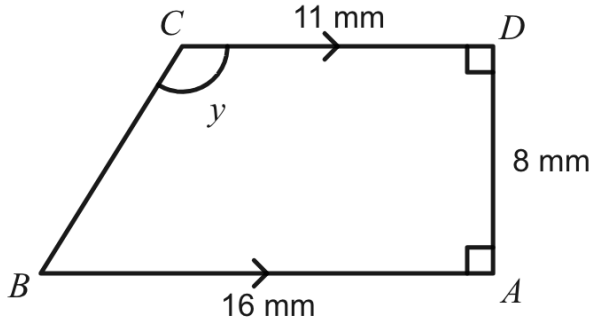
$ABCD$ is a trapezium.



Work out the value of x.
Give your answer correct to 1 decimal place.

Your Turn

$ABCD$ is a trapezium.



Work out the value of y.
Give your answer correct to 1 decimal place.

Worked Example	Your Turn
Find the angle that the line joining $P(-5, 6)$ and $Q(1, -2)$ makes with the positive direction of the x-axis. Give your answer correct to 1 decimal place.	Find the angle that the line joining $P(-3, 2)$ and $Q(5, -2)$ makes with the positive direction of the x-axis. Give your answer correct to 1 decimal place.

Extra Notes