% % % % % % % % % % % % %

PERCENTAGES

% %

~ II ~

P E R C E N T A G E S II

Lesson 1

GCSE (Year 10) Mathematics
Percentages II

Non Calculator

1.1 Mental Arithmetic Percentages

In "Percentages I" good use was made of the following table to do many calculations without the need to use a calculator. It shows many common fractions and their percentage equivalents.

$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{25}$	$\frac{1}{50}$	$\frac{1}{100}$
50%	$33\frac{1}{3}$%	25%	20%	10%	5%	4%	2%	1%

With this table in mind, tackle the following exercise, intended as revision.

1.2 Twenty-One Quick Percentage Questions

Twenty-One Today

Work quickly, but accurately.
You have 25 minutes to answer as many questions as you can.

Do NOT use a calculator - show your working

Question 1

10 % when written as a common fraction, is $\frac{1}{10}$

Write 70 % as a common fraction.

Answer : _____

Question 2

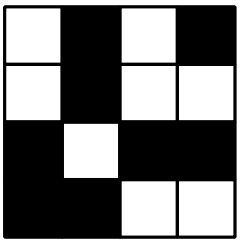
$\frac{1}{5}$ when written as a percentage is 20 %

Write $\frac{4}{5}$ as a percentage.

Answer : _____

Question 3

What percentage of the squares in this diagram are black ?



Answer : _____

Question 4

What is 10 % of £4.80 ?

Answer : _____

Question 5

5 % when written as a common fraction is $\frac{1}{20}$

Write 45 % as a common fraction.

Answer : _____

Question 6

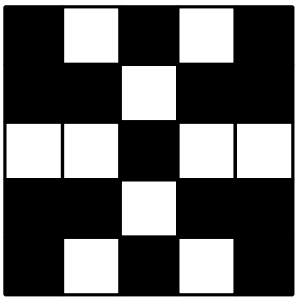
$\frac{1}{25}$ when written as a percentage is 4 %

Write $\frac{6}{25}$ as a percentage.

Answer : _____

Question 7

What percentage of the squares in this diagram are black ?



Answer : _____

Question 8

What is 20 % of £14.50 ?

Answer : _____

Question 9

25 % when written as a common fraction is $\frac{1}{4}$

Write $12\frac{1}{2}$ % as a common fraction.

Answer : _____

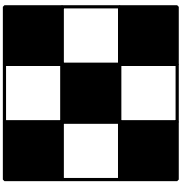
Question 10

$\frac{1}{9}$ when written as a percentage is $11\frac{1}{9}$ %

Write $\frac{2}{9}$ as a percentage.

Answer : _____

Question 11
What percentage of the squares in this diagram are black ?



Answer : _____

Question 12
What is 25 % of £8.48 ?

Answer : _____

Question 13
Increase £8 by 15 %

Answer : _____

Question 14
Decrease £8 by 15 %

Answer : _____

Question 15

I open a savings account with £400.
It pays interest at 4 % per annum.
How much is in my account after one year ?

Answer : _____

Question 16

5 % when written as a common fraction is $\frac{1}{20}$

Write 95 % as a common fraction.

Answer : _____

Question 17

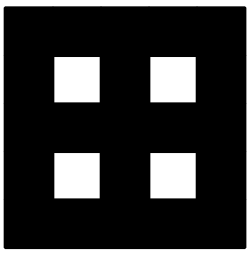
$\frac{1}{25}$ when written as a percentage is 4%

Write $\frac{24}{25}$ as a percentage.

Answer : _____

Question 18

What percentage of the squares in this diagram are black ?



Answer : _____

Question 19

$\frac{1}{6}$ when written as a percentage is $16\frac{2}{3}$ %

Write $\frac{5}{6}$ as a percentage.

Answer : _____

Question 20

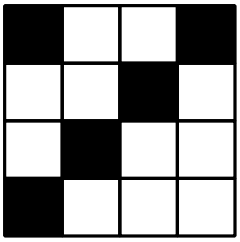
$6\frac{1}{4}$ % when written as a common fraction is $\frac{1}{16}$

Write $93\frac{3}{4}$ % as a common fraction.

Answer : _____

Question 21

What percentage of the squares in this diagram are black ?



Answer : _____

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1.3 Solutions (1.2 Exercise)

GCSE (Year 10) Mathematics
Percentages II

Answer 1	**Answer 2**	**Answer 3**	**Answer 4**
$\frac{7}{10}$	80 %	50 %	£0.48 or 48p

Answer 5	**Answer 6**	**Answer 7**	**Answer 8**
$\frac{9}{20}$	24 %	60 %	£2.90

Answer 9	**Answer 10**	**Answer 11**	**Answer 12**
$\frac{1}{8}$	$22\frac{2}{9}$ %	$55\frac{5}{9}$ %	£2.12

Answer 13	**Answer 14**	**Answer 15**	**Answer 16**
£9.20	£6.80	£416	$\frac{19}{20}$

Answer 17	**Answer 18**	**Answer 19**	**Answer 20**
96 %	84 %	$83\frac{1}{3}$ %	$\frac{15}{16}$

Answer 21

$31\frac{1}{4}$ %

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1.4 Homework

GCSE (Year 10) Mathematics
Percentages II

You may use a calculator

Question 1

Fill in the gaps in the following table;

Vulgar Fraction		$\frac{1}{3}$			$\frac{1}{10}$			$\frac{1}{50}$	
Decimal Fraction	0.5			0.2			0.04		
Percentage %			25			5			1

Question 2

Convert the following vulgar fractions into exact percentages;

(i) $\frac{3}{10}$ **(ii)** $\frac{7}{20}$ **(iii)** $\frac{12}{25}$

(iv) $\frac{130}{50}$ **(v)** $\frac{17}{1000}$ **(vi)** $\frac{8.6}{16}$

Question 3

Convert the following percentages into vulgar fractions;
Give your answers in as simple a form as possible.

(i) 60 % **(ii)** 32 % **(iii)** 85 %

(iv) 214 % **(v)** $\frac{1}{2}$ % **(vi)** 0.2 %

Question 4

(i) What exact percentage of £52 is £13 ?

(ii) What exact percentage of $120 is $40 ?

(iii) What exact percentage of 15kg is 2.5kg ?

(iv) What exact percentage of £80 is 10p ?

(v) What exact percentage of a foot is an inch ?
(12 inches = 1 foot)

Question 5

What percentage of the letters in this sentence are vowels ?

Question 6

In a test with 40 questions, William gets 32 correct and Kate gets 14 wrong.
How many percent higher is William's score, than Kate's ?

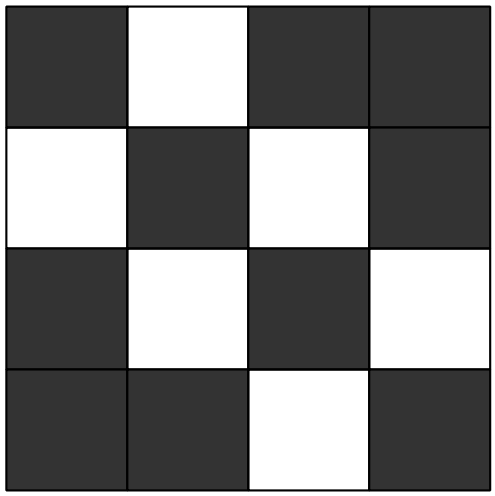
Question 7

On average I spell 95 % of words correctly.
How many spelling mistakes am I likely to make in a 2500 word essay ?

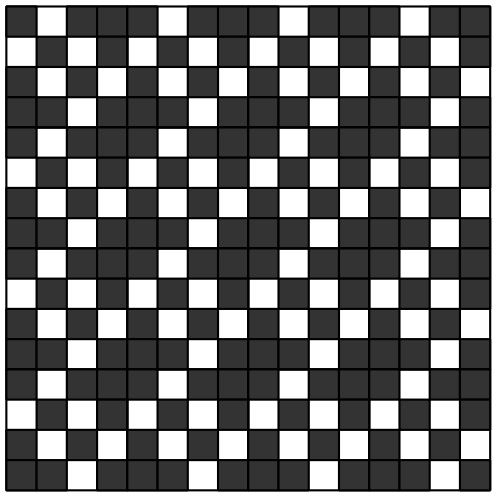
Question 8

What percentage of the large square is shaded ?

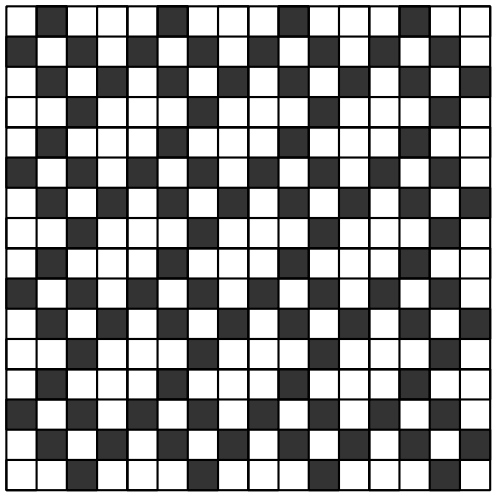
(i)



(ii)

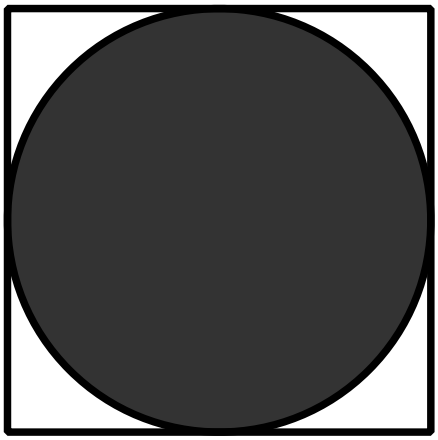


(iii)

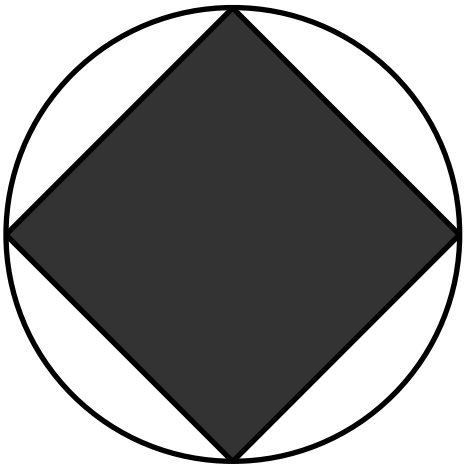


Question 9

(i) What percentage of a square's area will be contained within the inscribed circle, as shown below ?
Show your working, making your method clear



(ii) What percentage of a circle's area will be contained within the inscribed square, as shown below ?
Show your working, making your method clear



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1.5 Solutions (1.4 Homework)

GCSE (Year 10) Mathematics
Percentages II

Answer 1

Vulgar	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{25}$	$\frac{1}{50}$	$\frac{1}{100}$
Decimal	0.5	0.33	0.25	0.2	0.1	0.05	0.04	0.02	0.01
Percentage	50	$33\frac{1}{3}$	25	20	10	5	4	2	1

Answer 2

(i) 30 % **(ii)** 35 % **(iii)** 48 %
(iv) 260 % **(v)** 1.7 % **(vi)** 53.75 %

Answer 3

(i) $\frac{3}{5}$ **(ii)** $\frac{8}{25}$ **(iii)** $\frac{17}{20}$
(iv) $\frac{107}{50}$ or $2\frac{7}{50}$ **(v)** $\frac{1}{200}$ **(vi)** $\frac{1}{500}$

Answer 4

(i) 25 % **(ii)** $33\frac{1}{3}$ % **(iii)** $16\frac{2}{3}$ %
(iv) 0.125 % **(v)** $8\frac{1}{3}$ %

Answer 5

$$\frac{18}{49} \times 100 = 36.73... \%$$

Answer 6

$$William - Kate = 80 - 65$$
$$= 15\,\%$$

Answer 7

$$5\,\% \text{ incorrect} \Rightarrow \frac{1}{20} \times 2500 = 125 \text{ spelt incorrectly}$$

Answer 8

(i) 62.5 % **(ii)** 62.5 % **(iii)** 37.5 %

Answer 9

(i) $\frac{\pi r^2}{4 r^2} \times 100 = 78.54\,\%$ **(ii)** $\frac{2 r^2}{\pi r^2} \times 100 = 63.66\%$

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Lesson 2

GCSE (Year 10) Mathematics
Percentages II

Calculator Needed !

2.1 Percentage Increase & Decrease

Example #1
Suppose George has saved £250 towards the cost of a laptop computer.
His Uncle Henry offers to increase his savings by 70%.

The amount George will then have is given by,

$$250 + \frac{70}{100} \times 250$$
$$= 250 + 0.70 \times 250$$
$$= 250 \times (1 + 0.70)$$
$$= 250 \times 1.70$$

Thus to increase the £250 by 70%, multiply by 1.70

Notice that the 1.70 is made up of two parts, the 1 which represents George keeping 100% of what he already had, and the 0.70 which is the 70% extra from Uncle Henry.

The entire problem of working out increasing £250 by 70% boils down to one very simple computation,

$$250 \times 1.70 = £425$$

Ordinarily the 1.70 would be written 1.7 but, if it helps you think, write it as 1.70

Example #2
Shares initially worth £1800 on 1st January 2014, experience the following annual rate of interest (APR) over a five year period.

Year	2014	2015	2016	2017	2018
APR	3 %	7.5 %	2 %	6 %	5 %

How much are the shares worth on 1st January 2019 ?

2.2 Exercise

Question 1

(i) What would £75 be multiplied by to increase it by 75 % ?

(ii) What would $104 be multiplied by to increase it by 2.4 % ?

(iii) What would a distance of x miles be multiplied by to increase it by 12% ?

(iv) To increase a mass of y kg by 134 %, what would y be multiplied by ?

(v) What should I multiply a number by to increase it by 300% ?

Question 2

Explain why, to decrease the price of a box of apples by 32 % I should multiply it's current price by 0.68

Question 3

(i) What would £96 be multiplied by to decrease it by 25 % ?

(ii) What would 25 kg be multiplied by to decrease it by 4 % ?

(iii) What would a mass of x kg be multiplied by to decrease it by 99 % ?

(iv) To decrease a price of £y by 7.5 % what would y by multiplied by ?

(v) Explain why a mass of z kg cannot be decreased by more than 100 %

Question 4

When born, Tobin weighed 2.97 kg.

Over the first two weeks of his life, he lost 7 % of his weight, then gained 22% over the following two weeks.

(i) Explain why his weight, aged four week, is given by the calculation,

$$2.97 \times 0.93 \times 1.22$$

(ii) What was his weight, to three significant figures, four weeks after birth ?

Question 5

In the shop “Man Cave Essentials” a desk tidy costs £145.

The shop decides to increase all of it's prices by 12 % ahead of a “SALE” two weeks later in which it will reduce those prices by 20 %.

(i) Write down a calculation that will give the sale price of the desk tidy.

(ii) What to the nearest penny is the sale price of the desk tidy ?

Question 6

In 2018 production of Olive Oil in Italy fell by 65% due to drought, disease and deforestation caused by the start of constructing a Trans Adriatic Pipeline to carry natural gas from the Caspian Sea to Europe.

This followed a decline of 18% the previous year, in 2017.

In 2016 Italy produced 182300 tonnes of Olive Oil.

(i) Write down a calculation that will give the tonnage of Olive Oil produced by Italy in 2018.

(ii) How much Olive Oil was produced by Italy in 2018 ?

Question 7

An engineering company received 1437 orders in 2015.
In 2016 it experiences a 12 % increase in orders and in 2017 orders increased by 17%.
However, in 2018 orders fell by 18%.
How many orders did the company receive in 2018 ?

Question 8

The average circulation of The Sun newspaper in January 2016 was
1 787 096 papers sold per day.
(Data from Audit Bureau of Circulations)

In January 2017 sales were 6.7% lower than the year before.
In January 2018 sales were 7.3% lower than the year before.
In January 2019 sales were 8.7 % lower than the year before.

What was the average circulation of The Sun newspaper in January 2019 ?

Question 9

A rectangular plot of land measures 60 m by 50 m.

(i) Calculate its area in m^2

Another rectangular plot of land has sides that are each 20 % bigger than those of the first plot.

(ii) Calculate the area of the second plot of land.
Show your working.

(iii) Calculate, as a percentage, how much greater the area of the second plot is than the area of the first.

Question 10

The tables below gives the annual inflation rate in the UK between 2000 and 2018. (The data is from the UK's office for National Statistics)

Year	2000		2001		2002		2003		2004	
Inflation, %		3.0		1.8		1.7		2.9		3.0
Investment, £	1000				1049		1066			

Year	2005		2006		2007		2008		2009	
Inflation, %		2.8		3.2		4.3		4.0		- 0.5
Investment, £	1130		1162		1199		1251			

Year	2010		2011		2012		2013		2014	
Inflation, %		4.6		5.2		3.2		3.0		2.4
Investment, £			1354		1424		1470		1514	

Year	2015		2016		2017		2018		2019	
Inflation, %		1.0		1.8		3.6		2.5		
Investment, £	1550		1566							

(i) Explain why what was bought for £1000 at the start of 2017 would typically cost, at the start of 2019, £1061.90 to buy.

(ii) Rebecca's Dad invested £1000 when she was born on 1st January 2000 in a Government Bond that guaranteed to match the rate of inflation. Complete the table to show how the value of the bond has changed with the passage of time. Several values are already in the table.
On the 1st January 2019, how much was the Bond worth ?

(iii) Suppose there is a number, x, that will multiply the £1000 from 1st January 2000 and give the part (ii) answer for 1st January 2019.
What is x ?

(iv) What percentage does x suggest that prices have increased by between 1st January 2000 and 1st January 2019 ?

Question 11

A cube has edges of length x cm.

(i) What is it's volume, in terms of x ?

(ii) The cube is similar to another larger cube in which each edge is 15 % longer.
What is the volume of the larger cube, in terms of x ?

(iii) By what percentage has the volume of the small cube been increased by the enlargement ?
Explain your answer.

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2.3 Answers

2.3.1 Solution to Example #2

$$1800 \times 1.03 \times 1.075 \times 1.02 \times 1.06 \times 1.05 = 1800 \times 1.257$$
$$= £2262.62$$

Some points to notice:

- The 1.257 shows that the interest paid overall is 25.7%
- The bank can't round to three significant figure and so only pay out £2260
  An answer given as £2260 is incorrect !
- Banks never round up when paying out.
  £2262.629943 gets rounded DOWN to £2262.62

2.3.2 Solutions to Exercise 2.2

Answer 1

(i) 1.75
(ii) 1.024
(iii) 1.12
(iv) 2.34
(v) 4.00

Answer 2

Decreasing by 32% is the same as keeping 68%
68% as a decimal is 0.68
So, keep 68 % of the current price

Answer 3

(i) 0.75
(ii) 0.96
(iii) 0.01
(iv) 0.925
(v) A decrease of 100% reduces the mass to 0 kg.
As it's not possible to have negative mass, it doesn't make sense to reduce the mass by more than 100%

Answer 4

(i) The 2.97 is his birth weight
The 0.93 is the 7% loss of weight over the first two weeks
The 1.22 is the 22% gain in weight over the subsequent two weeks

(ii) $2.97 \times 0.93 \times 1.22 = 2.97 \times 1.1346$
$= 3.37\,kg$
Note : Overall his weight increased by 13.46 %

Answer 5

(i) $145 \times 1.12 \times 0.8$

(ii) £129.92

Answer 6

(i) $182\,300 \times 0.82 \times 0.35$

(ii) 52 320 tonnes

Answer 7

$$1437 \times 1.12 \times 1.17 \times 0.82 = 1544 \textit{ orders}$$

Answer 8

$$1\,787\,096 \times 0.933 \times 0.927 \times 0.913 = 1\,411\,172$$

Answer 9

(i) $60 \times 50 = 3000\ m^2$

(ii) $60 \times 1.20 \times 50 \times 1.20 = 3000 \times 1.44 = 4320\ m^2$

(iii) 44 % (from the 1.44)

Answer 10

(i) $1000 \times 1.036 \times 1.025 = £1061.90$

(ii)

Year	2000		2001		2002		2003		2004	
Inflation, %		3.0		1.8		1.7		2.9		3.0
Investment, £	1000		**1030**		1049		1066		**1097**	

Year	2005		2006		2007		2008		2009	
Inflation, %		2.8		3.2		4.3		4.0		- 0.5
Investment, £	1130		1162		1199		1251		**1301**	

Year	2010		2011		2012		2013		2014	
Inflation, %		4.6		5.2		3.2		3.0		2.4
Investment, £	**1294**		1354		1424		1470		1514	

Year	2015		2016		2017		2018		2019	
Inflation, %		1.0		1.8		3.6		2.5		
Investment, £	1550		1566		**1594**		**1651**		**1692**	

(iii)

$$x \times 1000 = 1692$$

$$x = \frac{1692}{1000}$$

$$x = 1.692$$

(iv) 69.2%

Answer 11

(i) $x \times x \times x = x^3$

(ii) $x \times 1.15 \times x \times 1.15 \times x \times 1.15 = x^3 \times 1.15^3 = x^3 \times 1.52$

(iii) 52 % (from the 1.52)

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Lesson 3

GCSE (Year 10) Mathematics
Percentages II

Calculator Needed !

3.1 Return on an Investment

In recent times, Banks have not offered attractive rates to savers and so placing large amounts of money in a Bank has become unattractive. If a Bank goes 'bust' a maximum of £85 000 in compensation can be claimed. Anything over that is likely to be lost.
Consequently, investing in property is regarded as more secure. Far higher rates of return than those offered by savings accounts are to be found (by those who know what they are doing) by investing in stocks and shares, or art, for example.
Of course such investments may need to be insured, lessening the return on the investment. Property can be rented out and so enhance the return.

3.2 Simple Interest

A finance company offers a fixed income saving account where a large amount of capital may be invested. At the end of each month a payment is made to the account holder of 0.4% of the capital held.
The capital may be withdrawn at any time, and the account closed.

George places one million pounds into such an account.

(i) What is the amount paid to George by the account each month ?

(ii) What is George's annual income from the account ?

(iii) What is the Annual Percentage Rate (APR) payed by the account ?

3.3 Compound Interest

Jake opens a savings account with £4000.
It pays compound interest at 5 % per annum.

(i) Calculate how much money is in Jake's account after each of the first three years.

(ii) Show how Jake could quickly perform one calculation to determine how much money is in his account after three years.

3.4 Exercise

Question 1
I open a savings account with £4000.
Interest will be payed into the account at 4% per annum.
How much is in the account after 3 years ?

Question 2
I borrow £1000 from a friend.
He tells me I'm a “bad risk” and charges me 12% interest per annum.
How much do I owe my friend after 3 years ?

Question 3
I open a savings account with £5000.
Interest will be payed into the account at 3% per annum.
How much is in the account after 3 years ?

Question 4
I borrow £8000 on a credit card.
The rate charged is 26% interest per annum.
How much would I owe the credit card company after 3 years if no repayments were made during that time ?

Comment on the wisdom of borrowing money in this way.

Question 5
To decrease £8 by 15% first work out 100%-15%
(O.K. That's 85%)
Now work out £8 × 0.85

Question 6
Decrease £24 by 15% using the method of question 5.

Question 7
Decrease £47 by 8% using the method of question 5.

Question 8
(i) The Bank Of England is raising money by selling £1000 ten year government bonds. These guarantee to pay 8% interest per year but cannot be cashed for ten years.

Suppose you buy one of these £1000 bonds.
Calculate its value in ten years time by working out.....

$$Value = 1000 \times 1.08^{10}$$

(ii) Similar £1000 Bonds issued ten years ago, were sold at a rate of 13.5%
How much is one of those bonds now worth ?

Question 9
A man buys £4000 worth of shares in "Ye Trusty School Sweet Shop".
During the first year the value of the shares increases by 30%.

(i) How much are the shares worth after that first year ?

The following year the value of the shares falls by 30%
(ii) Calculate how much the shares are then worth, and show that this is not £4000.

(iii) Over the two year period, were the shares a good investment ?

When buying shares they often come with a warning that the value of the shares can go down as well as up !

Question 10

At “Honest Joe's” electrical store a Microsoft Surface™ is priced at £400.
It is sold to a customer at a discount of 20%.

(i) What was the price the customer paid ?

Later, the customer sells the Microsoft Surface™ to a friend, making a profit of 20%.

(ii) How much did the friend pay for the Microsoft Surface™ ?
(Note that the answer is NOT £400)

Question 11

In the early 1980s, teachers, policemen and nurses got some big pay increases.
Work out the new salary of the following;

(i) A teacher on £6040 a year who gets a 28% pay increase.

(ii) A policeman on £7124 a year who gets a 16% pay rise.

(iii) A nurse who gets £5207 a year and a 38% pay rise.

(iv) Who has the highest salary after the pay increases ?

Question 12

In 2012 University tuition fees of £3000 were increased to £9000.
What is this increase when expressed as a percentage ?

Question 13

In June 2019 the UK's National Savings and Investments offered an income bond that paid interest as an income at a rate of 0.11% per month on the capital invested. The capital invested was 100% protected by the UK Treasury as investors are, in effect, lending money to the UK Government.

The maximum investment per customer was one million pounds.

(i) What is the monthly income generated from a one million pound investment ?

(ii) What in the annual income generated from a one million pound investment ?

(iii) In June 2019 the annual rate of inflation was 2.1%.
Is this more or less than the annual percentage rate on the return from the investment in an Income Bond ?

(iv) Explain what your part (iii) answer is telling you about keeping money with the UK's national Savings and Investments Income Bond scheme.

Question 14

GCSE Examination Question from Paper 1H, May 2019, Q8

On 1st January 2016 Li bought a boat for $170 000

The value of the boat depreciates by 8% per year

Work out the value of the boat on 1st January 2019

Give your answer correct to the nearest dollar.

[3 marks]

Question 15

Molly buys a car for £14 000

The car is likely to depreciate at a rate of 28 % per annum.

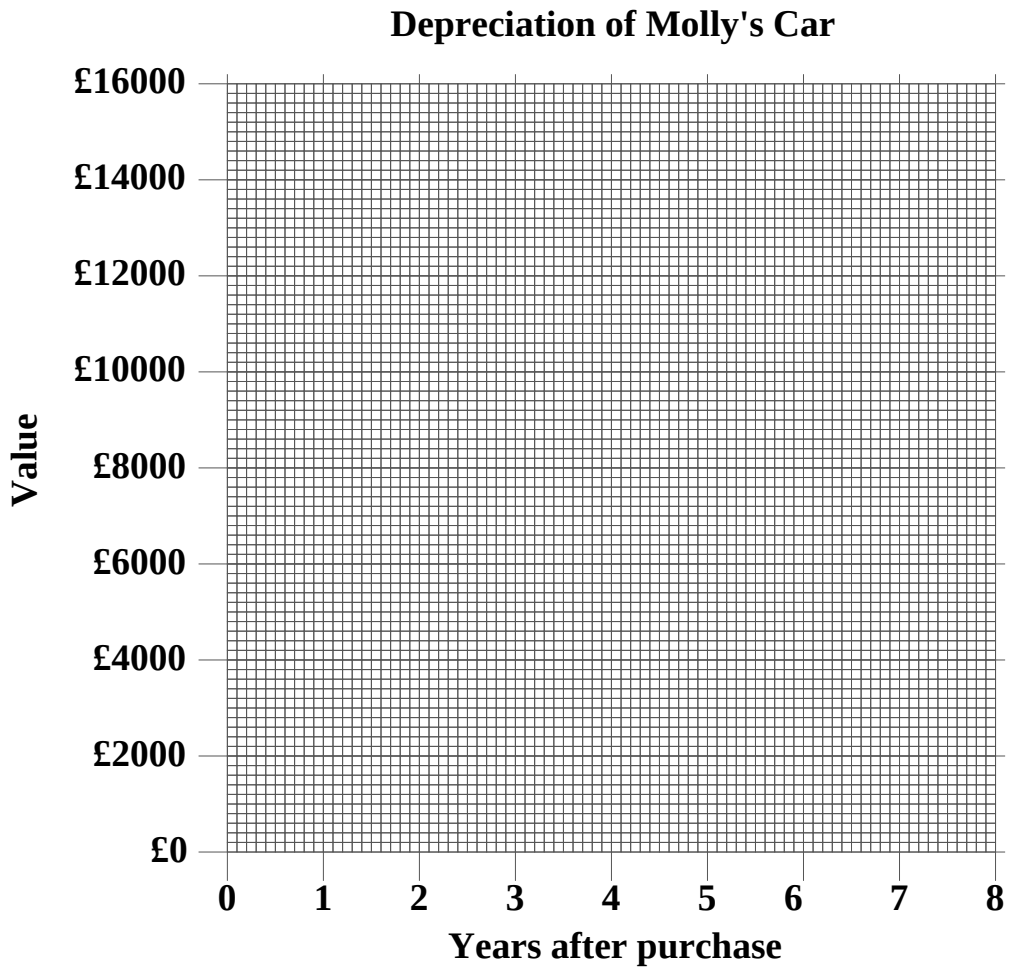
(i) How much is the car likely to be worth in one years time ?

(ii) How much has the value of the car gone down by in that first year ?

(iii) How much is the car likely to be worth in four years time ?

(iv) After how many years is the car likely to be approximately worth £1000 ?

(v) Plot a graph to show how the value of the car falls with time.



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3.5 Answers

3.5.1 Solution to 3.2 Simple Interest

(i) $1\,000\,000 \times \dfrac{0.4}{100} = £4000$

(ii) Annual income = £48 000

(iii) The cautious approach is,

$$1\,000\,000 \times x = 1\,048\,000$$

$$x = \frac{1\,048\,000}{1\,000\,000}$$

$$x = 1.048$$

So the APR is 4.8%

Although caution is generally needed when adding percentages, in this situation the answer can be deduced from noticing that George received 0.4% of £1 000 000 twelve times giving 4.8% of £1 000 000 being received in total over the year.

3.5.2 Solution to 3.3 Compound Interest

(i) Year 1

£4000 × 1.05 = £4200

Year 2

£4200 × 1.05 = £4410

Year 3

£4410 × 1.05 = £4630.50

(ii) $4000 \times 1.05^3 = £4630.50$

3.5.3 Solution to 3.4 Exercise

Answer 1

$4000 \times 1.04^3 = £4499.45$ Banks do not round up when paying out.

Answer 2

$1000 \times 1.12^3 = 1404.93$ or £1404.92 as he's my friend.

Answer 3

$5000 \times 1.03^3 = £5463.63$ Banks do not round up when paying out.

Answer 4

$8000 \times 1.26^3 = £16\,003$ To borrow £8000 has 'cost' £8000 - Expensive !

Answer 5
£6.80

Answer 6
$24 \times 0.85 = £20.40$

Answer 7
$47 \times 0.92 = £43.24$

Answer 8

(i) $1000 \times 1.08^{10} = £2158.92$

(ii) $1000 \times 1.135^{10} = £3547.79$
(Don't round up)

Answer 9
$4000 \times 1.3 = £5200$
$5200 \times 0.7 = £3640$ i.e. NOT £4000

Answer 10
$400 \times 0.8 = £320$
$320 \times 1.2 = £384$

Answer 11

(i) Teacher : £7731.20
(ii) Policeman : £8263.84 *Highest **(iv)**
(iii) Nurse : £7185.66

Answer 12

$$3000 \times x = 9000$$
$$x = \frac{9000}{3000}$$
$$x = 3$$
$$x = 1 + 2.00$$

$\therefore$ It's a 200% increase

Often, an incorrect answer of “300% increase” is given

Answer 13

(i)

$$1000000 \times \frac{0.11}{100} = 1000000 \times 0.0011$$
$$= £1100$$

(ii) £13 200

(iii) APR = $0.11 \times 12 = 1.32\%$ so it's less than the annual rate of inflation

(iv) The investment is not keeping pace with inflation

Answer 14

$170\,000 \times 0.92^3 = \$132\,377$

Answer 15

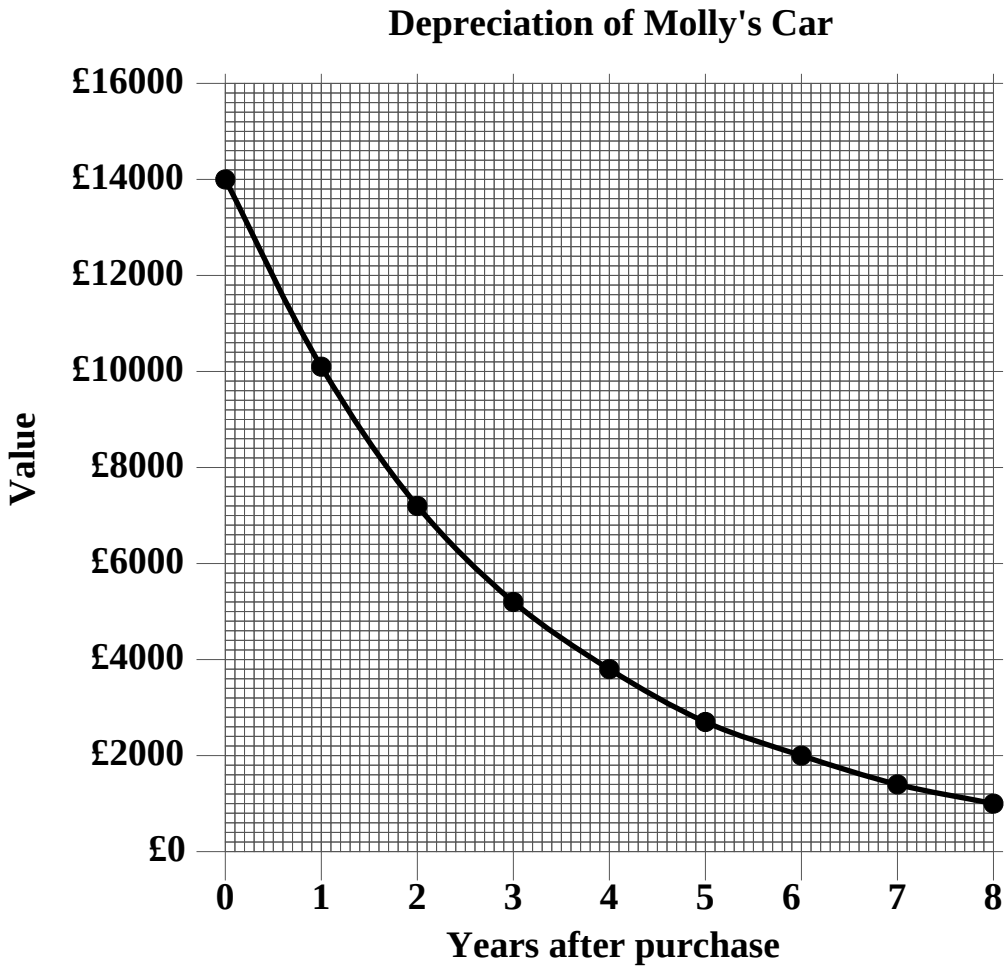
(i) $14\,000 \times 0.72 = £10\,080$

(ii) $14\,000 - 10\,080 = £3920$

(iii) $14\,000 \times 0.72^4 = £3762.34$

(iv) Keep multiplying by 0.72 : After 8 years it's worth £1011

After *n* years	0	1	2	3	4	5	6	7	8
Value, £	14000	10080	7258	5225	3762	2709	1950	1404	1011



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Lesson 4

GCSE (Year 10) Mathematics
Percentages II

Calculator Needed !

4.1 Percentage Profit & Loss

When a shopkeeper purchases stock, and then selling it for a profit, it is the percentage of the extra money gained in relation to *the original purchase price* that is calculated.
The idea is not restricted to money; a percentage profit is simply a percentage increase and this can be of any measurable quantity.
Likewise a percentage loss is a percentage decrease.

4.2 Example of Percentage Profit

Charlie buys a complete set of "Surging Sparks" Pokemon Trading Cards on ebay for £575 which he then sells at a Games Fair for £645.
Calculate his percentage profit.

4.3 Example of Percentage Decrease

The Amazon rainforest is an area of 5 500 000 km^2
By the year 2000 deforestation for cattle farming had caused 587 000 km^2 to be turned into pasture.
(Data from Wikipedia)

(i) What percentage of the Amazon Rainforest had been deforested by 2000 ?

By the start of 2019 deforestation had reached 27%.
(Data form WWF, World Wild Fund)

(ii) What area had been deforested by 2019 ?

(iii) Given that the area of England is 130 395 km^2, how many areas the equivalent of England have been deforested in the Amazon Rainforest ?

4.4 Exercise

Question 1

Two weeks ago Peter spend an average of 57 minutes a day on his mobile phone.
One week ago his average had increased to 92 minutes per day.
What percentage increase is this ?
Give your answer accurate to one decimal place.

Question 2

On Monday, Judy's Fitbit reported that she had walked 7431 steps that day.
The next day, on Tuesday, Judy walked 9214 steps.
What percentage increase is this ?

Question 3

From public domain historical house price data on the RightMove website, a certain house, chosen at random, in Shrewsbury was bought for £68 500 in 1995 and sold for £91 500 in 1999.

(i) Calculate the percentage profit made by this 1st set of owners.
Give your answer accurate to one decimal place.

The same house next sold for £262 500 in 2006

(ii) Calculate the percentage profit made by this 2nd set of owners

This house next sold for £230 000 in 2012

(iii) Calculate the percentage loss made by this 3rd set of owners.

The house was most recently sold for £282 500 in 2018

(iv) Calculate the percentage profit made by this 4th set of owners.

Question 4

To track and time his racing pigeons, Gerard is considering buying an iPigeon system pack. He is considering buying either

- The 1-Bird pack for £395

or

- The 4-Bird pack for £511

(i) How many percent more than the 1-Bird pack is the 4-Bird pack ?

(ii) How many percent less than the 4-Bird pack is the 1-Bird pack ?

Question 5

In January 2019 the Society of motor Manufacturers and traders reported that 2.54 million new cars were registered in the UK in 2017 and 2.36 million new cars were registered in the UK in 2018.
They said Brexit and a collapse in sales of diesel engine vehicles caused the decline.

Calculate the percentage fall in car sales for 2018 in comparison with 2017.

Question 6

In London, June 2019, Sebastian is analysing the M^{c}Donalds™ Menu,

Cola-Cola Classic	small	medium	large
Price	97 p	£1.11	£1.53
Capacity	250 ml	400 ml	500 ml

(i) What percentage more in cost is the medium size drink than the small ?

(ii) What is the corresponding percentage increase in capacity ?

(iii) In the light of your answers to parts (i) and (ii) make a relevant comment.

Question 7

Fully fuelled, the Saturn V “heavy lift” rocket that took astronauts to the moon had a mass of 2 950 000 kg. Of the total 15 that were built, 13 were launched and two were “left over” when going to the moon was abandoned in 1972.
The Saturn V rocket was designed to be able to send a 41,000 kg payload to the moon.
What percentage of the rocket's mass was 'lost' in getting the payload to the moon ?

Question 8

The Saturn V rocket's payload capacity to Low Earth Orbit (LEO) was 118,000 kg.
It's replacement, the Space Shuttle could lift 24,400kg into Low Earth Orbit.
What was the percentage reduction in payload capacity in moving from the Saturn V rocket to the Space Shuttle ?

Question 9

The amount of carbon dioxide, of interest because it is a greenhouse gas, in the Earth's atmosphere is measured in parts per million, ppm.
At the start of 2019 they were reported to be 406.42 ppm.
Before the industrial revolution which began in 1760, they were about 280 ppm.
What is the percentage increase in carbon dioxide levels in the Earth's atmosphere since the industrial revolution began ?

Question 10

In May 2017, Niel Woodford's Equity Income Fund held £10.7 bn.
By June 2019, when trading in the fund was suspended, it's value had fallen to £3.7 bn.

(i) What is the percentage fall in the value of the fund ?

(ii) If, in May 2017, you invested £3,400 in the fund, what was it worth in June 2019 ?

Question 11

By the end of 2016, the total installed wind power generation capacity in the UK was 14 512 MW. (MegaWatts)
By the end of 2017 this had increased to a total of 17 852 MW.

(i) What is this increase, expressed as a percentage ?

(ii) In the UK annual energy consumption per person in 2017 has been estimated to be 34.82 MWh. (Mega Watt hours)
In 2017 it was estimated that wind power provided 5.22 MWh of an average person's energy consumption.
What percentage of the average person's energy consumption came from wind power in 2017 ?

Question 12

In a 2016 report it was observed that, since 1925, the average number of days to market for a US chicken had been reduced from 112 to 48, while its average weight had ballooned from a market weight of 2.5 pounds to 6.2
(Data source : Live Chicken Production Trends, 2016)

(i) What is the percentage increase in average chicken weight between 1925 and 2016 ?

(ii) What is the percentage reduction in the average number of days to market between 1925 and 2016 ?

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4.5 Answers

4.5.1 Solution to 4.2 Example of Percentage Profit

$$\frac{645 - 575}{575} \times 100 = \frac{70}{575} \times 100$$
$$= 12\ \%\ \text{profit}$$

4.5.2 Solution to 4.3 Example of Percentage Decrease

(i) $\frac{587000}{5500000} \times 100 = 10.67\ \%$ deforested

(ii) $0.27 \times 5500000 = 1\,485\,000$

(iii) $\frac{1\,485\,000}{130\,395} = 11.4$ Englands

4.5.3 Solution to 4.4 Exercise

Answer 1

$$\frac{92 - 57}{57} \times 100 = 61.4\%$$

Answer 2

$$\frac{9214 - 7431}{7431} \times 100 = 24\%$$

Answer 3

(i) $\frac{91500 - 68500}{68500} \times 100 = 33.6\%$ profit

(ii) $\frac{262500 - 91500}{91500} \times 100 = 187\%$ profit

(iii) $\frac{262500 - 230000}{262500} \times 100 = 12.4\%$ loss

(iv) $\frac{282500 - 230000}{230000} \times 100 = 22.8\%$ profit

Answer 4

(i) $\frac{511 - 395}{395} \times 100 = 29.4\%$ more

(ii) $\frac{511 - 395}{511} \times 100 = 22.7\%$ less

Notice the two answers are not the same.
What is the same is $0.294... \times 395$ and $0.227... \times 511$

Answer 5

$\frac{2.54 - 2.36}{2.54} \times 100 = 7.1\%$ fall in car sales

Answer 6

(i) $\frac{111 - 97}{97} \times 100 = 14.4\%$ more cost

(ii) $\frac{400 - 250}{250} \times 100 = 60\%$ more capacity

(iii) The most obvious answer is that the medium drink is better value for money than the small drink.
A standard fast food outlet technique is to have a small capacity drink at a high price and a much larger capacity drink for a marginally higher price. The small capacity drink is there to make the next size up seem good value for money although it's actually extortionately priced and a high profit item for the fast food outlet.

Answer 7

$\frac{2\,950\,000 - 41\,000}{2\,950\,000} \times 100 = 98.6\%$

Answer 8

$\frac{118000 - 24400}{118000} \times 100 = 79.3\%$

“The US space community came to lament ceasing production of the Saturn V as continued production would have allowed the International Space Station, which has a mass of 420000 kg, to be built using four Saturn V launches, rather than 18 launches of the Space Shuttle"

Answer 9

$$\frac{406.42 - 280}{280} \times 100 = 45.15\% \text{ increase in } CO_2$$

Answer 10

(i) $\frac{10.7 - 3.7}{10.7} \times 100 = 65.4\%$ fall in value

(ii) $3400 \times 0.346 = £1176.4$

Answer 11

(i) $\frac{17852 - 14512}{14512} \times 100 = 23\%$

(ii) $\frac{5.22}{34.82} \times 100 = 15\%$

Answer 12

(i) $\frac{6.2 - 2.5}{2.5} \times 100 = 148\%$ increase in average weight

(ii) $\frac{112 - 48}{112} \times 100 = 57.1\%$ decrease in time to market

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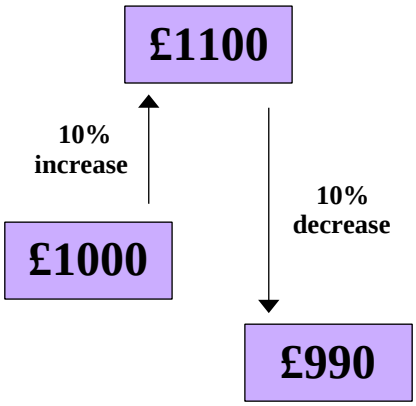
Lesson 5

GCSE (Year 10) Mathematics
Percentages II

Calculator Needed !

5.1 "Reverse" Percentage Problems

Whenever a percentage problem gives the amount *after* a percentage increase and requests the original amount, care is needed. This is because, for example, £1000 increased by 10% is £1100 but working out 10% of £1100 in an attempt to reverse the increase does not get back to the £1000.



5.2 Example

After a 2.5% salary increase, Dr Parker is paid an annual salary of £84 283
What was his salary before the increase ?

5.3 Compound Interest Example

Five years ago, Natasha bought a five-year government bond. It guaranteed to pay compound interest at a fixed rate of 4% per annum. The bond has just matured and is worth £15208.16
How much did Natasha originally pay for the bond ?

5.4 Exercise

Question 1

The current rate of VAT in the UK is 20%
I've just bought a Chinese Take-Away meal for £24.90
What is the cost of this meal before the VAT applied ?

Question 2

From an email;
"We write to you with exciting news.
An annual subscription to our digital magazine *Crucial Mathematics* has been reduced by an utterly amazing 35%.
It can now be your's for only £85.80
Can you afford not to buy ?"
How much did Crucial Mathematics cost before the reduction ?

Question 3

GCSE Examination Question from May 2018, Q7 (b)
Jalina gets a salary increase of 5%
Her salary after the increase is HK$252 000
Work out Jalina's salary before the increase.

[3 marks]

Question 4
In 2017 the UK consumed 14.2 million metric tons of coal.
This was a reduction of 62% from 2015.
How many million metric tons of coal did the UK consume in 2015 ?
(Data Source : Digest of UK Energy Statistics (DUKES), 2018)

Question 5
In July 2019 the “Fastest Man in the World” was Usain Bolt who ran the 100 metres in a time of 9.58 seconds in the 2009 World Championships in Athletics in Berlin.
This was 1.114% faster than the previous world record.
What time was the previous world record for the 100 metres ?

HINT :
Make sure that the answer you give for the previous world record is a longer time !

Question 6
Three years ago, Robert bought a new Ford Ka+.
This model of car depreciates at 15% per annum and is now valued at £7032.
What did Robert pay for the car when it was new ?

Did you know ?
In 2006, a commercial advertising the Ford SportKa in the UK showed a pigeon flying towards it to befoul it. At the last moment, the SportKa violently pops its hood killing the bird. A second commercial showed the SportKa open its sunroof, enticing a cat to peer in. The sunroof closes, beheading the cat.
After many complaints both advertisements were removed and not used by Ford again.

Question 7

GCSE Examination Question from January 2019, Q7

Jenny invests $8500 for 3 years in a savings account.
She gets 2.3 % per year compound interest.

(a) How much money will Jenny have in her savings account at the end of 3 years ? Give your answer correct to the nearest dollar.

[3 marks]

Rami bought a house on 1st January 2015.
In 2015, the house increased in value by 15 %
In 2016, the house decreased in value by 8 %

On 1st January 2017, the value of the house was $687 700

(b) What was the value of the house on 1st January 2015 ?

[3 marks]

Question 8

GCSE Examination Question from June 2019, Q5 (b)

One book that Josh owns has a value of £15 on the 1st May 2019
The value of the book had increased by 20 % in the last year.
Find the value of the book on the 1st May 2018

[3 marks]

Question 9

GCSE Examination Question from January 2017, Q10

In a sale, normal prices are reduced by 18%

The sale price of an umbrella is £25.83

Work out the normal price of the umbrella.

[3 marks]

Question 10

IMC Question from February 2019, Q3

There are 120 000 red squirrels living in Scotland.

This represents 75% of their total UK population.

How many more red squirrels live in Scotland than live in the remainder of the UK ?

Question 11

SMC Question from November 2016, Q2

On a Monday, all prices in Isla's shop are 10% more than normal.

On Friday all prices in Isla's shop are 10% less than normal.

James bought a book on Monday for £5.50.

What would be the price of another copy of this book on Friday ?

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5.5 Answers

5.5.1 Solution to 5.2 Example

The key technique is to call to unknown, original salary before the increase x

$$x \times 1.025 = 84283$$
$$x = \frac{84283}{1.025}$$
$$x = £82\,227.32$$

5.5.2 Solution to 5.3 Example

Call the original purchase price of the bond, x

$$x \times 1.04^5 = 15208.16$$
$$x = \frac{15208.16}{1.04^5}$$
$$x = £12500$$

5.5.3 Solution to 5.4 Exercise

Answer 1

Let x be the cost of the meal before VAT is applied.

$$x \times 1.20 = 24.90$$
$$x = \frac{24.90}{1.20}$$
$$= £20.75$$

Answer 2

Let x be the cost of the magazine before the reduction.

$$x \times 0.65 = 85.80$$
$$x = \frac{85.80}{0.65}$$
$$= £132$$

Answer 3

Let x be Jalina's salary before the increase,

$$x \times 1.05 = 252000$$
$$x = \frac{252000}{1.05}$$
$$x = HK\$\ 240\,000$$

Answer 4

Let x be the UK's coal consumption in 2015,

$$x \times (1 - 0.62) = 14.2$$

$$x = \frac{14.2}{0.38}$$

$$= 37.4 \quad \text{million metric tons of coal}$$

Answer 5

Let x be the previous world record.

$$x \times (1 - 0.0114) = 9.58$$

$$x = \frac{9.58}{0.9886}$$

$$= 9.69 \text{ seconds}$$

Answer 6

Let x be the cost of the new Ford Ka+,

$$x \times 0.85^3 = 7032$$

$$x = \frac{7032}{0.85^3}$$

$$= £\,11\,450$$

Answer 7

(a)

$8500 \times 1.023^3 = \$9100$ to the nearest dollar

(b) Let x be the value of the house, 1st January 2015.

$$x \times 1.15 \times 0.92 = 687700$$

$$x = \frac{687700}{1.15 \times 0.92}$$

$$x = \$\,650\,000$$

Answer 8

Let x be the value of the book on 1st May 2018

$$x \times 1.2 = 15$$

$$x = \frac{15}{1.2}$$

$$= £\,12.50 \quad <== \quad \text{must have the zero}$$

Answer 9

Let x be the normal price of the umbrella.

$$x \times 0.82 = 25.83$$

$$x = \frac{25.83}{0.82}$$

$$= £31.50 \qquad <== \text{ must have the zero}$$

Answer 10

As there are 75% of red squirrels in Scotland, there must be 25% in the remainder of the UK. $\therefore$ 120 000 red squirrels is Scotland, and 40 000 in remainder of UK. This gives 80 000 more red squirrels in Scotland than in the remainder of the UK.

Answer 11

James bought a book for £5.50, so the normal price would be £5.
On Friday, another copy of this book would therefore cost £4.50.

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Lesson 6

GCSE (Year 10) Mathematics
Percentages II

Calculator Needed !

6.1 Revision (Homework)

Marks available : 52

Question 1

(i) What is 15% of £16 ?

[2 marks]

(ii) Increase 46 kg by 30%

[2 marks]

(iii) Decrease 2400 apples by 42%

[2 marks]

(iv) What percentage of $45 is $13.50 ?

[2 marks]

Question 2

GCSE Examination Question from January 2019, Q4

On Saturday, Jacob walked 10 800 steps.
On Sunday, he walked 7% more steps than on Saturday.
Work out how many steps Jacob walked on Sunday.

[3 marks]

Question 3

In the UK's referendum on EU membership in 2016,

- 16,141,241 voted REMAIN
- 17,410,742 voted LEAVE

What percentage of the vote was LEAVE ?

[3 marks]

Question 4

Last week Sara's score in a test was 20%
She was given a week to revise for a retest
This week Sara's score in a retest is 60 %
Express her improvement in this weeks test as a percentage of her previous score.

[3 marks]

Question 5

VAT at the Mr Egg restaurant is charged at 20%
The bill for a meal states that the VAT is £4.20
What was the cost of the meal, including VAT ?

[3 marks]

Question 6

The mass of Mr Pootoo, a pet cat, increased from 2.47 kg to 2.78 kg during a lazy summer. Express Mr Pootoo's gain in mass as a percentage.

[3 marks]

Did you know ?
Mass is measured in kilograms, weight in newtons.
Your mass is the same on the Moon as it is on Earth but your weight is much less.
When floating in space you are weightless but your mass is as on Earth.
When people ask you “How much do you weigh ?”, you can be annoying and ask them back, “Do you mean, How much is my mass ?"
If they persist in wanting your weight, on Earth, it's 9.81 times your mass or, to be really annoying tell them your weight on the moon. It's 1.625 times your mass.

Question 7
A 440 ml can of Coca Cola™ is sold as a 330 ml can with 110 ml extra free.
Express the amount of extra free Cola Cola™ as a percentage.

[3 marks]

Question 8
The number of kilometres of rail routes open in Britain fell from 20 031 km in 1968 to 17 901 km in 1978.
Express this as a percentage decrease.

[3 marks]

Question 9
A Silver white 9-11 mm graduated South Sea Peal Necklace is reduced in price by 28% to a cost of £4320. What was it's price before the reduction ?

[3 marks]

Question 10
What is the percentage error in using $\sqrt{10}$ to represent π ?

[3 marks]

Question 11

GCSE Examination Question from June 2019, Q8

On 1st January 2016 Li bought a boat for $170 000
The value of the boat depreciates by 8% per year.

Work out the value of the boat on 1st January 2019
Give your answer correct to the nearest dollar.

[3 marks]

Question 12

GCSE Examination Question from January 2019, Q4

The table gives information about the price of gold.

	1st February 2016	1st March 2016
Price of one ounce of gold	$1126.50	$1236.50

(a) Work out the percentage increase in the price of gold between 1st February 2016 and 1st March 2016
Give your answer correct to 3 significant figures.

[3 marks]

The price of one ounce of gold on 1st February 2016 was 1126.50 dollars
The price of gold increased by 19% from 1st February 2016 to 1st July 2016

(b) Work out the price of one ounce of gold on 1st July 2016.
Give your answer correct to the nearest dollar.

[3 marks]

Question 13

GCSE Examination Question from January 2016, Q8

In 1981, the population of India was 683 million.
Between 1981 and 1991, the population of India increased by 163 million.

(a) Express 163 million as a percentage of 683 million.
Give your answer correct to 3 significant figures.

[2 marks]

In 2001, the population of India was 1028 million.
Between 2001 and 2011, the population of India increased by 17.6%

(b) Increase 1028 by 17.6%
Give your answer to the nearest million

[3 marks]

In 2001, the population of India was 1028 million.
Between 1971 and 2001, the population of India increased by 87.6%

(c) Work out the population of India in 1971
Give your answer correct to the nearest million

[3 marks]

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6.2 Answers

GCSE (Year 10) Mathematics
Percentages II

Answer 1

(i) £2.40 <== must have £ sign and the zero
(ii) 59.8 kg
(iii) 1392 apples
(iv) 30 %

[8 marks]

Answer 2

11 556 steps

[3 marks]

Answer 3

$$\frac{17410742}{17410742 + 16141241} \times 100 = 51.89\,\%$$

[3 marks]

Answer 4

A 100% improvement would be a score of 40%
so Sara's score of 60% is a 200% improvement.

[3 marks]

Answer 5

20% *is* £4.20 $\Leftrightarrow$ 100% *is* £21.00
The meal cost £21 + £4.20 = £25.20

[3 marks]

Answer 6

$$\frac{2.78 - 2.47}{2.47} \times 100 = 12.55\,\%$$

[3 marks]

Answer 7

$$\frac{110}{330} \times 100 = 33\frac{1}{3}\,\%\ extra\ free$$

[3 marks]

Answer 8

$$\frac{20031 - 17901}{20031} \times 100 = 10.6\,\%$$

[3 marks]

Answer 9

Let x be the price before the reduction

$$x \times (1 - 0.28) = 4320$$
$$x = \frac{4320}{0.72}$$
$$= £6000$$

[3 marks]

Answer 10

$$\frac{\sqrt{10} - \pi}{\pi} \times 100 = 0.658\,\%$$

[3 marks]

Answer 11

$$170000 \times 0.92^3 = \$\,132\,377$$

[3 marks]

Answer 12

(a) $$\frac{1236.50 - 1126.50}{1126.50} \times 100 = 9.76\%$$

[3 marks]

(b) $$1126.50 \times 1.19 = \$\,1340.54$$

[3 marks]

Answer 13

(a) $$\frac{163}{683} \times 100 = 23.9\,\%$$

[2 marks]

(b) $$1028 \times 1.176 = 1209 \text{ million}$$

[3 marks]

(c) Let x be the population in 1971

$$x \times 1.876 = 1028$$

$$x = \frac{1028}{1.876}$$

$$= 548 \text{ million}$$

[3 marks]

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Lesson 7

GCSE (Year 10) Mathematics
Percentages II

Calculator Needed !

7.1 Test

Marks available : 72

Question 1

(i) What is 85% of £12 ?

[2 marks]

(ii) Increase 350 kg by 62%

[2 marks]

(iii) Decrease 5800 bananas by 72%

[2 marks]

(iv) What percentage of $65 is $39 ?

[2 marks]

Question 2

Here are the masses of the eight planets in our solar system,

Planet	Mass ($\times 10^{24}$ kg)
Mercury	0.330
Venus	4.87
Earth	5.97
Mars	0.642
Jupiter	1898
Saturn	568
Uranus	86.8
Neptune	102

What percentage of the mass of Earth is the mass of the Mars ?

[3 marks]

Question 3

GCSE Examination Question from May 2019, Q5 (a)

Josh buys and sells books for a living
He buys 120 books for £4 each
He sells half of the books for £5 each
He sells 40% of the books for £7 each
He sells the rest of the books for £8 each

Calculate Josh's percentage profit

[5 marks]

Question 4

GCSE Examination Question from June 2018, Q6

Hiran invests 20 000 rupee in an account for 3 years at 1.5% per year compound interest. Work out the total amount of money in the account at the end of 3 years. Give your answer to the nearest rupee.

[3 marks]

Question 5

GCSE Examination Question from January 2019, Q9

Omar invests 6000 dirham for 4 years in a savings account.
He will get 1.5% per year compound interest.

Work out the total amount of interest Omar will have received by the end of 4 years. Give your answer correct to the nearest dirham

[3 marks]

Question 6

A water tank is 86% full

Once 40 litres of water is removed it is 22% full

How much water does the tank hold when it is half full ?

[3 marks]

Question 7

GCSE Examination Question from May 2018, Q12

A company makes cars.

In 2016 the company made 350 cars.

In the first 6 months of 2017 the company made 25 cars each month.

In the last 6 months of 2017 the company made 45 cars each month.

(a) Work out the percentage increase in the number of cars the company made from 2016 to 2017

[4 marks]

The company's income in 2017 was $500 000 more than the company's income in 2016. The company's income in 2017 was 8% more than the company's income in 2016.

(b) Work out the company's income in 2016

[3 marks]

Question 8

SMC Question from November 2015, Q3

When Louise had her first car, 50 litres of petrol cost £40. When she filled up the other day, she noticed that 40 litres of petrol cost £50.

By what percentage has the cost of petrol increased over this time ?

[3 marks]

Question 9

In the United States 2016 Presidential election, an estimated 245,289,093 American's were entitled to vote. Of those entitled to vote, 136,626,025 turned out to do so.

President Trump was thus elected on what percentage turn out ?

[3 marks]

Question 10

GCSE Examination Question from June 2018, Q3

Gopal is paid 20 000 rupee each month.

Jamuna is paid 19 200 rupee each month.

Gopal and Jamuna are both given an increase in their monthly pay.

After the increase, they are both paid the same amount each month.

Gopal was given an increase of 8%

Work out the percentage increase that Jamuna was given.

[4 marks]

Question 11

Einstein's famous equation gives the theoretical maximum energy, *E*, (in joules) that can be obtained from a mass, *m*, (in kilograms) of "stuff".

$$E = m c^2$$

where c is the speed of light, 3×10^8 m/s

(i) Work out the amount of energy that is contained within 1 kg of stuff. Give your answer in joules in standard form.

[3 marks]

A typical car engine, in burning one litre of petrol, extracts 3.78×10^7 joules of useful energy. This is, energy that results in the movement of a typical car between two places.

(ii) When burning 1 kg, (equivalent to 1 litre) of petrol, what percentage of the theoretical maximum energy within the fuel is extracted by a car engine ? Show the calculation made.

[3 marks]

(iii) What is this question telling you about the energy extraction capability of mankind's latest high technology car engines ?

[2 marks]

Question 12

A square with sides of length *w* cm has its area increased by 44%
Given that after the increase the square has an area of 324 cm^2 what was the percentage increase in the perimeter of the original square ?

[4 marks]

Question 13

In 1989, 3% of the UK's population claimed they were Vegetarian.
In a 2019, 5.7% of the UK's population claimed they were Vegetarian.
What is the percentage increase in the number of Vegetarians in th UK over this time ?
(Data Source : Mori poll on 10 000 people : vegetarians include vegans)

[3 marks]

Question 14

The average Mini depreciates at a rate of 15 % per annum.
If a six year old Mini is worth £4450 what was it's price when new ?

[3 marks]

Question 15

A cube has each side increased by x %

Find a formula in terms of x for the corresponding percentage increase in the volume of the cube.

[6 marks]

Question 16

When his daughter, Penny, was born, Mr Wise placed £2250 in a bank savings account that guarantees to pay interest, compounded annually at a rate of 4%, until the value of the savings has doubled.

The bank would then send Penny a cheque for £4500 and close the account.

How old will Penny be when she receives the cheque ?

Be as accurate as you can giving your answer in years, months and days.

[6 marks]

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7.2 Answers

GCSE (Year 10) Mathematics
Percentages II

Answer 1

(i) £10.20 <== must have £ sign and zero
(ii) 567 kg
(iii) 1624 bananas
(iv) 60 %

[8 marks]

Answer 2

$$\frac{0.642}{5.97} \times 100 = 10.8\,\%$$

In size Mars has about half the diameter of Earth but it's density is far less. It's thought that Jupiter migrated inward scooping up much of the material that would otherwise have become part of Mars. Fortunately (for Earth) the planets further out, especially Saturn, pulled Jupiter back out via complex gravitational 'tugs of war'.

[3 marks]

Answer 3

Purchase cost : $120 \times 4 = £480$

sales at £5 : $60 \times 5 = £300$

sales at £7 : $48 \times 7 = £336$

sales at £8 : $12 \times 8 = £96$

Total sales : £732

$$\text{profit} = \frac{732 - 480}{480} \times 100 = 52.5\%$$

[5 marks]

Answer 4

$$20000 \times 1.015^3 = 20\,914 \text{ rupee}$$

[3 marks]

Answer 5

Question only asks for the interest !

$$6000 \times 1.015^4 - 6000 = 6368 - 6000$$
$$= 368 \text{ dirham}$$

[3 marks]

Answer 6

$$64\% \textit{ is } 40 \text{ litres}$$
$$\Leftrightarrow \quad 1\% \textit{ is } 0.625 \text{ litres}$$
$$\Leftrightarrow \quad 50\% \textit{ is } 31.25 \text{ litres}$$

[3 marks]

Answer 7

(a) First 6 months : $6 \times 25 = 150$ cars

Second 6 months : $6 \times 45 = 270$ cars

Total : 420 cars

$$\text{Percentage increase} = \frac{420 - 350}{350} \times 100$$

$$= 20\%$$

[4 marks]

(b) Told that 8% is \$500 000

$\Leftrightarrow$ 1% is \$62500

$\Leftrightarrow$ 100% is \$6 250 000

[3 marks]

Answer 8

Originally, petrol cost 80 pence per litre

Now, petrol costs 125 pence per litre

$$\text{Percentage increase} = \frac{125 - 80}{80} \times 100$$

$$= 56.25\%$$

[3 marks]

Answer 9

$$\frac{136\,626\,025}{245\,289\,093} \times 100 = 55.7\% \text{ turn out}$$

[3 marks]

Answer 10

After increase Gopal's pay is : $20000 \times 1.08 = 21\,600$

Percentage increase for Jamma : $\frac{21\,600 - 19\,200}{19\,200} \times 100 = 12.5\%$

[4 marks]

Answer 11

(i) $E = 1 \times \left(3 \times 10^8\right)^2 = 9 \times 10^{16}$ joules

[3 marks]

(ii) $\frac{3.78 \times 10^7}{9 \times 10^{16}} \times 100 = 0.000\,000\,042\,\%$

[3 marks]

(iii) Almost none of the theoretical maximum energy within the petrol is being extracted by the engine. i.e. Almost 100% is 'lost'.

[2 marks]

Answer 12

Let x be area of the original square,

$$x \times 1.44 = 324$$

$$x = \frac{324}{1.44} = 225\,\text{cm}^2$$

So, original square has sides of length 15 cm, and increased square's sides are 18 cm.

$$\text{Percentage increase} = \frac{4 \times 18 - 4 \times 15}{4 \times 15} \times 100$$

$$= \frac{18 - 15}{15} \times 100$$

$$= 20\%$$

[4 marks]

Answer 13

$$\text{Percentage increase} = \frac{5.7 - 3}{3} \times 100 = 90\,\%\text{ increase}$$

[3 marks]

Answer 14

Let x be the price of a new Mini, in which case, $x \times 0.85^6 = 4450$

$$= \frac{4450}{0.85^6}$$

$$p\# = £11\,800$$

[3 marks]

Answer 15

Let z be the side length of the original cube, so z^3 is its volume.

The volume of the increased cube will be,

$$z^3\left(1 + \frac{x}{100}\right)^3 = z^3\left(1 + \frac{3x}{100} + \frac{3x^2}{10000} + \frac{x^3}{1000000}\right)$$

$$\textit{Percentage increase} = \frac{z^3\left(1 + \frac{3x}{100} + \frac{3x^2}{10000} + \frac{x^3}{1000000}\right) - z^3}{z^3} \times 100$$

$$= 3x + \frac{3x^2}{100} + \frac{x^3}{10000}$$

[6 marks]

Answer 16

Penny will get the cheque between her 17th and 18th birthdays
(After about 17 years, 8 months, and 6 days)

[6 marks]

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