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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education
Functional Skills Certificate

Mathematics 9307
Functional Mathematics 9305

Pilot Specifications
2008

TASKS

Further copies of this resource are available from:

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Telephone: 0161 957 3852 Fax: 0161 957 3873

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Contents

1 Introduction

These tasks have been written by Leeds University's Assessment and Evaluation Unit to support teachers in developing approaches to the type of tasks that will appear in the pilot assessment of Functional Mathematics.

The problems are provided to assist teachers in their preparation for the delivery of courses based on the new AQA Specifications 9307 & 9305. The tasks in this document are available as a CD-Rom which is part of a Teacher's Guide and Teaching Resource for Functional Mathematics. That document contains detailed guidance on using these tasks as a teaching resource. The Specifications, Specimen Assessment materials and Teacher's Guide are available from the GCSE Mathematics Department, AQA, Devas Street, Manchester, M15 6EX, Telephone: 0161 957 3852, Fax: 0161 957 3873

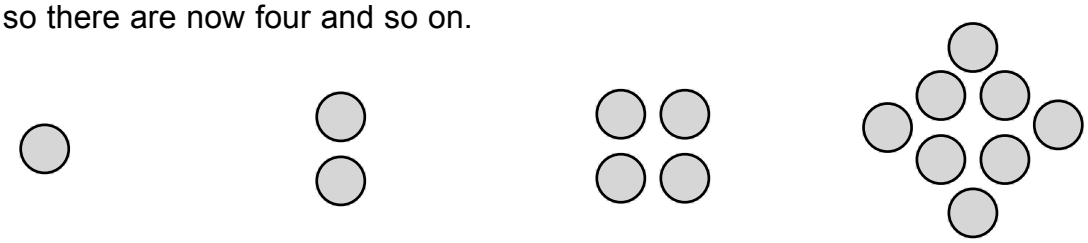
2 The Tasks

This document contains 30 functionality tasks consisting of a data sheet and a number of questions. These are presented alphabetically in PDF format.

Data sheet Bacterial growth

Bacteria are tiny single-cell organisms, too small to be seen without a microscope. Millions of bacteria live in the human body and help to keep us alive. Some bacteria are harmful to us - such as those that grow on decaying food: they can make us ill with food poisoning if they get inside us.

Bacteria grow in numbers by splitting into two parts (some types split into more than two parts). For example, a one-cell bacterium increases in size and then splits, forming two single-cell bacteria. These then grow and each one splits into two, so there are now four and so on.



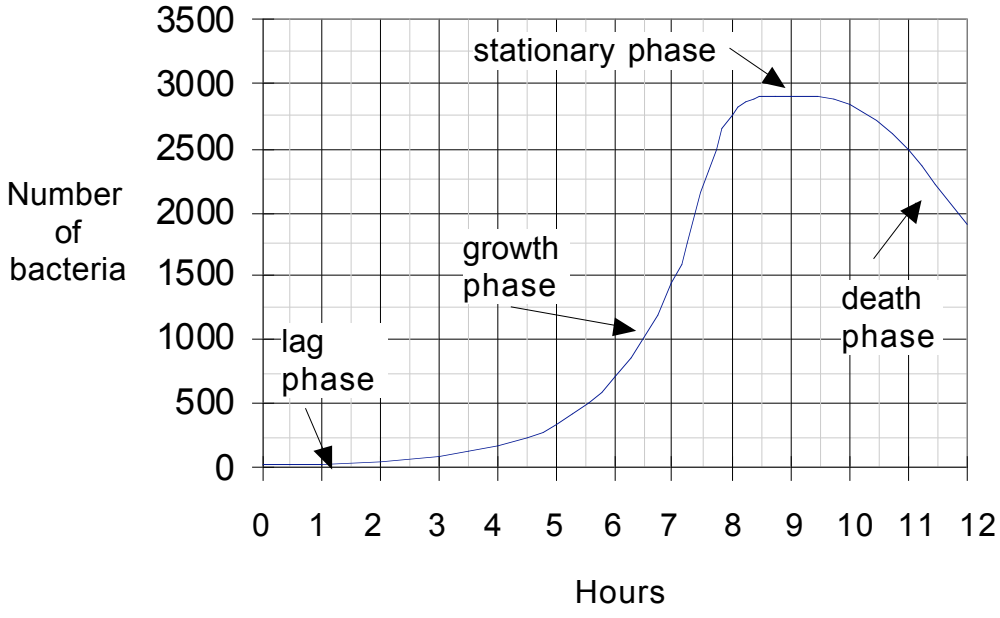
1st generation	2nd generation	3rd generation	4th generation
Population = 1	Population = 2	Population = 4	Population = 8

Some bacteria populations grow rapidly and can reach millions in a few hours. Other are much slower and may take days for each cell-division.

Phases of growth

Bacteria can be grown in a laboratory by giving them warmth and nutrients. The population growth of bacteria usually follows a pattern. Here is an example:

Graph of bacterial growth



There is an initial ‘lag phase’ as the bacteria get used to their environment. Then comes the growth phase and the population increases rapidly. This eventually slows down as the available food is used up and the population stops increasing (the stationary phase). Finally there is no food left, waste products build up and the bacteria start to reduce in numbers as they begin to die. This is the death phase.

Questions Bacterial growth

1

From the graph of bacterial growth on the data sheet, estimate answers to the following:

(a) What is the number of bacteria in the population after 7 hours?

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

(b) What is the maximum number the population reaches?

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

(c) How long is the population at maximum size?

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

2

Find two points on the graph during the growth phase that show that over an hour the population approximately doubles.

At _ _ _ _ _ _ hours, the population is _ _ _ _ _ _ _ _ _ _

At _ _ _ _ _ _ hours, the population is _ _ _ _ _ _ _ _ _ _

3

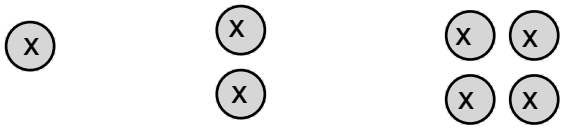
A type of bacterium cell (not the one in the graph) divides into two, every 20 minutes.

Starting with 5 bacteria, what will be the population after 3 hours?
Give your answer to the nearest hundred.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

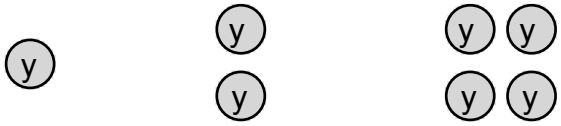
4

An organism, X, splits into two at each division.
This occurs every 2 minutes.



time: 0 2mins. 4 mins. .....

Another organism, Y, splits into two at each division.
This occurs every 3 minutes.



time: 0 3mins. 6 mins. .....

After 30 minutes, how many times bigger is the population of X than the population of Y?

- - - - - - - - - - - - - - - -

Data sheet Bookclub

Jody is looking for a book to buy for her brother as a present.

She thinks of two books –

"PALE" – the autobiography of Jack Pale.

"COOK!" – Alasdair MacDonald's new cookery book.

She finds a website that does price comparisons.

The table below shows the prices for the two books she is interested in.

Book Price Comparison

Book Shop	PALE	COOK!	Postage (per order)*
Blockwells Student discount = 20%	£16.00	£14.00	Free
Bookco (by post only)	£11.29	£9.99	£2.74
Bookish (by post only)	£14.14	£11.39	Free
Book Place	£14.50	£14.25	£1.25
DL Jones	£12.50	£9.99	£2.49
Fast Books	£14.24	£17.59	£2.50
Jungle UK (by post only)	£11.39	£9.96	£2.75
I Price Books	£17.09	£19.99	£2.95

* There is no postage to pay if books are collected from a shop branch

Jody also finds that books can be bought from book clubs, and the prices are cheaper, but there is an additional cost of being a club member.

Book club	Membership	PALE	COOK!	Postage
ABC	£5 per month	£7.49	£7.49	Free
PAGES	£20 per year	£8.99	£8.99	Free

Questions Bookclub

1

(a) How much would it cost to buy "Pale" from DL Jones if it was delivered by post?

(b) How much would it be to buy both "Pale" and "Cook!" from DL Jones, if they were collected from the shop?

2

Which company is the cheapest for "Cook!", if it is to be delivered by post?

3

Jody can claim the student discount at Blockwell's.
Would it be cheaper for her to buy both books from Blockwell's, or to get them sent from Jungle UK?
Say which is cheaper and by how much.

--- is cheaper, by ---

4

Jody buys two books every month on average.
Does the information on the data sheet suggest it would save her money to join one of these book clubs?

Yes / No

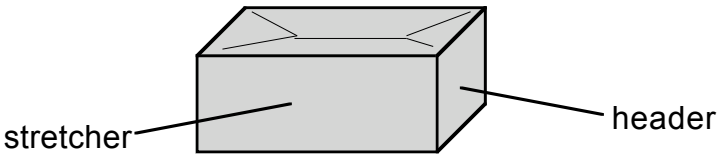
Explain your reasons

5

Use the information on the data sheet to estimate how much a person would save over a year by being a member of the Pages book club, compared to the ABC book club, if they bought two books every month.

Data sheet Bricklaying

Bricks are usually cuboid shape with dimples in the top and bottom faces. The long face is called the 'stretcher' and the short end face the 'header'.

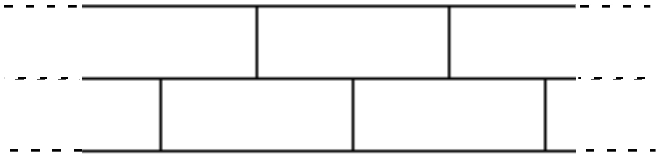


To make a brick wall you lay bricks on top of each other with mortar (a mixture of sand and cement and water) between to hold them together.

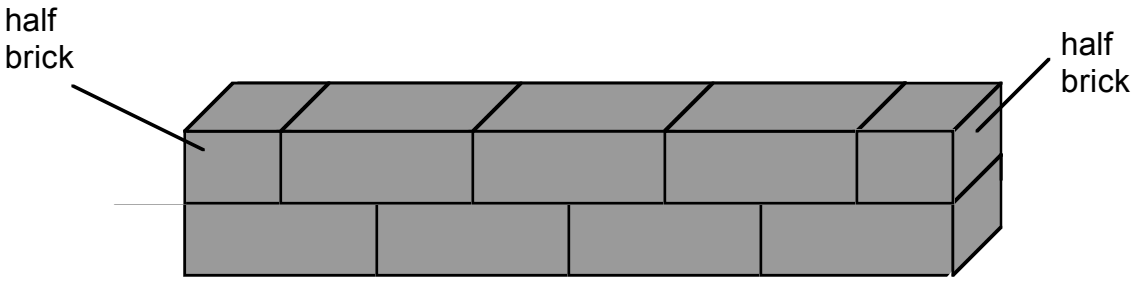
Stretcher bond

Bricks can be laid in many different patterns. The simplest pattern is '**Stretcher bond**', where one layer of bricks is offset by half a brick above the layer below. The thickness of the mortar is adjusted to keep bricks correctly spaced.

Stretcher bond



Here is an example of a stretcher bond wall. The bottom layer is four bricks long and the next layer is three whole bricks and two half-bricks. The mortar between the bricks is not shown.

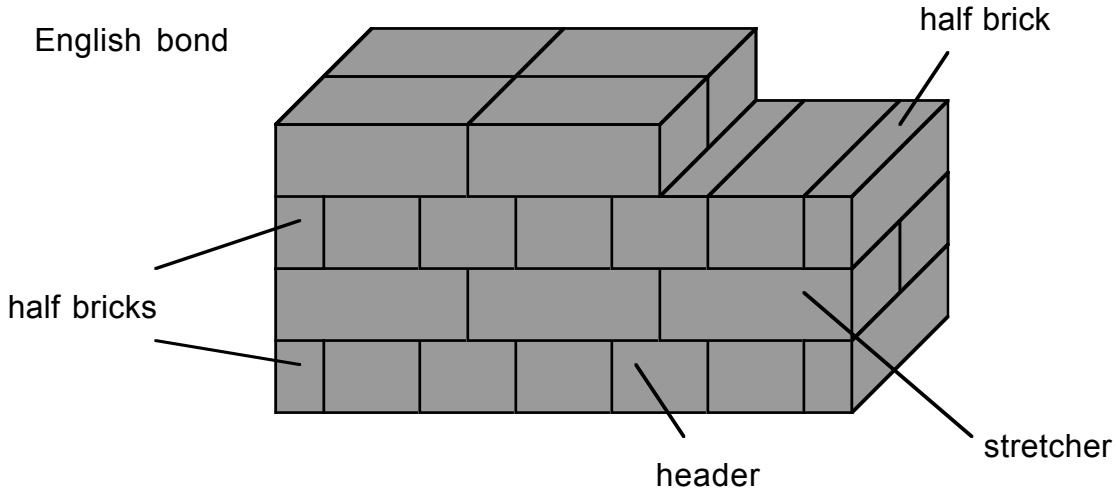


One whole brick can be used to make two half-bricks, so each layer uses the same number of bricks.

English bond

A stronger wall (with a more interesting pattern) is made by laying bricks using '**English bond**'. In this arrangement, alternate layers of bricks are laid showing stretchers and headers.

This diagram shows four layers of brick laid in English Bond pattern



An English bond wall has a thickness of one brick length.

One whole brick can be used to make two half-bricks

Buying bricks

All bricks are sold in pallets of 500 bricks. You can only buy bricks in pallets. For example, if you want 1200 bricks you will have to buy 3 pallets of 500 each. The least number of bricks you can buy is 1 pallet of 500.

The price of bricks is quoted as 'so much per thousand bricks'.
Standard house / wall bricks cost £495 per thousand.

A single pallet will cost half of the rate per thousand.

Questions Bricklaying

1

(a) What is the cost of one pallet of 500 standard house bricks?

£ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

(b) A builder needs 4200 bricks for a wall.

How many pallets will she have to buy? _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

(c) She buys standard house bricks.

How much will she have to pay? £ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

2

(a) How many bricks are needed for a stretcher bond wall that is 20 stretcher lengths wide and 18 layers tall?

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

(b) How many half bricks are used in this wall?

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

3

There are 2500 bricks available to build a wall in English bond.

The wall has to be 40 stretcher lengths wide.

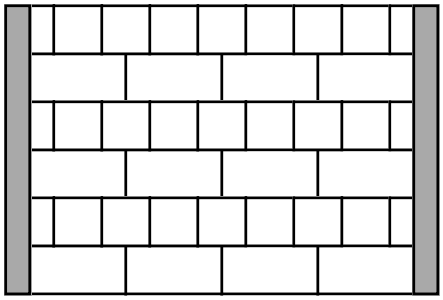
How many complete layers of brick can it have?

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

4

Here is a diagram of a wall built between two posts using English Bond.

How many of the bricks used to make the wall cannot be seen?



- - - - - - - - - - - - - - - -

5

In walls that have bricks that cannot be seen, 'rough finish' bricks can be used. These are cheaper than standard bricks.

Here are the prices.

supplied in pallets of 500 bricks	
standard bricks:	£495 per thousand
rough finish bricks:	£350 per thousand

A builder needs 20 000 bricks. He decides that 25% of them can be rough finish bricks.

How much will the bricks cost altogether?

- - - - - - - - - - - - - - - -

Data sheet Calendar

The Gregorian Calendar

The most widely used calendar in the world is the Gregorian Calendar (which is the one we use in Britain for most purposes).

One year is the time it takes the Earth to go around the Sun. The basis of the Gregorian Calendar is that the year is then divided up into 365 days. These 365 days are grouped into 12 months, which vary in size from 28 days to 31 days, as shown in this table:

month	days
January	31
February	28/29
March	31
April	30
May	31
June	30
July	31
August	31
September	30
October	31
November	30
December	31

The year is also divided into 52 weeks of seven days each. However, 52 x 7 = 364, so the year has 52 weeks and one day in it. This means each year of 365 days results in the dates 'moving on' a day. For example,

in 2006 January 1st was on a Sunday;
in 2007 it was on a Monday;
in 2008 it will be on a Tuesday.

More problems

The time the Earth takes to go around the Sun is not exactly 365 days. It varies a little from year to year, but it averages out to 365.24219 days (approximately). This is close to 365¼ (365.25) days. This means that each year, the calendar is about a quarter of a day short, so over four years, the calendar is a whole day short. An extra day is put into the calendar every four years, to make up for the missing '¼ days' that have built up. This is the 'leap year', when there is a February 29th

inserted in the calendar. A rule has been invented for this: leap years are when the year number divides by 4. So 2004 was a leap year and 2008 will also be one.

...and more problems

There are still small problems with this, however. The Earth does not take exactly $365\frac{1}{4}$ days to go around the Sun. The difference between the average of 365.24219 and 365.25 is 0.00781. This means that over 100 years there will build up an error in the calendar of 0.781 days (= 0.00781 x 100), which is about $\frac{3}{4}$ of a day. Over 400 years this will be about 3 days. In other words, over 400 years, the calendar will have 3 days too many in it.

The rule to deal with this is that at the turn of each century, the century year, for example, 1800 or 1900, is not a leap year (although it ought to be according to the previous rule, because the year number divides by 4). But this would mean the removal of 4 days over 400 years, when only 3 days need to be removed. The rule is therefore adjusted slightly and only the century years which divide by 400 are left as leap years. This meant that the year 2000 was a leap year (because 2000 divides by 400), but 1900 was not a leap year (because 1900 does not divide by 400).

Questions Calendar

1

Which of the years from 1965 to 1975 were leap years?

2

In a 365-day year, what is the date of the day that is the exact middle of the year?

3

Explain why 1600 was a leap year, but 1700 was not.

4

2004 was a leap year and May 1st was on a Saturday.

(a) Complete this table to show the days on which May 1st occurred.

May 1st	2002	2003	2004	2005	2006
			Saturday		

(b) In which year is May 1st next on a Saturday after 2004 ?

5

A quarter of a year is 'three months' and a quarter of 52 weeks is 13 weeks.

Find three consecutive months in the year that are exactly 13 weeks.

Data sheet Codes

Here is an encrypted message:

2	4	0	1
t	m	a	e
e	f	r	o
i	t	u	r

key: 32^2

To decode the message,

1 Evaluate the key: $32^2 = 32 \times 32 = 1024$

2 Notice that the digits at the top of the code are 1, 0, 2, 4 but in a different order.

3 Put these digits in the correct order (1024), along with the columns of letters below them:

4 Read the message: ‘eat more fruit’.

1	0	2	4
e	a	t	m
o	r	e	f
r	u	i	t

Questions **Codes**

1

Decode this message:

9	1	6	3
o	d	n	o
a	t	w	s
w	l	o	l
s	p	p	i

key: 37^2

- -

2

Here is a message before encryption

1	0	2	4
r	i	d	e
a	b	i	k
e	t	o	w
o	r	k	☐

key 32^2

Write the message in its encrypted form in this grid.

2	4	0	1

3

Why would an encryption based upon a key of 38^2 not be a good idea?

- -

- -

- -

4

If you do not know the key to the code, you can try to decipher the message by simply trying to rearrange the columns of letters until a message appears.

Here are two different ways the message 'eat more fruit' could be encrypted:

key: 75^3

7	5	1	8	2	4
o	r	t	m	a	e
i	t	r	u	f	e

A

key: 32^2

2	4	0	1
t	m	a	e
e	f	r	o
i	t	u	r

B

Which of these two encryptions would be easier to decipher by just rearranging the columns until a message appeared?

A / B

Give a reason for your answer.

- -

- -

- -

Data sheet Coffee

In the UK

In 2000, sales of coffee overtook tea in the UK for the first time, with more than 50% of the hot drinks market. Around 30 billion cups of coffee are drunk in the UK every year.

Coffee is sold in two main types in the UK – instant or beans (including ground). In 2000, 76% of coffee sold was instant coffee.

Across the world

Worldwide, coffee is grown in more than 50 countries and is the second most valuable commodity after crude oil. In fact, it is the most valuable *agricultural* commodity in world trade - in 2000, exports worldwide totalled £4.4 billion.

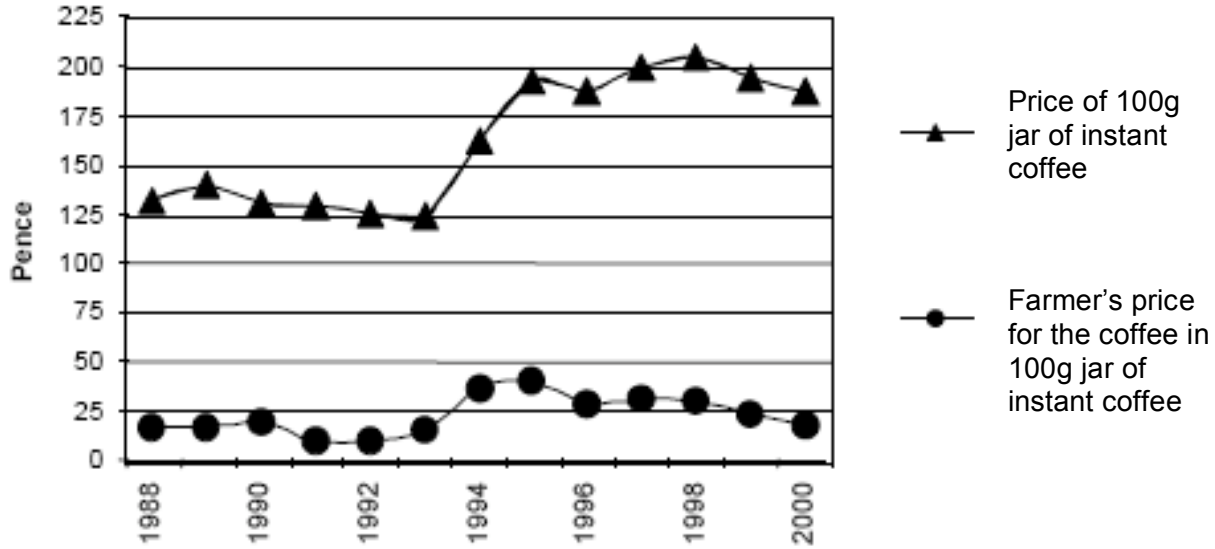
Altogether, approximately 100 million people worldwide are involved in the growing, processing, trading and retailing of coffee. This includes around 20 million farmers, two-thirds of whom are smallholders whose farms are less than 50,000 m^2 each.

The farmer's share

The final price of a cup of coffee in the UK includes the costs of insurance, taxes, transportation, processing, packaging, marketing, storage and much more. It is claimed that of the £1.75 charged for a cappuccino in a coffee shop, the grower will receive at best the equivalent of 2p.

The graph below shows the gap between the price of a jar of instant coffee in a shop and what the farmers get paid for their coffee beans.

UK retail prices for instant coffee and the farmer's price



Questions Coffee

1

What fraction of those in the coffee industry (growing, processing, trading and retailing) are farmers?

2

In the UK in 2000, what percentage of coffee sold was beans (including ground)?

3

Estimate to the nearest million how many coffee growers have farms smaller than 50,000 m^2.

4

According to the data sheet, what percentage of the cost of a £1.75 cappuccino coffee will the farmer receive, at best?

5

The population of the UK is approximately 60 million.

(a) Use the figures in the data sheet to estimate how many cups of coffee were drunk on average per person in a year.

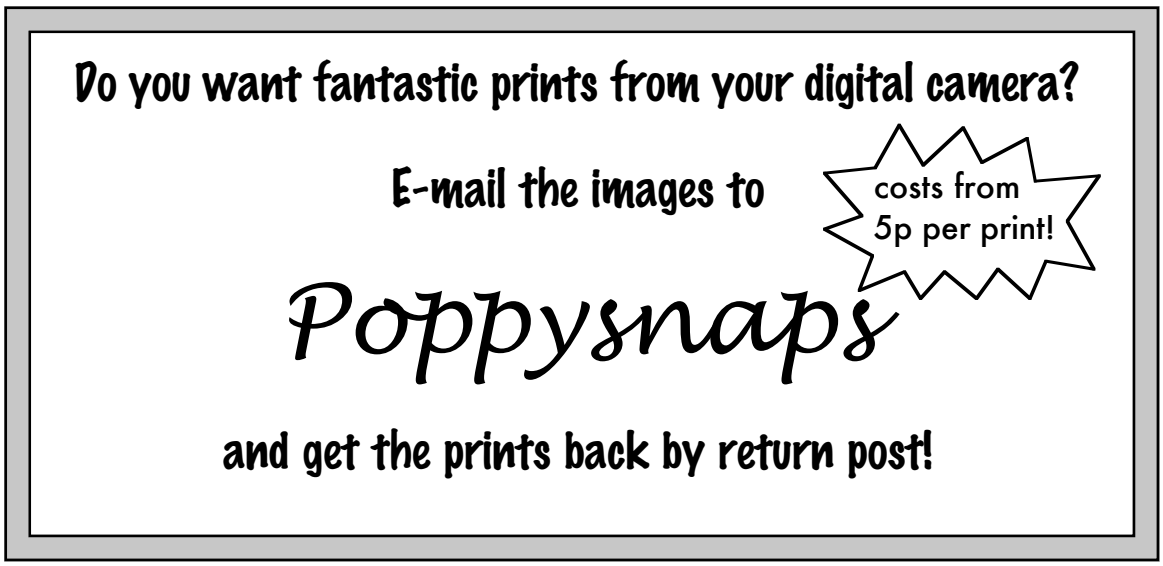
(b) Explain why this is an under-estimate of the average amount of coffee drunk by coffee drinkers.

6

The graph on the data sheet shows how shop and farm prices over the period 1988 to 2000 changed.

Use the graph to describe how the farmer's proportion of the price has changed by comparing the figures for 1988 and 2000.

Data sheet **Digital Prints**



Print costs

Table of costs for 6” by 4” size prints

Number of prints	Cost per print
1 - 50	15p
51 - 100	12p
101 - 250	9p
251 - 500	8p
501 - 750	6p
750+	5p

For example, if you want 120 prints 6” by 4”, the table shows they cost 9p each, so the cost for 120 is

120 x 9p = 1080p = £10.80

Postage and handling

As well as the cost of printing, there is a charge for postage and handling.

This table shows the charges at Poppysnaps.

Postage and handling charges

Number of prints	Postage and handling
1 - 40	£1.39
41 - 60	£1.69
61 - 80	£1.99
81 - 100	£2.49
each additional 50 prints or part of 50	£0.79

For example, the postage and handling charge for 50 prints 6” by 4” size is £1.69

The postage and handling charge for 170 prints would be

£2.49 + £0.79 + £0.79 = £4.07

Questions Digital prints

1

What is the cost of 75 prints 6" by 4" size (**not** including postage) from Poppysnaps?

- - - - - - - - - - - - - - - -

2

Karen has 100 images for printing as 6" by 4" photos.

Mike says the printing costs (**not** including postage) will be less if she sends 101 images for printing.

Work out how much less the printing costs will be if Karen follows Mike's advice.

- - - - - - - - - - - - - -

3

(a) What is the total cost (printing and postage etc.) for 75 prints?

- - - - - - - - - - - - - -

(b) The publicity flier says 'costs from 5p per print'.

What is the actual cost per print for 800 prints when you add on the postage and handling charges to the charges for printing?

- - - - - - - - - - - - - - p per print

4

Pixyprints has different charges from Poppysnaps.

For 6” x 4” photos, these are:

Pixyprints		
Number of prints	Cost per print	Postage/ packing
1 - 40	15p	up to 100 prints £2.40
41 - 80	10p	
81 - 160	8p	over 100 prints £4.00
161 +	6p	

Which company, Poppysnaps or Pixyprints, is cheaper and by how much for 80 prints (including postage etc.)?

_____ company is cheaper by _____

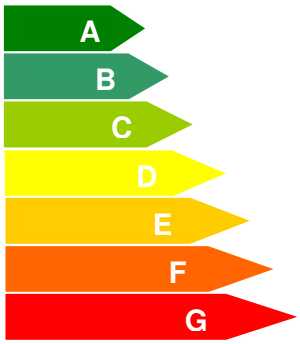
Data Sheet Energy Labels

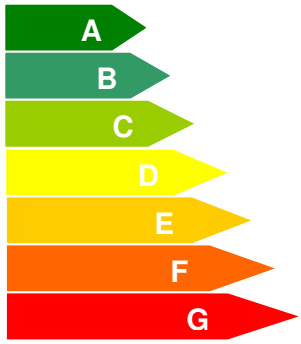
New electrical equipment has energy labels that show a rating for energy efficiency, based on how much energy they use.

A is the most energy efficient and **G** is the least energy efficient.

These labels allow us to make a choice about the energy efficiency of what we buy.

Here are two labels for fridge-freezers with different energy efficiency ratings.

Energy Manufacturer model	*Freezepoint* RF70
More efficient  **Less efficient**	
Energy consumption kWh/year **Actual consumption will depend on how the appliance is used and where it is located**	**325**
Fresh food volume in litres Frozen food volume in litres	215 95

Energy Manufacturer model	LEX BR20
More efficient  **Less efficient**	
Energy consumption kWh/year **Actual consumption will depend on how the appliance is used and where it is located**	**420**
Fresh food volume in litres Frozen food volume in litres	215 95

Questions Energy Labels

1

(a) Which of the two fridge-freezers is the less energy efficient?

(b) How many kilowatt hours (kWh) of energy is used by the Freezepoint RF70 in a year?

(c) One kilowatt hour (kWh) of energy costs about 10p.
On that basis, approximately how much money would the more energy efficient fridge-freezer save in a year, compared to the other one?

This table shows some information about five fridge-freezers.

	 **Coolmaster**	 **Bravo**	 **Zen**	 **Vortex**	 **Basch**
Price	£259	£270	£289	£349	£360
Fridge capacity	205 litres	190 litres	245 litres	235 litres	230 litres
Freezer capacity	90 litres	140 litres	70 litres	120 litres	90 litres
Energy Rating			**B**		**B**
Annual energy consumption	440 kWh/year	335 kWh/year	357 kWh/year	220 kWh/year	335 kWh/year

2

(a) Three of the fridge-freezers in the table do not have an Energy Rating.
One should have an **A** rating, one a **B** rating and the other a **C** rating.

Show on the table which fridge-freezer should have which Energy Rating.

(b) A customer wants the most energy efficient fridge-freezer they can afford.

- The annual energy consumption must be less than 400 kWh/year.
- The fridge capacity must be at least 200 litres.
- The most they can spend is £300.

Which of these five fridge-freezers should they buy?

(c) One kilowatt hour (kWh) of energy costs about 10p.
On that basis, after how many years will the total costs of the Vortex (the price to buy plus the cost to run) become less than the total costs of the Coolmaster?

Data Sheet Farm animals

This table shows the approximate numbers of animals on farms in the UK over an eight year period.

The numbers are in thousands (rounded to the nearest thousand).

Animals on UK farms

	1998	1999	2000	2001	2002	2003	2004	2005
Total Cattle	11519	11423	11135	10602	10345	10517	10603	10414
Dairy cows	2439	2440	2336	2251	2227	2192	2131	2065
Beef cows	1947	1924	1842	1708	1657	1700	1739	1768
Total Sheep	44471	44656	42264	36716	35834	35846	35890	35517
Ewes	21260	21458	20449	17921	17630	17599	17665	16990
Lambs	22138	22092	20857	17769	17310	17335	17272	17532
Total Pigs	8146	7284	6482	5845	5588	5047	5161	4864
Total Fowl	148292	149867	154504	163875	155005	165324		160528
Table fowl	98224	101625	105689	112531	105137	116774	119912	111487
Laying fowl	29483	29258	28687	26895	28778	29274	29662	29550

Questions Farm animals

1

How many beef cows were on UK farms in 2003?
Give your answer to the nearest thousand.

- - - - - - - - - - - - - - -

2

How many fewer sheep were there in 2005 compared to when the population was at its maximum?
Give your answer to the nearest thousand.

- - - - - - - - - - - - - - -

3

The number of pigs went down from 1998 to 2005. Which year saw the largest drop in numbers compared to the year before?

- - - - - - - - - - - - - - -

4

When lambs become one year old they are re-named as ewes (female sheep) and rams (male sheep). How many rams were there on UK farms in 2005?
Give your answer to the nearest thousand.

- - - - - - - - - - - - - - -

5

Figures for the total number of fowl on UK farms in 2004 are not available.

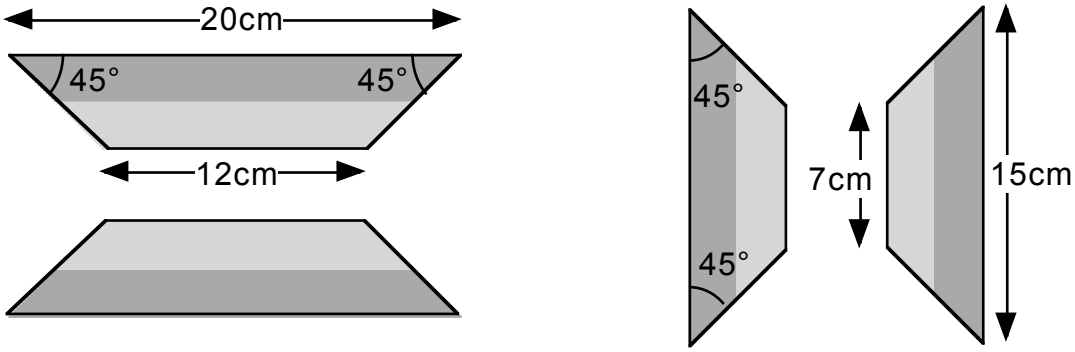
Which of these is the most likely estimate of the number?
(Put a ring around the right one.)

140 million 150 million 160 million 170 million 180 million

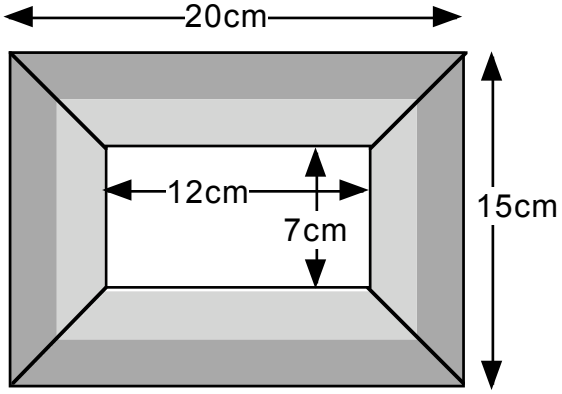
Explain your answer.

Data sheet Frames

Each of these four pieces of card is a trapezium with two 45° angles.



The four pieces fit together to make a rectangular frame.

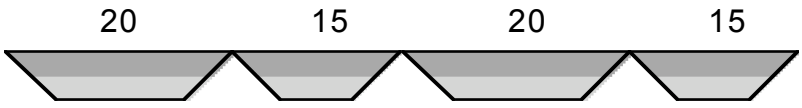


The area enclosed by the frame is

$12 \times 7 = 84\text{cm}^2$

The outside perimeter of the frame is

$20 + 15 + 20 + 15 = 70\text{cm}$

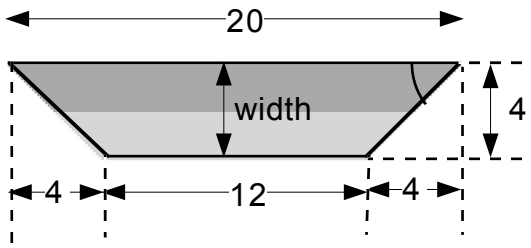


The length of card needed for the whole frame = the outside perimeter

= 70cm

The width of the card used in a frame

= half the difference between the long and short sides.



In this example, long side = 20cm, short side = 12cm

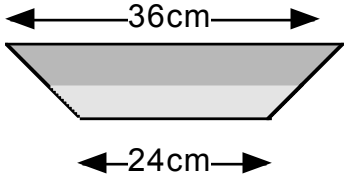
$$20 - 12 = 8$$

so, width of card = $8 \div 2 = 4$cm

Questions Frames

1

Mary uses four pieces of card this size to make a square frame.



(a) What is the area that the frame will enclose?

_____ cm^2

(b) What is the outside perimeter of the frame?

_____ cm

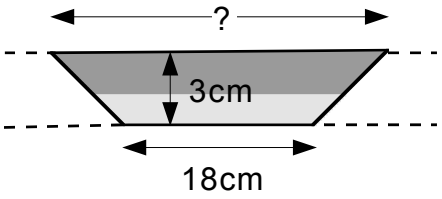
(c) What is the width of the card?

_____ cm

2

Pablo cuts a length of card to make a trapezium that will be one side of a frame.
The card is 3cm wide.
The shorter side of the trapezium is 18cm.

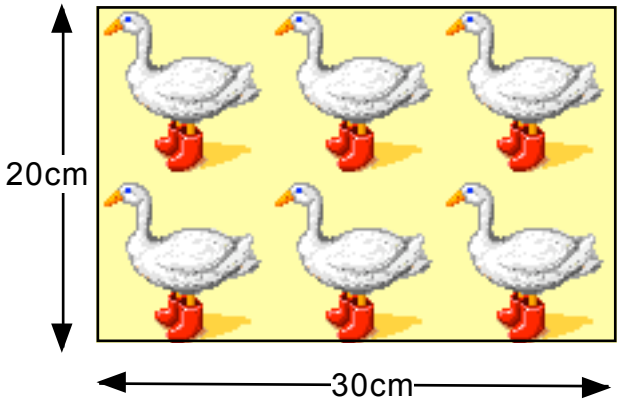
How many centimetres is the longer side?

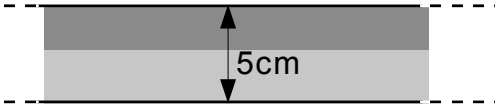


_____ cm

3

Calculate the length of 5cm wide card that is needed to make a rectangular frame that fits exactly around this picture.





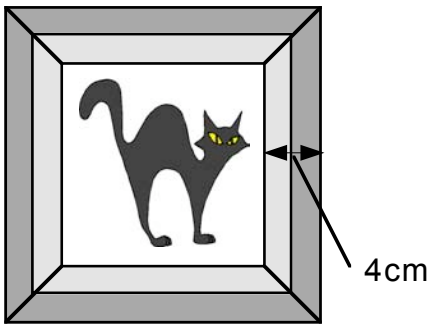
cm

4

A 1 metre length of card is used to make a frame for a square picture.

The card is 4cm wide.

What is the area of the picture it frames?



cm^2

Data sheet Game of '31'

In the game of '31' two people take it in turns to add numbers to a total that starts at zero. The only numbers they can add are chosen from

1 2 3 4 5 6

These numbers can each be used more than once. As each turn proceeds, the total increases. The person who finally reaches 31 is the winner.

For example, with two players A and B:

	0	
A goes first and adds 4	4	
B adds 5	9	
A adds 2	11	
B adds 1	12	
A adds 5	17	
B adds 3	20	
A adds 4	24	
B adds 1	25	
A adds 6	31	A wins.

Winning strategies

Some people suggest you can always win a game of '31' if you are the person who has the first go.

Others suggest that a way to win is to follow the other person's go with the number that combines with theirs to make a total of 7 eg if they add 4, you add 3; if they add 1, you add 6 etc.

Others say that to win the game of '31' you should make sure you are the person who makes a total of 24

Other versions

Other versions of the game can be made by changing the target total from 31, changing the numbers you can use to make the total, and changing the operation from addition.

Questions Game of '31'

1

Jack and Sarah are playing '31'
The total so far is 23
It is Jack's turn and he chooses '3'

What number must Sarah now choose in order to win the game?

2

Andy and Megan are playing '31'

The total so far is 21
It is Megan's turn.

What numbers could Megan choose so that Andy cannot win on his turn?

3

Explain how, if you make the total of 24 on your turn, you can guarantee that you will win the game.

4

In a game of '31', Andy makes a total of 12.
What number should Megan now choose, to guarantee that she can reach a total of 24?

5

Luke and Emma play a new game called '42'.
In this game you have to make a total of 42 and you can choose any of the numbers 1, 2, 3, 4, 5, 6, 7, 8

Luke says

If you can reach a total of 34 on your turn, you can always win the game.

Emma says

The number you must reach in order to win is 33

Who is correct?

Explain why.

6

Another game is to start at 50 and subtract any of the odd numbers

1 3 5 7 9

from the total. The winner is the person who reaches zero.

Aaron and Zoe play this game.

Aaron goes first.

Show how Zoe can always make the totals 40, 30, 20, 10, 0 on her turns and so be sure of winning the game.

Data sheet Gold

Properties of gold

Gold is a very dense material, nearly twenty times as dense as water. 1 cm^3 of gold has a mass of 19.3g.

Gold can be beaten into very thin sheets without tearing or fracturing. 1g can be beaten into a thin sheet of area 1 square metre. This property is useful because gold is used in such things as electrical circuits – the thinner the layer that can be used, the less it will cost.

Use in jewellery

Pure gold is generally too soft to use in jewellery because it wears away too easily. Instead it is combined with other metals (often silver or copper), which make it harder wearing (and change the colour slightly).

Pure gold is 24 karat (24k). '22 karat gold' has 22 parts out of 24 gold and 2 parts another metal, by weight.

Distribution

In the crust of the Earth there is, on average, about 1g of gold in every 30 million grams of earth. There is gold in sea water at the rate of about 1g in every thousand million grams (or 1g every billion grams).

Gold ore, extracted from mines, contains gold usually in the range 1g to 5g per million grams. For gold to be visible to the naked eye, there needs to be at least 30g in each million grams, so in most gold mines you cannot see any gold.

Gold ingots

Large amounts of gold are stored as bars called ingots.

When gold is being traded, the weight is measured in troy ounces (a troy ounce is slightly heavier than an ordinary ounce).

One ingot is 400 troy ounces (approximately 12.5kg).

Questions Gold

1

(a) A ring is described as '10 karat' gold.

What fraction of it is gold?

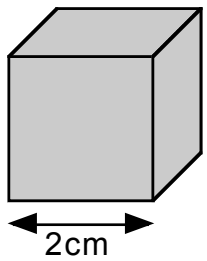
- - - - - - - - - - - - - - - -

(b) How many karats is a metal mixture that is three-quarters gold?

- - - - - - - - - - - - - - - -

2

What will be the mass in grams of a 2cm cube of gold?



- - - - - - - - - - - - - - - - g

3

2g of gold is beaten flat into a 1metre square.

This square is cut into smaller squares 25cm by 25cm.

How much does one of these smaller squares weigh?

- - - - - - - - - - - - g

4

A gold mine processes ore that contains 5 grams of gold per million grams of gold ore.

How many kilograms of ore do they need to process to produce 1kg of gold?

- - - - - - - - - - - - kg

5

In January 2007, the price of gold reached £355.72 per troy ounce.

1 troy ounce = 31.10g (to 2 decimal places).

At this price, how much is 1 gram of gold worth (to the nearest penny)?

£ _____

6

At the same price of gold (£355.72 per troy ounce), approximately how many ingots would be needed to make £1 million worth of gold?

_____

Data sheet Hair salon

At ***Headlines*** hair salon one of the treatments available is hair colouring.
For hair colouring the hairdresser puts a rinse on the client's hair.
The amount of colour needed depends on the length of hair.
This is shown in the first table.

Amount of colour mixture needed

Hair length	Millilitres (ml) of colour mixture needed
Very short	20
Short	30
Medium	40
Long	50
Very long	60

The mixture for the rinse consists of the colours and the proportions shown in the table below

		Main colours			
		Black	**Brown**	**Red**	**Blonde**
Colour required by client	**Black rinse**	1			
	Dark brown rinse	¾	¼		
	Brown rinse		1		
	Auburn rinse		½	½	
	Red rinse			1	
	Copper rinse		¼	½	¼
	Light brown rinse		½		½
	Blonde rinse				1

Questions Hair Salon

1

Shirley has long hair.
She wants a brown rinse on her hair.

How many millilitres of brown colour does the hairdresser need to use?

_____ ml

2

Paul has very short hair.
He wants blonde highlights.
This uses half of the usual volume of colour.

How many millilitres of blonde colour does the hairdresser need to use?

_____ ml

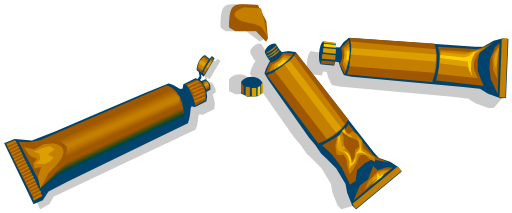
3

Hafifa is having a copper rinse on her hair.
She has medium length hair.
How many millilitres of each colour does the hairdresser need to mix?

Brown _____ ml Red _____ ml Blonde _____ ml

4

Each main colour comes in 100ml tubes.



Jane has medium length hair.
She wants a brown rinse put on her hair.

What fraction of a brown tube is needed?
Give your answer in its simplest form.

_____

5

Monica has very short hair.
She wants a dark brown rinse on her hair.

What fraction of each tube does the hairdresser need to use?
Give your answer in its simplest form.

_____

Data sheet Heart rate

The heart rate (HR) is the number of times the heart beats each minute. Exercise causes the heart rate to increase. After the exercise, the heart rate drops back to its 'resting rate'. The *maximum heart rate* (MHR) is the recommended maximum a person should reach during exercise.

Calculating MHR

There are a number of ways to calculate a value of MHR based on age. These methods are only approximate because individuals vary in their physical ability. Two such methods are presented below:

Simple method

A simple way to calculate MHR is to subtract your age (in years) from 220:

MHR = 220 – age (in years)

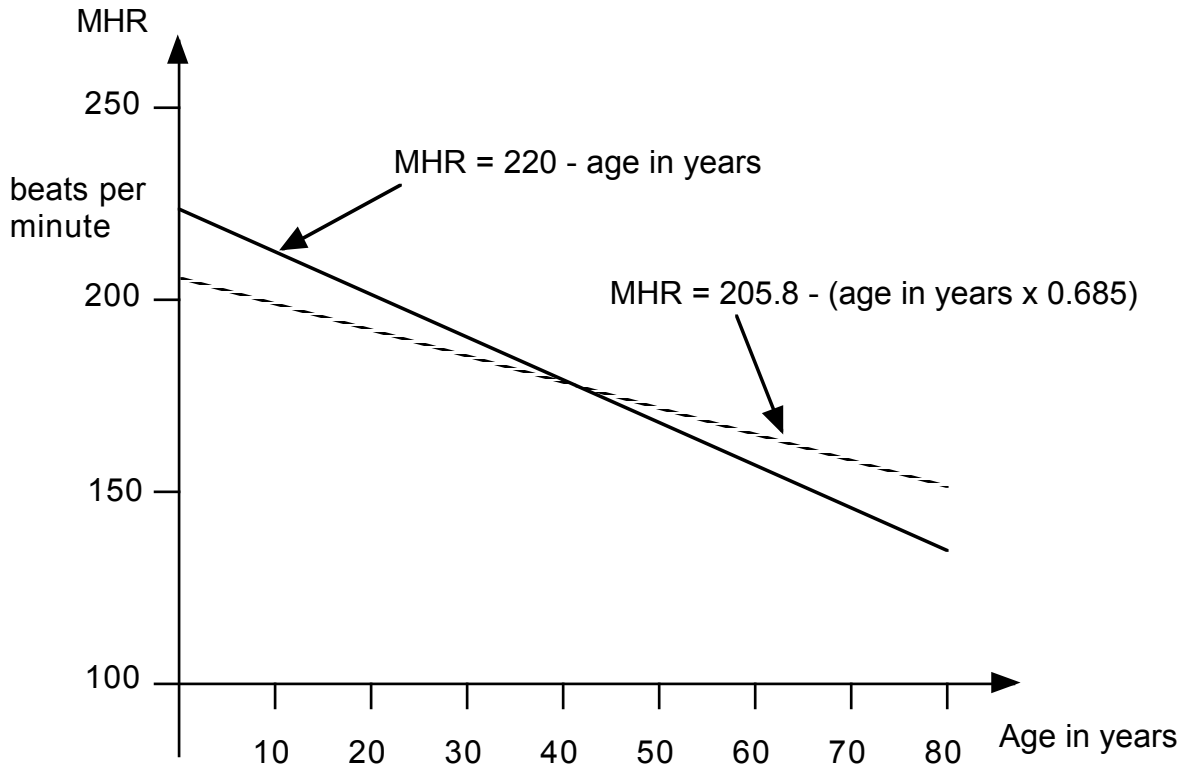
A more accurate method

The simple method of calculation does not give particularly accurate results.

A more reliable formula, though still approximate, is this:

MHR = 205.8 – (age in years x 0.685)

Here are the graphs of the two ways of calculating MHR.



Measuring MHR

The direct way to measure MHR is to monitor the person's heart as they do strenuous exercise. This does, however, carry some risk if a person is not used to such exercise.

Different training levels

People who want to improve their physical fitness often take part in a training programme.

There are a number of levels at which you can exercise in such a programme depending on the percentage of maximum heart rate that is to be reached.

These levels are given in the table below.

Level	**Description**
Healthy heart level (warm up) *Target = 50 - 60% of MHR*	The easiest level and the best one for people just starting up a fitness program. It can also be used as a warm up for training competitive walkers
Fitness level (fat burning) *Target = 60 - 70% of MHR*	This level is a little more demanding than the *Healthy heart level* and so burns more calories.
Aerobic level (endurance training) *Target = 70 - 80% of MHR*	This level will increase the size and strength of your heart. It is the preferred level if you are training for an endurance event.
Anaerobic level (performance training) *Target = 80 - 90% of MHR*	This level will increase the greatest amount of oxygen you can consume during exercise, so you can fight fatigue better.
Red level (maximum effort) *Target = 90 - 100% of MHR*	This level burns the highest number of calories and it is very intense. Most people can only stay at this level for short periods.

Questions Heart rate

1

Stephen is working at 65% of his maximum heart rate.
What level is he exercising at?

- - - - - - - - - - - - - - - - - - - -

2

Use the two methods for calculating MHR to find the MHR for a 25-year-old.

	MHR in beats per minute	
	simple method	more accurate method
25-year-old	- - - - - - - - - -	- - - - - - - - - -

3

Use the graphs on the data sheet to find:

(a) The approximate age at which both methods give the same result for MHR.

- - - - - - - - - - - - - - - - - - - -

(b) Eshan designs a fitness program for people under the age of 25.
He uses the simple method to calculate the MHR.
Explain why this could lead to exercise which is too strenuous for this group.

- -

- -

- -

4

Alex is 30 years old.
She is training at the Aerobic level (endurance training).
She is going to use the more accurate method to calculate maximum heart rates.

(a) What is the lowest maximum heart rate she should be aiming for in her training?

- - - - - - - - - - - - - - - - - - - -

(b) What is the highest maximum heart rate she should be aiming for in her training?

- - - - - - - - - - - - - - - - - - - -

5

Phil is a 50-year-old who calculates his MHR using the simple method.
A friend tells him that the more complicated method is better.
He decides to re-calculate his MHR using the more complicated method.

Find the percentage change in Phil's MHR when going from the simple to the more complex method.

- - - - - - - - - - - - - - - - - - - -

Data Sheet Internet advertising

Advertising on internet web-sites involves paying for a box that appears on the screen when a web page is open, which contains a link to the web site of the advertiser, so that if the link is 'clicked', the user switches to the advertiser's website.

An internet advertisement agency arranges for adverts to appear on different web-sites. The advertiser pays an amount of money for their advert to be put onto sites for a period of time. Each advert is placed on different websites over that time, to ensure that it appears on the screens of as many users as possible. The number of times that the advert is shown is the number of "impressions".

The "click through rate" (CTR) is the percentage of times that users 'click' on the advert and go to the advertiser's website. A rate of 1% would mean that one in 100 users clicks on the advert and goes through to the advertiser's website.

There are two main kinds internet adverts, Tower and Banner.
Tower adverts generally appear on the right of the screen.
Banner adverts appear at the top of the screen.

Here are the costs of adverts from one internet advertisement agency.

	Tower Advert (small)	Tower Advert (large)	Banner Advert
Impressions (each month):	9000	12,000	7000
***CTR:**	1.8%	2.8%	9.6%
Cost per month:	**£20**	**£30**	**£50**
*Total clicks:	162	336	675
Cost for 3 months:	**£48**	**£72**	**£120**
*Total clicks:	486	1,008	2,025
Cost for a full year:	**£155**	**£235**	**£390**
*Total clicks:	1,944	4,032	8,100

*These are estimates based on what happened in the past.

Questions Internet advertising

1

A firm decides to buy a banner advert for 2 months. How much will it cost?

2

How much would it be to have both a large tower advert and a banner advert for a year?

3

One way of comparing costs for adverts is to work out the 'cost per click' – that is how much on average the advert has cost for each person who clicks through to the advertiser's website.

The cost per click for a one month small tower advert is just over 12p.

(a) What is the cost per click for a one month banner advert?
Give your answer to the nearest number of pence.

(b) Out of all the choices for adverts, which option gives the lowest cost per click?

4

The costs for 3 months and for a whole year include a discount, compared to the monthly rate.

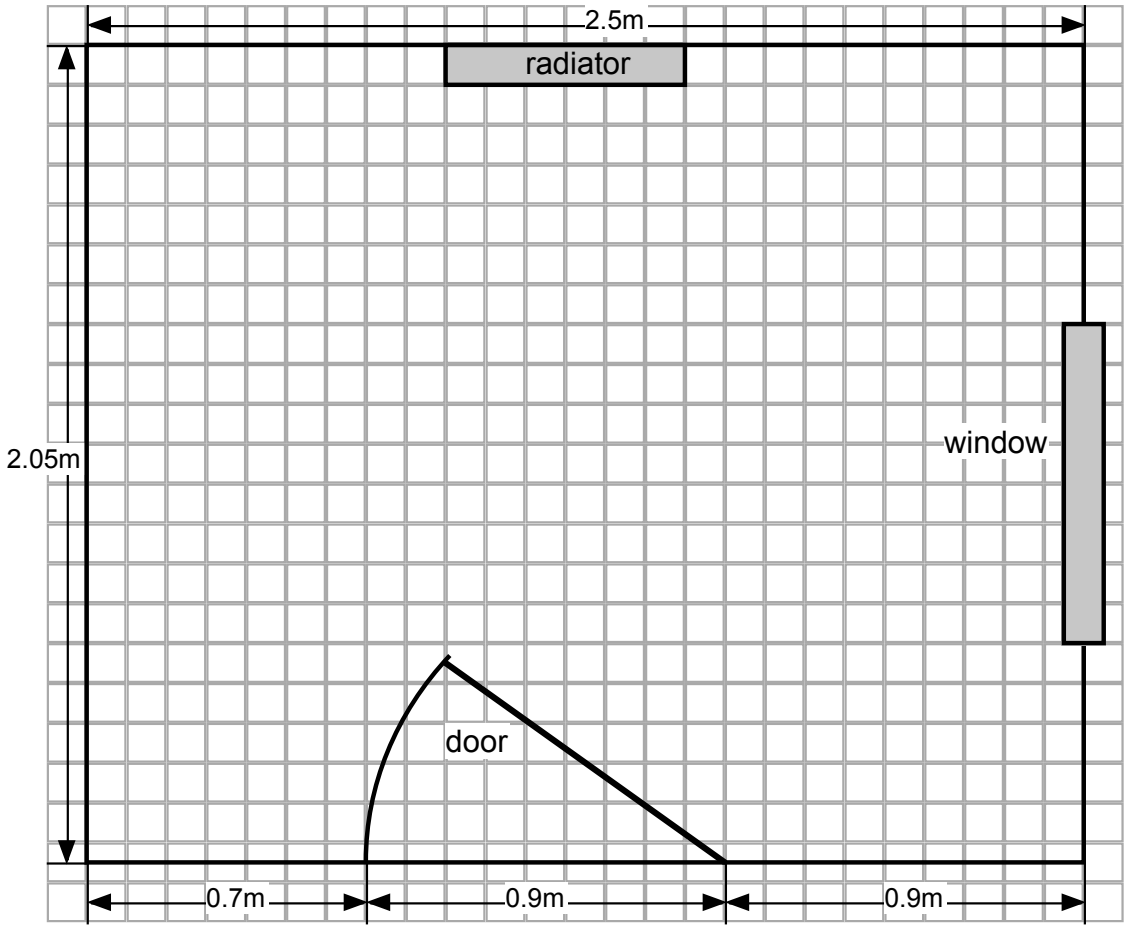
What percentage discount is given for 3 months?

5

If you are going to spend up to £200 on internet advertising over a 12 month period, what is the best way to spend it – that is, what combination of adverts will give the most clicks?

Data Sheet Kitchen design

Here is the scale plan of a small kitchen.



List of kitchen items

These are the appliances and units which are available for the kitchen.
Their dimensions and other information are shown in the table below.

oven

fridge freezer

washing machine

sink unit

double cupboard unit

single cupboard unit

large 2 drawer unit

small 3 drawer unit

Appliances	**Height mm**	**Width mm**	**Depth mm**	**Other Information**
oven	900	500	600	Requires a 25 mm gap at either side to let heat escape
fridge freezer	1750	650	650	
washing machine	850	600	550	
Units				
sink unit	900	1000	600	
double cupboard unit	900	800	600	
single cupboard unit	900	400	600	
large 2 drawer unit	900	1100	600	
small 3 drawer unit	900	500	600	

Questions Kitchen design

1

Which kitchen item on the data sheet has a width of 600mm?

_____

2

A blind is needed for the kitchen window.
It needs to be wider than the window by 5cm at each side.

What width does the blind need to be?

_____cm

3

Skirting boards need fixing to the bottom of the walls all the way around the kitchen, except where the door is.
Skirting board is available in 3m lengths.

How many 3m lengths of skirting board will be needed?

_____

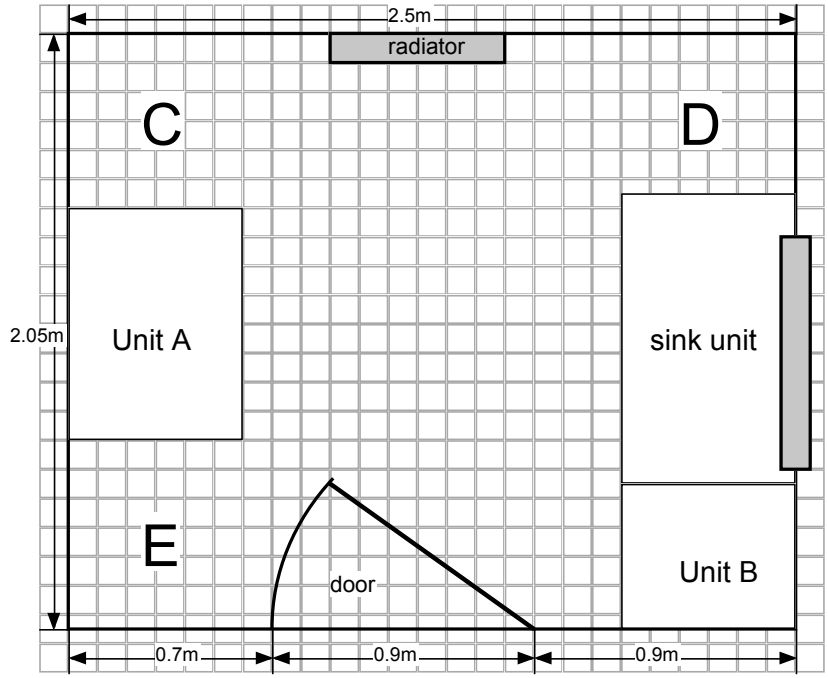
4

Before the kitchen appliances and units can be fitted into the kitchen the floor needs to be tiled.
Each tile is 30cm x 30cm. A box contains 9 floor tiles.

How many boxes of tiles are required to tile the whole kitchen floor?

_____

Here is the plan showing the positions of the sink and two other units that will be used in the kitchen.



5

On the kitchen plan where Unit A and Unit B are shown, which units from the list of kitchen items are they?

Unit A is _____. Unit B is _____

6

The position of the washing machine, oven and fridge freezer from the list of kitchen items still need to be put on the plan.

All three appliances need to go in the kitchen, in spaces C, D and E.
Which space will each appliance fit into?

Draw an arrow to match each space with the appliance that should go there.

Space C	fridge freezer
Space D	washing machine
Space E	oven

Data sheet Nines

N-form

Writing long decimals can be tedious especially when the same digit repeats in a decimal such as 0.999999 Also, it is easy to make a mistake in counting how many nines there are. In the case of long strings of nines, a coding system has been developed to get around this problem.

0.999999 is written as 6N (or 'six nines')

This coding can be modified to deal with numbers such as 0.9999995

0.9999995 is written as 6N5 (or 'six nines five')

Using this coding, 3N means 0.999, and 3N5 means 0.9995

Percentages

The coding can include percentages.

For example, 99% as a decimal is 0.99, which can be written as 2N

99.5% is 0.995, which can be written as 2N5

Uses

1 The purity of chemicals is often expressed in this way:

a sample of oxygen is 99.9% pure (with 0.1% impurity).
99.9% = 0.999 and this can be written as 3N

2 The reliability of systems such as a computer network:

a system that is 99% reliable is one that works correctly 99% of the time.
99% = 0.99 which can be written 2N

Questions Nines

1

Write down the number ***four nines***:

(a) As a decimal _ _ _ _ _ _ _

(b) As a percentage _ _ _ _ _ _ _

2

Write down the number 0.995 in ***N-form***.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

3

A website is said to be ***1N5*** available to visit online.

(a) Find the percentage of the time that the website is available.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

(b) Work out the average number of minutes per day the site would be unavailable.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

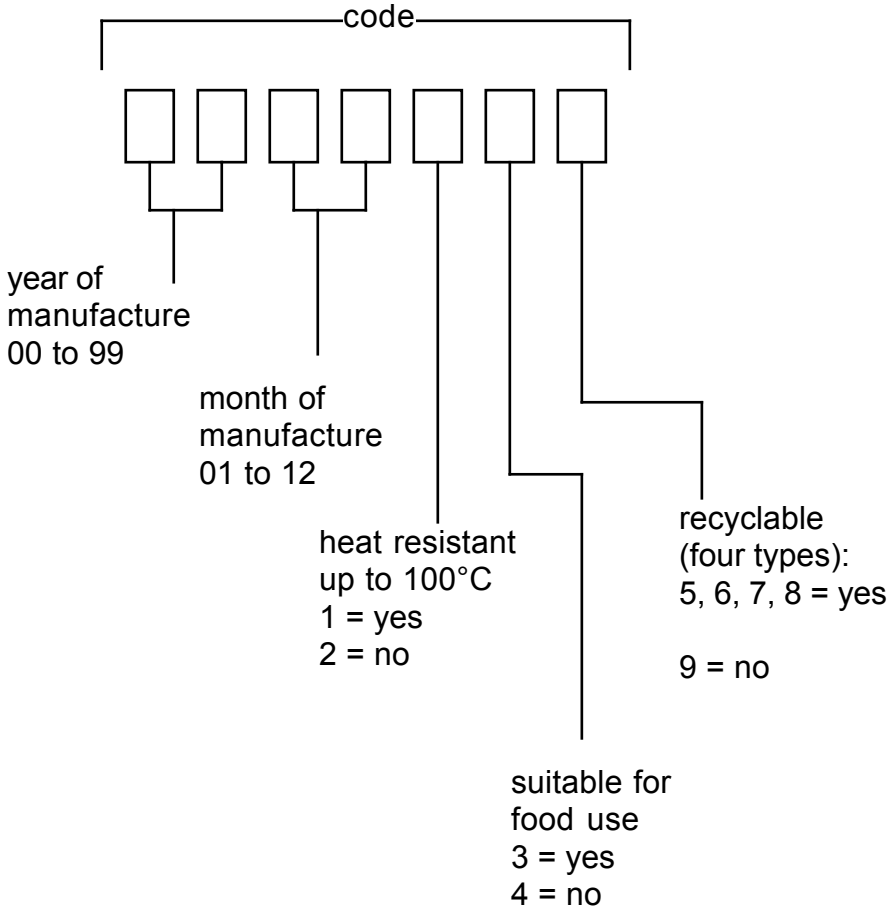
4

A certain metal is ***4N5*** pure by weight.
Work out the weight of the impurities in 100kg of the metal.
Give your answer in grams.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ g

Data sheet Plastic codes

A manufacturer of plastics marks a seven-digit number on all the different types of plastic produced. These seven digits are a code that identifies the date of production and properties of the material.



For example, a piece of plastic with the code

0 3 1 1 2 3 8

was manufactured in 2003, November; it is not heat resistant; it is suitable for food use and is recyclable.

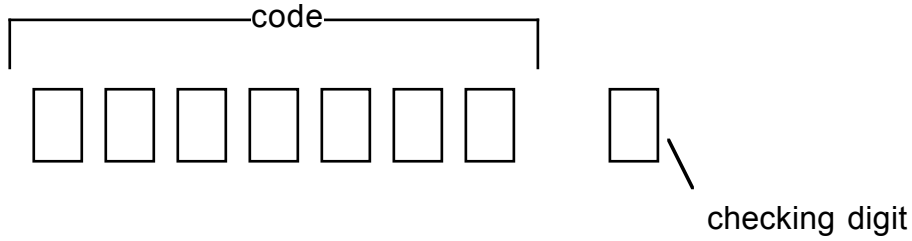
Checking digits

When you write down a long string of digits, it is easy to make a mistake – usually getting two digits next to each other the wrong way round. For example, in the previous code,

0 3 1 1 2 3 8 might be accidentally written as 0 3 1 2 1 3 8

This will give wrong information about the product.

A checking digit can be used to tackle this problem. This is an additional number at the end of the code.



One way to get a checking digit is to take the digits of the code and treat them as a whole number, divide it by 11, and use the remainder as the checking digit. If there is no remainder, the checking digit is ‘0’.

In the example given the code was 0 3 1 1 2 3 8. This is treated as 311,238

311,238 ÷ 11 = 28,294 remainder 4

so '4' becomes the checking digit, and the full code, including checking digit is

0 3 1 1 2 3 8 4

A remainder of 10 is written as 'X' , so that the checking digit is always a single digit or letter. For example, code 0 3 1 2 2 4 5 has a checking digit of X

How checking digits act as a check

If a code is copied incorrectly by writing two digits the wrong way round, the checking digit will not fit with the new number, so the mistake can be detected.

For example, as suggested above, 0 3 1 1 2 3 8 could be written incorrectly as 0 3 1 2 1 3 8, but this number would have a remainder of 2 when divided by 11, so,

0 3 1 2 1 3 8 4

indicates that the code has been incorrectly copied.

Questions **Plastic codes**

1

List the date of manufacture and all the properties of a piece of plastic with the code

0 6 0 5 1 4 6 3

- -

- -

2

Here are two codes (without checking digits).

Explain why each one cannot be correct.

0 3 1 4 1 3 7 -

- -

0 5 0 5 2 3 3 -

- -

3

Underline the two codes in this list that do not match their checking digits.

0 1 1 1 1 4 5 9 9 9 1 2 2 3 9 7

0 0 0 7 1 3 8 X 0 4 0 2 2 4 7 1

4

Write the code and checking digit for some plastic manufactured on the 4th of September 2006, heat resistant up to 100°C, suitable for food use, type 5 recyclable.

- -

5

A possible checking digit system is to use divisibility by 9 and make the checking digit the remainder after dividing by 9

Do you think this would detect a mistake in a coding due to digits next to each other being written the wrong way round?

Yes / No

Give an example to justify your answer.

- -

- -

- -

Data sheet Premium Bonds

How they work

Premium Bonds cost £1 each (you cannot buy less than 100 at a time). Each bond has a number and each month the numbers from all the Premium Bonds that are held are put into a prize draw. A computer (nicknamed 'ERNIE' - Electronic Random Number Indicator Equipment) picks the winning numbers each month. The winning numbers win prizes from £50 to £1 million.

Where does the money come from?

The amount of money available for prizes is calculated each month as 0.3% of the value of all the Premium Bonds held that month. A big attraction of Premium Bonds is that you can always get your money back by cashing in your bonds. In other words you have the chance of winning up to £1 million pounds without losing your money. The prize money is the amount that would have been paid in interest on the money if it had been put into a savings account.

The prizes

About £30 billion worth of Premium Bonds are held by 23 million people in the UK. This means that about £100 million is available for prizes each month. The number of prizes is adjusted each month so that the chance of a single Premium Bond winning a prize is 1 in 24,000. The prizes are in three groups: higher, medium and lower values.

In May 2007, there were a total of 1,474,002 prizes and their total value was £106 million (to the nearest million).

The table following shows the number and the value of all the prizes available for May 2007. It shows, for example, that there were 344 prizes of £5000 each in May. This makes the total value of £5,000 prizes = 344 x £5,000 = £1,720,000

Premium bond prizes in May 2007

Prize band	Prize value £	Number of prizes
Higher value	1 million	2
	100,000	17
	50,000	35
	25,000	69
	10,000	172
	5,000	344
Medium value	1,000	4,244
	500	12,732
Lower value	100	241,676
	50	1,214,711

Questions Premium Bonds

1

(a) How many lower value prizes were there in May?

(b) How many more £500 prizes were there than £1000 prizes in May?

2

How much money was paid out in £50,000 prizes in May?

3

Tom buys £250 worth of Premium Bonds and holds them for one year. He wins one £50 prize during the year. At the end of the year he cashes in his 250 Premium Bonds and gets his money back.

Taking into account his £50 prize, what has been the percentage increase in Tom's money over the year?

4

What is the average value of the Premium Bonds held by the 23 million people who hold them?
Give your answer to the nearest £100

£ _____

5

The total value of prizes in May was £106 million.

What percentage of the money available for prizes in May was taken up by the £1,000,000 and the £100,000 prizes altogether?
Give your answer to 1 decimal place.

_____ %

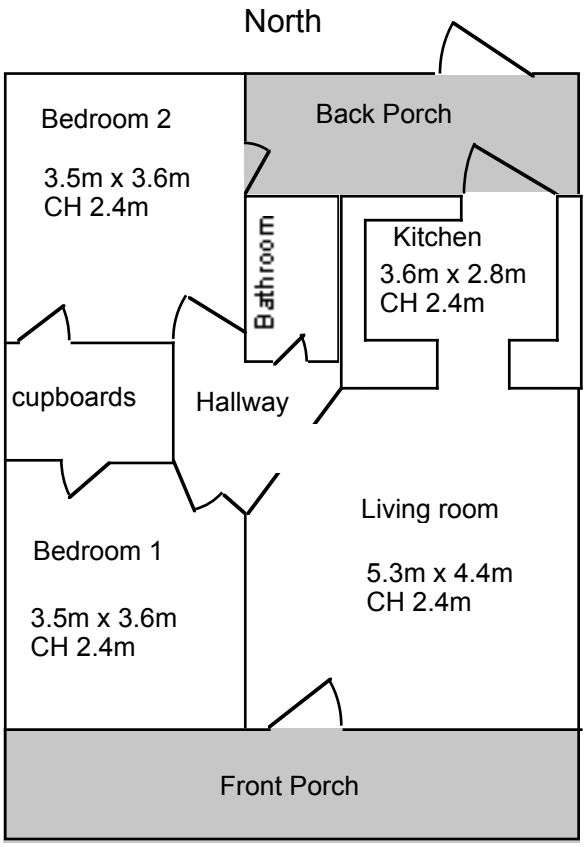
6

What percentage of the total prize money was given out in lower value prizes in May?

_____ %

Data sheet Radiators

The diagram shows the plan of a bungalow.
The dimensions of the rooms and the ceiling height are given.



CH = ceiling height

Choosing a radiator

To work out the size of a radiator, in kilowatts (kw), needed to heat a room, use the formula

Number of kw = volume of room x 0.04

For example for a room 3m x 4m x 2.5m high

no. of kw = 3 x 4 x 2.5 x 0.04
= 1.2

If a room has a **north** facing **outer wall** then increase the result by 25%

Radiators come in different sizes.
The table shows some radiators and their product codes.

1kw = 1000watts

	Product Code	Size H x W	Heat output
	055s	500 x 500mm single	399 watts
	065s	600 x 500mm single	461 watts
	068s	600 x 800mm single	738 watts
	065d	600 x 500mm double	858 watts
	310d	300 x 1000mm double	978 watts
	067d	600 x 700mm double	1200 watts
	510d	500 x 1000mm double	1476 watts
	612d	600 x 1200mm double	2058 watts

Questions Radiators

1

(a) Use the formula to work out how many kilowatts of heat Bedroom 1 requires.

Bedroom 1 _____kw

(b) How many more kilowatts of heat does Bedroom 2 require compared to bedroom 1?

Bedroom 2 _____ kw

2

The volume of the kitchen is 24.192m^3

Give the product code of the radiator that is the most sensible choice for the kitchen.

_____

3

To save space in the kitchen, a householder wants one large radiator in the living room to heat both the kitchen and the living room.

The heating requirement of both rooms together is approximately 3200 watts.

She wants to use a **600mm high double radiator**.

Radiators can be made in widths that come in 100mm units.
Estimate the width of radiator she needs for the kitchen and living room together.

_____ mm

Data Sheet Rainforest Facts

The Disappearing Rainforests

In 1950 rainforests covered 15% of the Earth's land surface; now they cover 7% and experts estimate that in 40 years time rainforests could have almost disappeared. It is estimated that 137 species of plants and animals become extinct every day in the rainforest and that 22km^2 of rainforest are lost every hour.

Most of the deforestation is due to logging to sell wood and forest clearance to make room for farm land to grow soya beans and, more recently, palm-oil.

Palm-oil Plantations

By 2005 the palm-oil industry had set up 65,000km^2 of oil-palm plantations across Sumatra and Borneo. It is projected that by 2020 the palm oil plantations will be three times this size.

Orang-utans which live in these forest areas are at risk of becoming extinct. It is estimated that the rate of decline is about 8% per year from a total current population of approximately 60,000.

Questions Rainforest Facts

1

(a) According to the data sheet how many species of plants and animals become extinct in one week?

_____.

(b) How many km^2 of rainforest are lost in a week?

_____.

2

(a) Since 1950 what percentage of the Earth's land surface has lost its rainforest ?

_____.

(b) What percentage of the 1950 rainforest has now disappeared?

_____.

3

By 2020 how many km^2 of palm-oil plantations are there projected to be in Sumatra and Borneo?

_____. km^2

4

The table below shows the projected orang-utan population if it continues to decline at its current rate of 8% per year.

Complete the table for 2009 and 2010 rounding each figure to the nearest hundred

Year	**Projected Population** Rounded to the nearest hundred	**Estimated decline** Rounded to the nearest hundred
2007	60 000	4 800
2008	55 200	4 400
2009	50 800	
2010		

5

In the media large areas are often compared to the size of Wales.

The area of Wales is 20 000 km^2.

Calculate how many days it takes to lose an area of rainforest the size of Wales.

days

Data sheet Shoe sizes

For a shoe to be comfortable, it needs to be slightly larger than the foot that goes in it, but if it is too large, the foot slides about inside the shoe. Traditionally, shoes are designed to be about 0.8 inches longer than the foot they are intended for.

The difference in length between one shoe size and the next is one 'barleycorn', which is one third of an inch. In many European countries shoes sizes differ in size by a 'Paris point', which is two-thirds of a centimetre.

Calculating shoe sizes

Manufacturers use formulae for calculating shoe sizes. In the UK, a typical formula is

male shoe size = 3 x (foot length in inches + 0.8) – 24.5

female shoe size = 3 x (foot length in inches + 0.8) – 21.5

Example

Peter's foot length is 10.7 inches. His shoe size can be calculated:

shoes size = 3 x (10.7 + 0.8) – 24.5
= 10

In Europe there is generally no separation of men's and women's sizes, and a typical formula is

shoe size = 1.5 x (foot length in cm + 2)

The shoe size that fits

In the UK, manufacturers only make shoes in a whole or half number sizes eg size 8, 8½, 9 etc. In Europe they use only whole number sizes 35, 36, 37 etc. Someone in the UK whose shoe size is calculated to be, for example size 8.75, has to make a choice from what is available and choose, in this particular case, 8½ or 9. What they choose may depend on other factors, apart from their foot length, such as design of shoe, width of their feet and prevailing fashion.

Questions Shoe sizes

1

Jane and Rita both wear the same style of shoes.
Jane takes size 4 and Rita takes size 6.

What is the difference in the length of their shoes?

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ inches

2

Danielle has a foot length of 22cm.
According to the formula given in the data sheet, what is the European shoe size that she needs?

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

3

Use the formula given on the data sheet to find the longest foot length that will fit a European shoe of size 39

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _

4

(a) Stephan measures the length of his foot as 26.3cm.

What European sizes of shoe should he try on as a likely fit?

----- and -----

(b) Mary's foot is $9\frac{1}{4}$ inches long.

What UK sizes of shoe (including half sizes) should she try on as a likely fit?

----- and -----

Data sheet Speed Check

The 1865 Locomotive Act (the 'Red Flag' Act) required horseless (motorised) vehicles to have three drivers - two to travel in the vehicle and one to walk in front with a red flag. The speed limits were 4 mph in the open country and 2mph in towns. This act was repealed in 1896. The familiar 30mph speed limit in built-up areas did not appear until 1934, along with the driving test and pedestrian crossings.

National speed limits

We now have a range of speed limits for motorised vehicles, as shown in the table below.

National Speed Limits (mph) - UK

Vehicle type		Built up areas	Open areas single carriageways	Open areas dual carriageways	Motorways
A	Cars	30	60	70	70
B	Cars towing caravans or trailers	30	50	60	60
C	Buses and coaches	30	50	60	70
D	Goods vehicles - under 7.5 tonnes loaded	30	50	60	70
E	Goods vehicles - over 7.5 tonnes loaded	30	40	50	60

Passing a road sign showing a black stripe on a white background does not mean you can travel as fast as you like or that you can now go at 70mph, wherever you are. It indicates the end of a special speed restriction (for example, for road works) and that one of the National speed limits now applies, as shown in the table.

Speed cameras

One way to enforce speed limits is through the use of cameras. The camera is usually at the side of the road and is triggered by a sensor in the road or radar in the camera box as a speeding car passes. It then takes two photographs half a second apart. These show two positions of the car and the speed can be calculated from markings on the road.

The two photos here show the position of a car at two moments, half a second apart. The white markings on the side of the road are 5 feet apart.

The car has travelled 12 five-feet gaps in half a second. This means it is travelling at an average speed of 60 feet in half a second = 120 feet per second.

There are 3600 seconds in an hour.

This is 120 x 3,600 feet per hour = 423,000 feet per hour.

1 mile = 5280 feet

So the speed of the car is

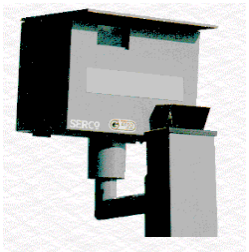
423,000 ÷ 5280 mph
= 82mph.

photos from West Midlands Police

Being prosecuted for speeding

Generally speeding motorists are only prosecuted if their speed is measured at 10% above the road limit + 2mph. So, in a 50mph speed limit zone, the speed at which the Police are likely to prosecute for speeding is:

50 + (10% of 50) + 2mph = 57mph



Questions

Speed check

1

Which vehicles are **not** allowed to travel at 70mph on a motorway?

2

On which types of road is a car allowed a higher maximum speed than a bus?

3

Some people argue that the car speed limit of 70mph on a motorway should be raised to 80mph.

If this were done, what is the speed at which the Police would be likely to prosecute a motorway car driver for speeding?

4

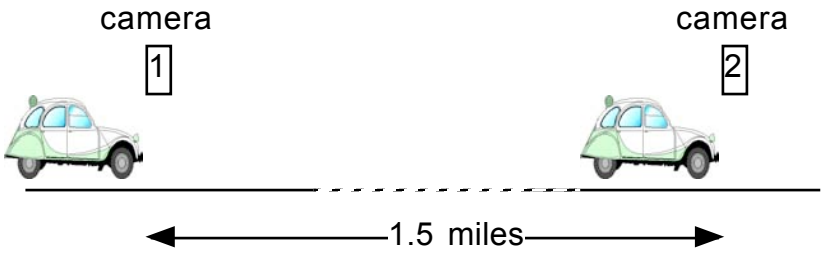
A car driver is charged with travelling at more than 60mph in a 40mph-speed-limit zone. The evidence is two photographs taken half a second apart, that show the car has moved 45 feet in the half second.

Show how the photograph measurements confirm that she was travelling at more than 60mph.

5

Another way to check for speeding is to use two cameras - one to take a photo at the start of a speed restricted section of road (eg road works) and the other to take a photo at the end. These can then be compared to work out the average speed over the section of road.

A section of motorway has road works and a 50mph speed limit for 1.5 miles.



A car passes camera no.1 and then passes camera no.2 after 1minute 30 secs.

Has the driver broken the 50mph speed limit? Yes / No

Explain your answer

Data sheet Steep hill road signs

Some of the signs used on Britain's roads give advance warning of steep hills.

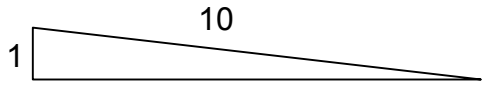
The sign is a red triangle (as are all road warning signs) with a slope going up or down, and a numerical expression.

If the road goes downhill, the slope on the sign goes down from left to right.
If the road goes uphill, the slope on the sign goes up from left to right.

The approximate gradient of the slope is shown on the sign, either

- as a percentage, such as 10% or 14%, or
- as a ratio, for example 1 : 7 (written as 1 in 7 on older signs)

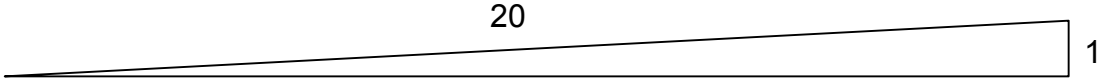
A gradient of 1:10 (1 in 10) means that for every 10 metres of forward travel on the hill, the height changes by about one metre.



One tenth is 10%, so the sign above is for a 1 in 10 downhill slope.

A hill of 1 : 20 means that there will be a change in height of one metre for every 20 metres of forward travel.

One twentieth is 5%, so a gradient of 5% indicates a 1 in 20 slope.



Questions Steep hill road signs

1

(a) Does this sign indicate that the road will be going downhill or uphill?

(b) The slope following this sign is 200 metres long.
Approximately how much change in height will there be from the start to the finish of the slope?

2

Here is a photograph of another sign.

Which of these ratios is approximately equivalent to a gradient of 17% ?
Put a ring around the correct answer.

1 : 17 1 : 8 1 : 7 1 : 6 1 : 5

3

An old sign which shows the gradient as “1 in 25” is going to be replaced by a new sign.

What percentage should be written on the new sign?

4

Here are the gradients of some hills, as shown on road signs.

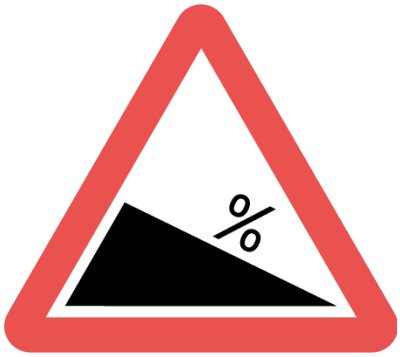
18% 1 in 7 10% 1 : 12 12%

(a) Which one is the steepest?

(b) Which one is the least steep?

5

A road that is 1 km long drops in height by 250m.
Complete the two possible signs for the slope



Data sheet

Sunshine Hotel

4* hotel
Reception staffed at all times

Rules for staffing

2 people are required to staff the reception between 7am and 11pm.
1 person is required to staff the reception overnight from 11pm to 7am.

No member of staff may work more than 8 hours in any one day.
Staff must have at least 12 hours off between shifts of 5 or more hours.

All staff are paid the national minimum wage.

National minimum wage (NMW)

Type of NMW	Hourly rate of NMW from 01.10.07
Workers aged 16-17	£3.40
Workers aged between 18-21	£4.60
Workers aged 22 and over	£5.52

Weekend staff for reception

Name	Age
Mike Harvey	17
Shirley Jones	21
Alan Marks	24
Jennifer Bartlett	26
Sarah Parker	29
David Williams	45

Regular Weekend Rota

(Friday 6pm to Sunday 12 midnight)

	Reception		
	Friday	**Saturday**	**Sunday**
12 midnight – 1am		David Williams	Jennifer Bartlett
1am – 2am		Alan Marks	Jennifer Bartlett
2am – 3am		Alan Marks	Jennifer Bartlett
3am – 4am		Alan Marks	Alan Marks
4am – 5am		Alan Marks	Alan Marks
5am – 6am		Alan Marks	Alan Marks
6am-7am		Alan Marks	Alan Marks
7am – 8am		Alan Marks Sarah Parker	Alan Marks Mike Harvey
8am – 9am		Alan Marks Sarah Parker	Alan Marks Mike Harvey
9am – 10am		Mike Harvey Sarah Parker	Alan Marks Mike Harvey
10am – 11am		Mike Harvey Sarah Parker	Alan Marks Mike Harvey
11am – 12 noon		Mike Harvey Sarah Parker	Mike Harvey Shirley Jones
12 noon – 1pm		Mike Harvey Sarah Parker	Mike Harvey Shirley Jones
1pm - 2pm		Sarah Parker David Williams	Mike Harvey Shirley Jones
2pm – 3pm		Sarah Parker David Williams	Shirley Jones Mike Harvey
3pm – 4pm		Shirley Jones David Williams	Shirley Jones David Williams
4pm – 5pm		Shirley Jones David Williams	Shirley Jones David Williams
5pm – 6pm		Shirley Jones David Williams	Shirley Jones David Williams
6pm – 7pm	Shirley Jones David Williams	Shirley Jones David Williams	Sarah Parker David Williams
7pm – 8pm	Shirley Jones David Williams	Shirley Jones Jennifer Bartlett	Sarah Parker David Williams
8pm – 9pm	Shirley Jones David Williams	Shirley Jones Jennifer Bartlett	Sarah Parker David Williams
9pm – 10pm	Shirley Jones David Williams	Shirley Jones Jennifer Bartlett	Sarah Parker David Williams
10pm – 11pm	Shirley Jones David Williams	Shirley Jones Jennifer Bartlett	Sarah Parker David Williams
11pm – 12 midnight	David Williams	Jennifer Bartlett	Sarah Parker

Questions Sunshine Hotel

1

How many hours does Jennifer Bartlett work on Sunday?

_____.

2

This table shows the start and finish times for each member of staff for each day during the regular weekend rota.

Complete the table by filling in the hours each member of staff worked on Sunday.

Mike Harvey's hours have been put on the chart for you.

	Friday night	Saturday	Sunday
Mike Harvey	-	9am – 1pm	7am – 3pm
Shirley Jones	6pm – 11pm	3pm – 11pm	
Alan Marks	-	1am – 9am	
Jennifer Bartlett	-	7pm – 12 midnight	
Sarah Parker	-	7am – 3pm	
David Williams	6pm – 12 midnight	12 midnight – 1am 1pm – 7pm	

3

How many hours will Mike Harvey get off work between his shifts on Saturday and Sunday?

_____.

4

How much does David Williams earn over the weekend?

£ _____.

5

Shirley Jones wants to finish her shift early at 5pm on Sunday.
Name all the staff who the manager could ask to cover the last hour of her shift.
Make sure the rules for staffing are followed.

_____

_____

6

Mike Harvey wants to finish an hour early at 12 noon on Saturday.
David Williams offers to start his shift one hour early.
Explain why he is not allowed to do this.

_____

_____

_____

Data sheet The solar system

This table gives some (approximate) data for the Earth.

The Earth	
Diameter (in km)	12,756.3
Mass (in tonnes)	5,980,000,000,000,000,000,000 (5.98×10^{21})
Radius of orbit (in km)	149,600,000
Period of orbit (days)	365.3
Number of moons	1

The path of a planet around the sun is its orbit. The radius of orbit is the average distance the planet is from the sun as it travels round.

The period of orbit is the length of time the planet takes to go around the sun once. For the Earth, this is a year, which is approximately 365.3 days.

The next table lists these properties for all of the solar system's eight planets.
The planets are listed in order of distance from the Sun.
The diameter, mass, and radius of orbit are all given relative to the Earth.

Planet	Diameter	Mass	Radius of orbit	Period of orbit (Earth years)	Number of moons
Mercury	0.382	0.06	0.387	0.241	none
Venus	0.949	0.82	0.72	0.615	none
Earth	1.00	1.00	1.00	1.00	1
Mars	0.53	0.11	1.52	1.88	2
Jupiter	11.2	318	5.20	11.86	63
Saturn	9.41	95	9.54	29.46	56
Uranus	3.98	14.6	19.22	84.01	27
Neptune	3.81	17.2	30.06	164.8	9

The **inner** planets are Mercury, Venus, Earth and Mars.
The **outer** planets are Jupiter, Saturn, Uranus and Neptune.

Questions The solar system

1

Which is the largest planet?

2

The total mass of the eight planets is approximately 447 Earth masses.

What is the total mass of the four inner planets?
Give your answer to the nearest whole number of Earth masses.

3

How many Earth days does it take for Mercury to orbit the sun?

4

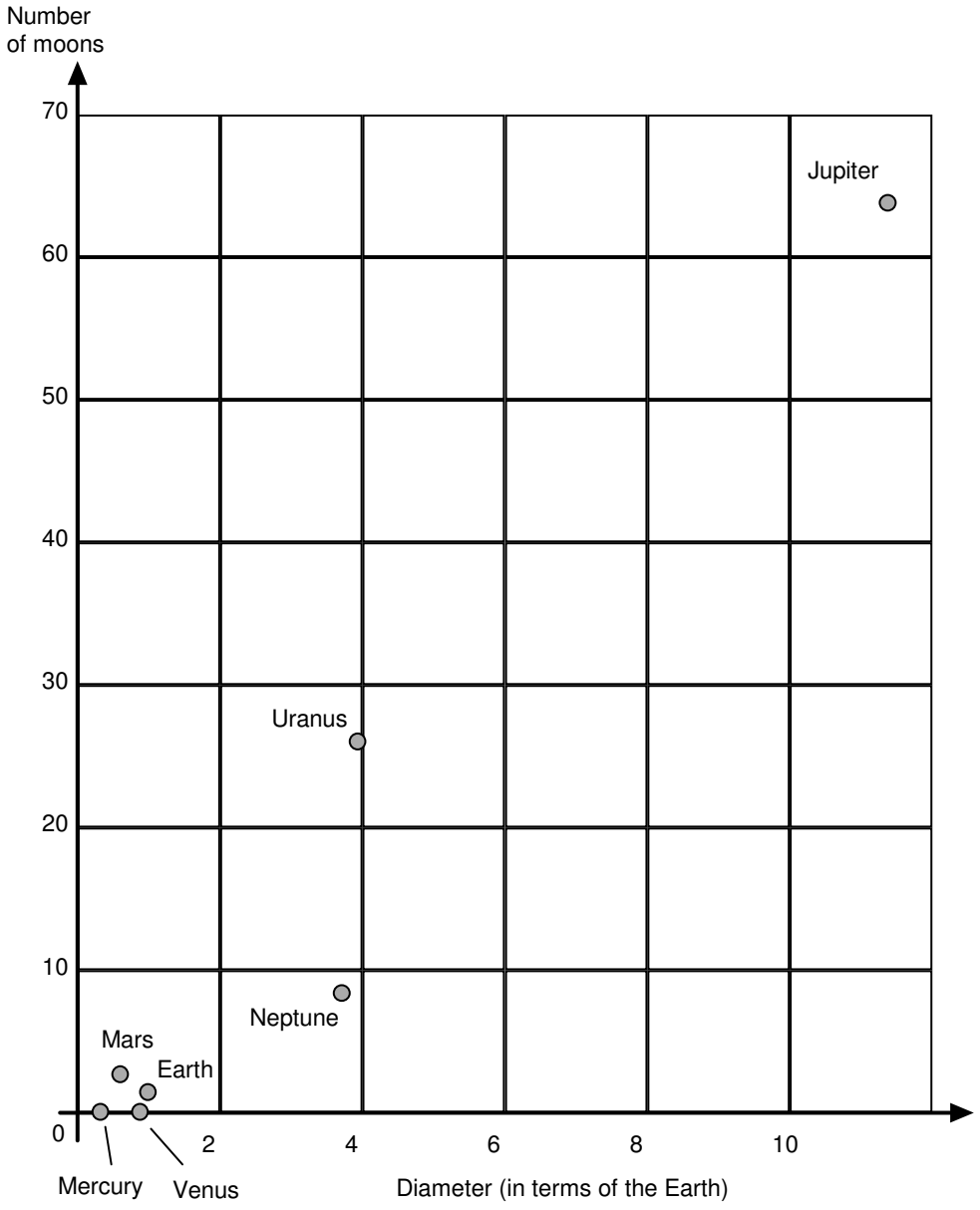
Neptune is the planet furthest from the sun.
Approximately how many kilometres is Neptune from the sun?

---. kilometres

5

This graph shows the diameters of the planets and the number of moons each has.

Saturn is missing from the graph.



(a) Plot the point for Saturn on the graph.

(b) Look at the graph. What seems to be the relationship between the number of moons and the diameter?

6

Kepler's third law says that, for all planets, if *P* is the period of orbit (relative to the Earth) and *R* the radius of orbit (relative to the Earth), then:

$$P^2 = R^3.$$

For example, for Mars, P = 1.88 so P^2 = 3.5 (to one decimal place)
and R = 1.52 so R^3 = 3.5 (to one decimal place)

Pluto is no longer considered be a planet, but nevertheless follows Kepler's law.

The radius of orbit for Pluto (R) is approximately 39.5 times that of the Earth.

Use Kepler's law to estimate the period of Pluto's orbit (P), in Earth years.

Earth years

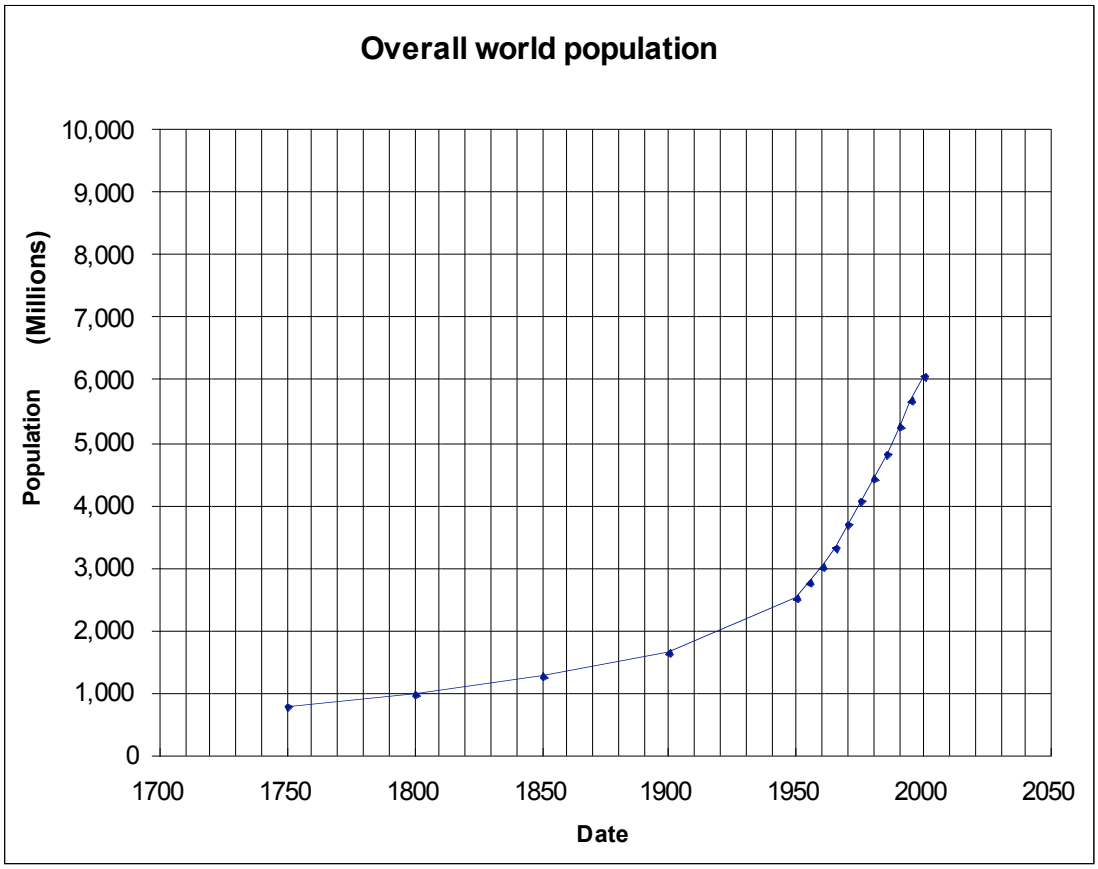
Data Sheet The world's population

This table shows world population figures from 1750 to 2000

Year	World population (millions)
1750	791
1800	978
1850	1,262
1900	1,650
1950	2,519
1955	2,756
1960	3,021
1965	3,335

Year	World population (millions)
1970	3,692
1975	4,068
1980	4,435
1985	4,831
1990	5,264
1995	5,674
2000	6,071

This graph uses the data to show how the world's population has grown over the period 1750 to 2000.



Populations in countries in 2005

This table shows the population of the world's most populous countries in 2005.

Population of the world's six most populous countries in 2005

Country / Territory	Population in 2005 (millions)
China	1,279
India	1,103
United States of America	300
Indonesia	233
Brazil	187
Pakistan	162
World	**6,487**

Projected population in future years.

It is possible to estimate how the world's population will grow in the future.

However, different assumptions - about how old people will be on average when they have children, how many children on average they will have, and how long on average people will live - give different results.

Two different estimates of population growth are shown below.

Projected world population (millions)

Year	Estimate A	Estimate B
2010	6,830	6,970
2020	7,540	7,900
2030	8,130	8,890
2040	8,590	9,940
2050	8,920	11,050

Questions The world's population

1

Use the graph on the data sheet to estimate the year when the world's population became 2 billion people.

2

How many more people were there in the world in 2005 compared to 2000?

3

Using the information on the data sheet, calculate what approximate percentage of the world's population lives in China.

4

Simone searches on the internet for an estimate of how fast India's population is increasing.

(a) One website says India's population is increasing at approximately 29 people per minute.
How many people is that per year?

(b) Another website says that India's rate of population growth is 1.38% per year.
Based on the 2005 population, how many people is that per year?

5

The data sheet gives two estimates about what is projected to happen to Earth's population up to the year 2050.

Draw lines to indicate which is the best description of the kind of change that each estimate predicts.

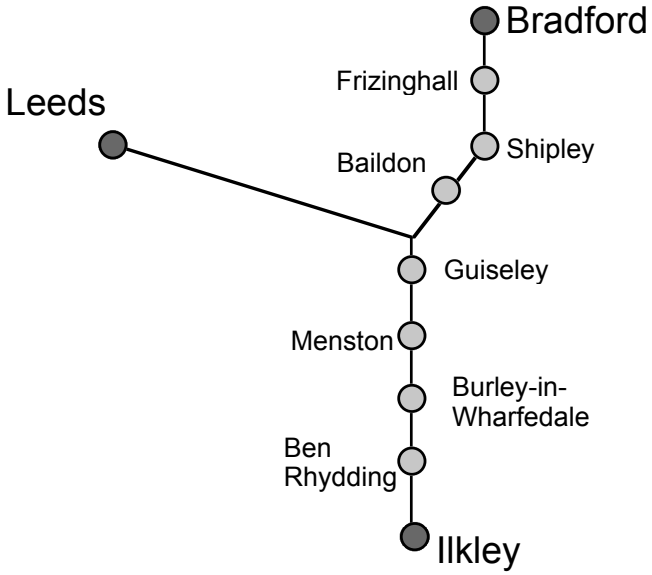
	The population of the world will rise but then fall.
Estimate A	The population of the world will rise and then become steady.
Estimate B	The population of the world will continue to increase but not as quickly as it has in the last 50 years.
	The population of the world will continue to increase more or less as it has in the last 50 years.

Data sheet

Trains

This diagram shows the train service on the Wharfedale line.

Trains go from Leeds to Ilkley and from Bradford to Ilkley.



This is part of the timetable for trains from Leeds and Bradford to Ilkley.

MetroTrain Wharfedale Line
Mondays to Saturdays

Leeds and Bradford to Ilkley

Leeds	d		1032		1102		1132		1202		1232
Bradford FS	d	1017		1047		1117		1147		1217	
Frizinghall	d	1020		1050		1120		1150		1220	
Shipley	d	1023		1053		1123		1153		1223	
Baildon	d	1026		1056		1126		1156		1226	
Guiseley	d	1032	1044	1102	1114	1132	1144	1202	1214	1232	1244
Menston	d	1035	1047	1105	1117	1135	1147	1205	1217	1235	1247
Burley-in-W.	d	1038	1050	1108	1120	1138	1150	1208	1220	1238	1250
BenRhydding	d	1041	1053	1111	1123	1141	1153	1211	1223	1241	1253
Ilkley	a	1047	1059	1117	1129	1147	1159	1217	1229	1247	1300

Leeds	d		1302		1332		1402		1432		1502
Bradford FS	d	1247		1317		1347		1417		1447	
Frizinghall	d	1250		1320		1350		1420		1450	
Shipley	d	1253		1323		1353		1423		1453	
Baildon	d	1256		1326		1356		1426		1456	
Guiseley	d	1302	1314	1332	1344	1402	1414	1432	1444	1502	1514
Menston	d	1305	1317	1335	1347	1405	1417	1435	1447	1505	1517
Burley-in-W	d	1308	1320	1338	1350	1408	1420	1438	1450	1508	1520
Ben Rhydding	d	1311	1323	1341	1353	1411	1423	1441	1453	1511	1523
Ilkley	a	1317	1329	1347	1359	1417	1429	1447	1501	1517	1529

This is part of the timetable for trains from Ilkley to Leeds and Bradford.

MetroTrain Wharfedale Line
Mondays to Saturdays

Ilkley to Leeds and Bradford

Ilkley	d	0951	1010	1021	1040	1051	1110	1121	1140	1151	1210
Ben Rhydding	d	0953	1012	1023	1042	1053	1112	1123	1142	1153	1212
Burley-in-W.	d	0959	1018	1029	1048	1059	1118	1129	1148	1159	1218
Menston	d	1002	1021	1032	1051	1102	1121	1132	1151	1202	1221
Guiseley	d	1005	1025	1035	1054	1105	1124	1135	1154	1205	1224
Baildon	d	1010		1040		1110		1140		1210	
Shipley	d	1014		1044		1114		1144		1214	
Frizinghall	d	1017		1047		1117		1147		1217	
Bradford FS	a	1023		1053		1123		1153		1223	
Leeds	a		1041		1108		1139		1208		1239

Ilkley	d	1221	1240	1251	1310	1321	1340	1351	1410	1421	1440
Ben Rhydding	d	1223	1242	1253	1312	1323	1342	1353	1412	1423	1442
Burley-in-W.	d	1229	1248	1259	1318	1329	1348	1359	1418	1429	1448
Menston	d	1232	1251	1302	1321	1332	1351	1402	1421	1432	1451
Guiseley	d	1235	1254	1305	1324	1335	1354	1405	1424	1435	1454
Baildon	d	1240		1310		1340		1410		1440	
Shipley	d	1244		1314		1344		1414		1444	
Frizinghall	d	1247		1317		1347		1417		1447	
Bradford FS	a	1253		1323		1353		1423		1453	
Leeds	a		1308		1338		1409		1439		1510

Questions Trains

1

There is a train from Bradford Forster Square to Ilkley at 11:17

What time is it due to arrive in Ilkley?

2

If you catch the 14:21 from Ilkley, how many minutes will it take to get to Menston?

3

How often is there a train from Leeds to Ilkley?

4

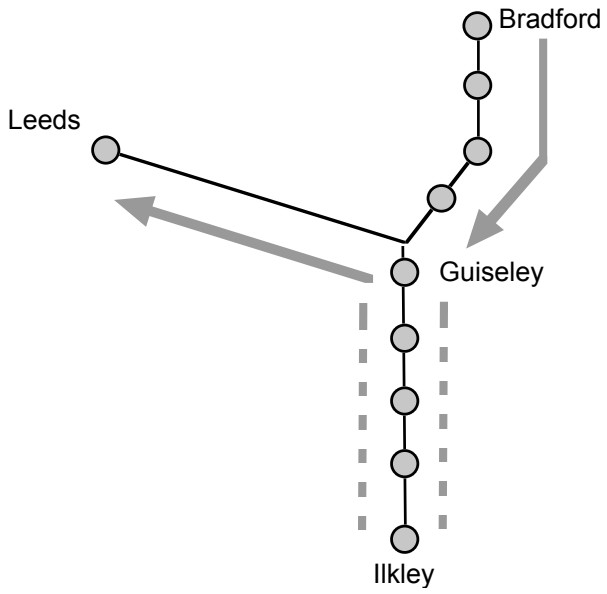
Sally travels from Bradford to Burley-in-Wharfedale.

She needs to arrive before 3 o'clock in the afternoon

What is the latest train she can catch from Bradford?

5

One way to get from Bradford to Leeds is to take the train from Bradford to Ilkley as far as Guiseley and then get on the Ilkley to Leeds train as it comes through Guiseley.



Dave catches the 10:47 train from Bradford to Guiseley.
He gets off at Guiseley and then waits to catch the next train to Leeds.

How many minutes does he have to wait in Guiseley?

Data Sheet Transport Issues

In 2004, the polling organisation Ipsos MORI carried out a survey of 2,102 adults (aged 15 and over) across Great Britain to investigate how people's views on various transport issues had changed. Some of the survey results are given below.

A. Which of the following modes of transport have you used in the last month?

Base	2003 (2,016) %	2004 (2,102) %	Change %
Car	89	84	-5
Bus	50	43	-7
Train	35	29	-6
Bicycle	18	19	+1
Motorbike	5	4	-1
None of these	1	4	+3
Don't know	1	3	+2

B. During peak times, how much of a problem would you say road congestion is in the area 5 miles around where you live? Is it…

	2003 %	2004 %	Change %
A very major problem	31	32	+1
A fairly major problem	41	38	-3
A minor problem	21	22	+1
No problem at all	5	6	+1
Don't know	3	2	-1

C. If the government were to invest extra money on transport, in which two or three of the following areas would you most like to see greater investment made?

	2000	2001	2002	2003	2004	Change ('00-'04)
	%	%	%	%	%	%
Improving road safety	34	34	33	33	31	-3
Reducing the cost of public transport	56	43	41	44	40	-16
Improving personal safety on public transport	19	16	17	17	16	-3
Road and pavement maintenance	35	33	35	38	34	-1
Building new roads in congestion 'hot spots'	35	29	33	34	34	-1
Improving train services	30	30	35	33	31	+1
Improving bus services	40	39	39	36	35	-5
Improving facilities for pedestrians and cyclists	n/a	20	17	20	21	n/a
Other	1	1	1	1	1	-
None of these	1	1	2	*	1	-
Don't know	2	2	2	2	2	-

D. Overall, how strongly do you support or oppose congestion charging in towns and cities?

Base:	2003 (2,016)	2004 (2,102)	Change
	%	%	%
Strongly support	10	11	+1
Tend to support	27	23	-4
Neither support nor oppose	13	13	-
Tend to oppose	19	20	+1
Strongly oppose	28	30	+2
Don't know	3	3	-

Figures have been rounded to the nearest percent.

Questions Transport Issues

1

How many people were surveyed in 2003?

_____

2

According to the survey, which mode of transport showed the largest percentage decrease in use between 2003 and 2004?

_____

3

Work out how many people in the 2004 survey thought road congestion in the 5 miles around where they live was either a very major or a fairly major problem. Give your answer to the nearest 100 people.

_____

4

In this survey an asterisk (*) has been used to indicate a value of less than 0.5 %, but greater than zero.

Estimate the largest number of people who could be represented by the asterisk in this survey.

_____

5

To help reduce congestion, motorists in London have to pay £8 to enter the central London Congestion Charging Zone.
This charge applies on weekdays between 7am and 6:00pm.

If a car is in the zone for the maximum amount of time that the charge applies, work out the average cost per hour of the congestion charge.
Give your answer rounded to the nearest penny.

6

Table D shows the opinions of the sample about congestion charging in towns and cities.

Describe how opinions about congestion charging have changed from 2003 to 2004

Data sheet Unusual measures

In science, engineering, business and especially the media, there are many examples of the use of unusual units to describe measurements. This is often done to give the story more impact and to give people a better sense of the actual size of the objects involved. Here are a few examples.

Length *Double-decker bus*

Newspapers will frequently refer to lengths in comparison to the length (8.4 metres) or height (4.4 metres) of a London Routemaster double-decker bus.

length 8.4m, height 4.4m

For example*:* *The Coast Redwood in California is the tallest tree in the world at 115m, the height of about 26 double-decker buses.*

Area *Belgium or Wales*

The area of Belgium is 30,528 km² and is often used, for example, in discussing the destruction of the Amazon Rainforest. In the United Kingdom, Wales, equal to 20,779 km², is used in phrases such as "an area the size of Wales" or "twice the area of Wales".

Belgium

area = 30,528 km²

Wales

area = 20,779 km²

For example: *The coastguard were searching an area of 3 million square kilometres, about 100 times the area of Belgium.*

Volume *Olympic-sized swimming pool*

One measure commonly used in the media in many countries is the Olympic-sized swimming pool. An Olympic-sized swimming pool holds about 2,500,000 litres.

volume = 2,500,000 litres

For example: *By 2010, there will be 10,000m^3 of nuclear waste in the country - enough to fill four Olympic size swimming pools*.

Questions Unusual measures

1

Clifton suspension bridge in Bristol is said to be the length of 26 double-decker buses.

Work out its approximate length in metres.

m

2

The tallest building in the UK is at Canary Wharf and is 235m high.

Work out how many double-deckers high it is.

3

The area of England is 130,410 km².

How many times the area of Wales is this?

4

Russia has the largest area of any country in the world.

Its area is approximately 559 times the area of Belgium.

How many times bigger is Russia compared to Wales?

5

The average UK household uses approximately 150 litres of water per day.

How long will it take to for this usage to be enough to fill an Olympic-sized swimming pool?

6

The state of New Mexico in the United States is approximately square.

New Mexico is shown shaded on the map.

It has an area equivalent to approximately 10 times the area of Belgium.

Work out the approximate length and width of New Mexico in kilometres.

7

The London Routemaster double-decker bus is 2.4 metres wide.

Someone suggests using the approximate volume of a Routemaster bus as a new unit for volume (assuming its shape is a cuboid).

How many of these are equivalent to the volume of an Olympic-sized swimming pool?
