THIS IS MATHS

Psychology

Psychology

The psychology of happiness.

When are you most happiest?

What makes you happy?

Volume of a spherical cap

The internet - How does it work?

Visit the website

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Welcome to This is Maths. If it's mathematical, we'll write about. We have a few underlying themes. In every issue we will include an article on the environment & sustainability and careers. Outside of that, anything could appear!

We have a website **www.thisismaths.co.uk** which we use as a vision board. Anyone can contribute to the magazine and if you do not make the final cut, you will be able to view your article on the website.

If you are a teacher and would like to get involved, please get in touch. For each issue there are differentiated lessons for the articles on careers, the environment and the main article on the front cover.

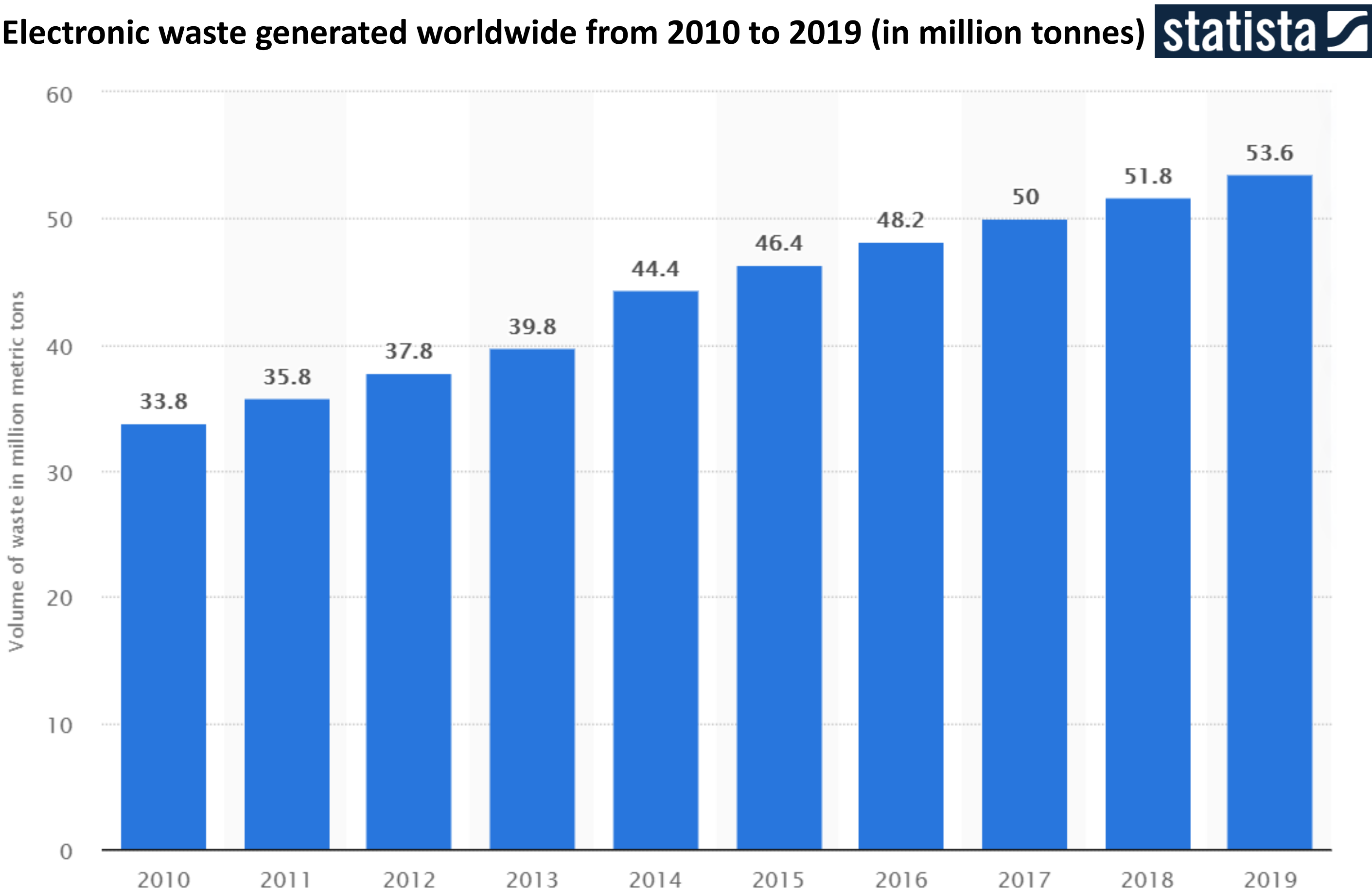
Happy reading and thank you to all those that have contributed.

Environment and sustainability

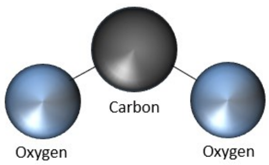
What is e-waste?

We change our gadgets almost as often as we buy new clothes. The seismic global shift to a remote working culture has seen a spike in demand for electronics. Electronic waste or e-waste, refers to any product with a battery or a plug. Mobile phones, notebooks, games consoles and refrigerators are all examples of e-waste. E-wastes are incinerated or buried in landfills where their toxins pollute our land, air, and water.

Electronic waste generated worldwide from 2010 to 2019 (in million tonnes)



50 million tonnes of e-waste is produced each year – the equivalent in weight to the total number of commercial aircraft ever built. Maybe an easier way to comprehend this figure is to consider the waste per person. **50 million tonnes** shared between the **≈7bn** people on earth is over **7kg** of e-waste each, though e-waste is concentrated in richer nations. People in northern Europe produced the most e-waste – **22.4kg per person** in 2019. Eastern Europeans only produced **50%** of this weight. Averages across Asia and Africa were much lower, at **5.6kg** and **2.5kg per person** respectively. The **50 million tonnes** could **double to 100 million tonnes** by 2050 according to the UN.

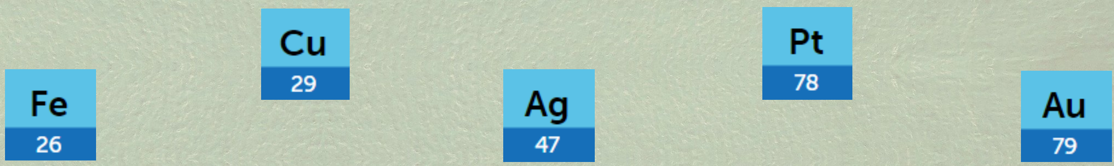


Environmental impact

Producing a computer along with its monitor takes at least **1.5 tonnes** of water, **22kg** of chemicals, and **240kg** of fossil fuels. E-waste can contain toxic or hazardous materials, such as mercury and lead. When discarded, these materials can be released into the land and can contaminate water supplies. Gases released from discarded fridges and air conditioning units were equivalent to **98 million tonnes** of atmospheric carbon dioxide in 2019.

What else is in e-waste?

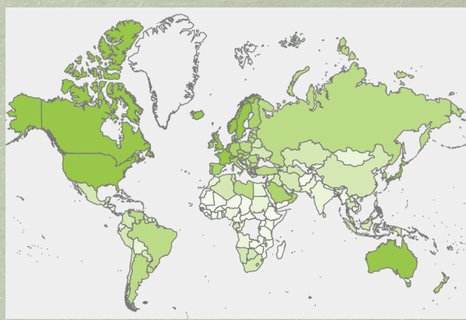
E-waste contains materials including copper, iron, gold, silver and platinum. As much as **7%** of the world's gold may currently be contained in e-waste, with **100 times** more gold in a tonne of e-waste than in a tonne of gold ore. According to the UN, **$10bn** worth of precious metals are dumped every year in the growing mountain of electronic waste.



Recycling

An average mobile phone user replaces their unit once every **18 months**. Libby Peake from the thinktank Green Alliance said: *"It doesn't have to be this way. Products could be designed to last, to be repaired and, just as crucially, to be upgraded."* By recycling **1 million** mobile phones, more than **15,000kg** of copper, **14kg** of palladium, **350kg** of silver, and **34kg** of gold can be recovered. Compared to disposal in landfills or by incinerators, reusing or recycling computers can create **296 more jobs** per year for every **10,000 tonnes** of computer waste processed. Recycling **1 million** laptops saves energy equivalent to the energy used by **3,600 homes** annually. At the moment, only **12.5%** of e-waste is recycled.

E-waste generated per capita



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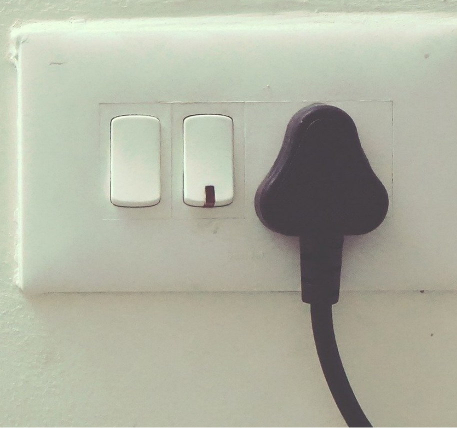


Hannah Fry

Hannah Fry studies the patterns in human behaviour. Areas of focus have been shopping, transport, urban crime, riots and terrorism.

Television

<u>Climate Change by Numbers</u>

Hannah Fry's very first documentary; Climate Change by Numbers aimed to cut through the oceans of information surrounding the subject and focus its attention on just three key figures.

The three numbers are:
0.85 degrees (the amount of warming the planet has undergone since 1880). **95%** (the degree of certainty climate scientists have that at least half the recent warming is man-made). **1 trillion tonnes** (the total amount of carbon we can afford to burn - ever - in order to stay below 'dangerous levels' of climate change)

<u>The Joy of Data</u>

This reveals what data is and how it is captured, stored, shared and made sense of.

In this documentary Fry looks at the phenomenon of wikipedia and philosophy. Clicking on the first lowercase link in the main text of a Wikipedia article, and then repeating the process for subsequent articles, usually ends up on the Philosophy article. As of 26th May 2011, 94.52% of all articles in Wikipedia lead eventually to the article Philosophy.

<u>BBC2 – City in the Sky</u>

"At any point in time there are a million people in the air - a city's worth of citizens in the sky. And the similarities with the city don't end there. These people need feeding, fuel, medical care and emergency response teams - just as we do on the ground. The logistics that go into the design of these systems require a surprising amount of mathematical optimisation, clever science and engineering. "

Radio Shows

BBC4 - The Curious Cases of Rutherford and Fry

BBC4 - Can Maths Combat Terrorism?

BBC1 - Music by Numbers

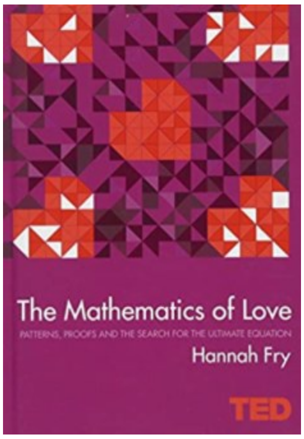
Ted Talk

In 2014 Fry gave a **TED talk** called 'The Mathematics of Love' which attracted thousands of views. Following the TED talk she published a book on the topic called *The Mathematics of Love: Patterns, Proofs, and the Search for the Ultimate Equation* in which Fry applies statistical and data-scientific models to dating, sex and marriage.

TED Ideas worth spreading

The mathematics of love | Hannah Fry
(2015)

Topics discussed in the lecture



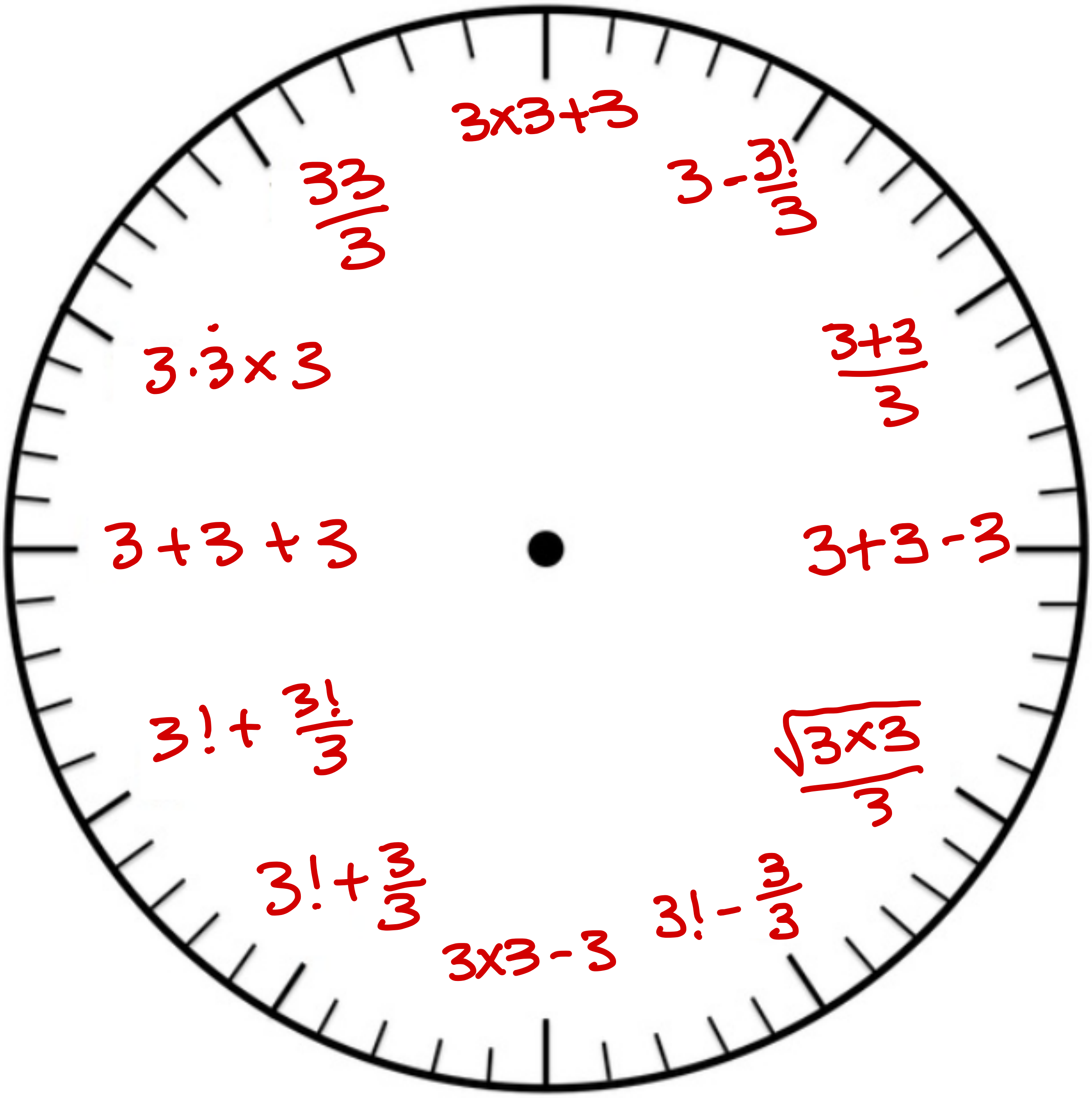
This formula produced by psychologist John Gottmann and mathematician James Murray predicts how positive or negative a wife and husband will be when they respond in the next turn of a conversation. The most successful couples are those that allow each other to complain and don't let trivial problems build up.

One mathematical trick to maximise your chances of finding long-term love is the "37 per cent rule". Basically, set aside 100 people you're interested in, swipe left on the first 37, and then choose the next person you come across that you think beats all the previous ones.

Quote

"An arguing couple spiralling into negativity and teetering on the brink of divorce is actually mathematically equivalent to the beginning of a nuclear war."

Three 3s



Puzzle – Using exactly three 3s each time, make all the numbers (1 to 12) on a clockface. The 3 can be used to represent different place values, powers and roots, and factorials. Any operation or maths notation can be used.

Example:

$$\sqrt[3]{(3)^3} = 3\ o'clock$$

Factorial - The product of a number and the integers preceding it.

3 factorial = 3! = 3 x 2 x 1 = **6**

Interview - Firefighter

Vital Statistics

Hours: 35 - 40 per week

Shift work which can include unsocial hours.

Starting salary:

Usually £22,000 - £30,000

Fires and fire fatalities have dropped significantly in the UK over the past 10 years.

Job title: Firefighter

Employer: Oxfordshire Fire and Rescue Service

Hours: 74 hours on call per week.

How long have you been practising? 6 years.

In your current role, what do you spend your time doing?
I put out fires, conduct emergency driving and oversee water, animal and person rescues or rescue people from heights. I sometimes have to remove bodies of the deceased and manage road traffic collisions.

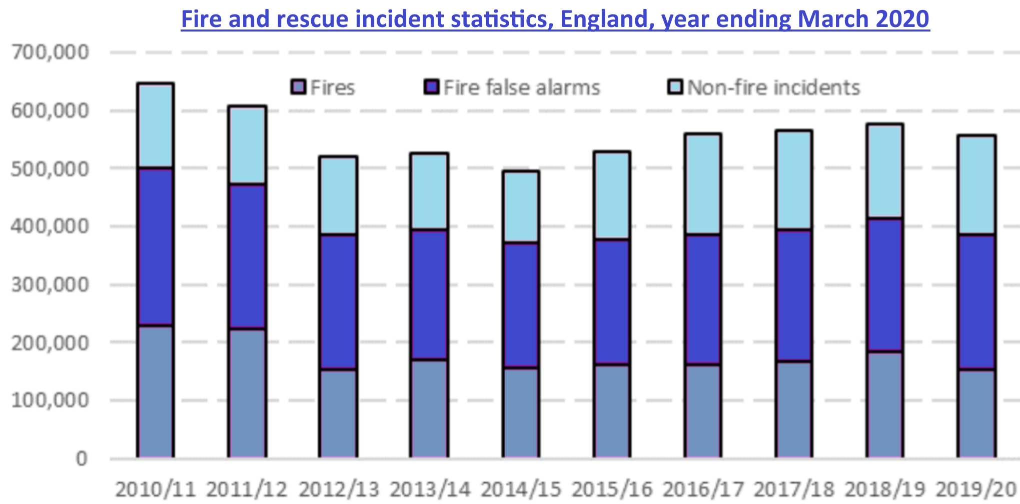
What's it like working in your role? What does a typical day look like?
Typically, most incidents tend to be RTC (road traffic collisions) or accidents on the highway. Generally the response depends on the crew; it's 1 driver and 1 firefighter in charge and then a minimum of 2 people in the back, so 4 people minimum and the maximum is 6. If I'm driving, I'd tend to stay on pump and radio message between incident ground and control office and other officers to relay messages and keep notes. If there's another person at the pump, I'll come off and run out hoses or get the cutting equipment out. I can also do first aid so that I can assist ambulance crews if there's minimal aid on site.

After that, we clear the road so it's usable again. Depending on the scene, sometimes we can't touch anything, for example if it requires crime scene photos, so we stay until the police are satisfied and then we can clean away the debris.

For a fire, I'll assess the scene or assess how people need to be rescued. You'll look at the condition of the casualty and consider the first aid needs of people or get on with rescuing.

When you go to an incident involving fire with persons reported, you'll have a BA crew (team lead and second) and go in groups of two. You'll be given a brief with basic instructions of which way to go through the building (left or right hand search) if you know where the casualty is, we'll head there and deal with hazards on the way like collapsing parts of the building. There could be an opening or window so people can walk down or be carried down, or if not, we'll take them the way we came in.

Recently I've been working in traumatic body recovery. This involves two crew members going out in an unmarked van to go to a specified area to pick up the deceased, place the body in a bag with tags and then send it to hospital. I am currently the only female to help with that, it's not for everyone.



FRSs attended 557,299 incidents in 2019/20. This was a 3% decrease compared with the previous year. Of these incidents, there were 153,957 fires. This was a 16% decrease compared with the previous year with falls in all types of fires.

Are there any specific qualifications you are required to have in your field?
There's two weeks of initial training - different elements from height to strength of being able to pick up ladders at certain angles.

What's your favourite part of your job?
Actually driving the fire engine. I really enjoy driving. Also, the variability, the diversity of always going to different places is nice and the training keeps it new and interesting. For example, we get to go to different buildings like stately homes, all with different rooms and small corridors.

I enjoy that I have a good crew to work with, you have a laugh, you know how everyone works. We have great rapport.

What were your favourite subjects at school?
Science, IT, Drama.

What did you want to be as a child when you 'grew up'?
A fire fighter!

Tell us about your career journey - how did you become a firefighter?
From a young age I was clear what I wanted to do, I never fitted the 'girl' mould. I did go through a period of feeling like I couldn't be a firefighter because I was a female - it was very male-oriented when I was growing up and they had height restrictions.

But, when I got older, I knew the guys at the local fire station and they said that I could join and that I should come and see what it's like. I thought to myself, if I try and don't get in, at least I know I tried. And I got in!

After that I enrolled for the fire service and was put on various courses to increase my knowledge and experience within different areas, and here I am!

Can you remember what your parents reactions were to that aspiration?
They knew it would be a good fit.

Has anyone ever been surprised when you told them that you were a Fire Fighter?
I usually get raised eyebrows as I'm 5ft 3in tall, so people are surprised. People usually assume I work in the office. There are other female firefighters I know but I'm the only one on my station. People are especially surprised when they find out I drive the engine, and then they say "oh my gosh, that's so cool".

Are there any challenges or benefits working as an Fire Fighter?
It does test you when it's hot and you have all your kit on and are squeezing through small spaces but it just challenges you and your mindset. I like a challenge!

What are 3 things you have to like to do your job?
Hard work, working as part of a team and problem solving.

You have to have an open mind and be someone who doesn't get stressed too easily. You always have your crew to fall back on and help you but being able to think outside the box can help.

What advice would you give to young people who are aspiring to be in your role, or who maybe haven't even considered it as a career?
Go and try it and see if you like it - one day you may not have that opportunity and you may well regret it. Just give it a go. ■

Exam question

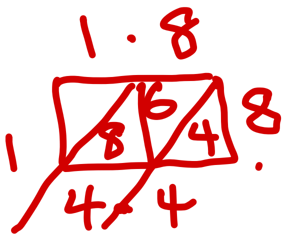
A company uses this formula to work out the cost, **£*A***, of a taxi ride.

$$A = 4 + 1.8m + b$$

£4 is a fixed charge
m is the number of miles travelled
£*b* is a charge for booking online

(a) Clare books a taxi online and travels **8 miles**.
She pays **£20** altogether.

How much is the charge for booking online?



(3)

$20 = 4 + 1.8 \times 8 + b$

$20 = 4 + 14.4 + b$

$20 = 18.4 + b$

$b = £1.60$

(b) A different company
has a fixed charge of **£3**
charges **£1.90 per mile**
has no charge for booking online.

Write a formula for the cost, **£*C***, of a taxi ride with this company.

(1)

$C = 3 + 1.9m$

(Total 4 marks)

Psychology

The psychology of happiness

What makes us happy? How important is money? At what time of our life are we the happiest? Can we control our happiness? Where is the happiest place in the world? How would you measure a persons happiness? How can you compare the happiness of different nations?

This article will probably generate more questions than it answers. Visit **www.thisismaths.co.uk/literacy** for references and further reading.

Happiness

People who regularly spend about a **quarter** of their hours each day with family and friends are **12 times** as likely to report feeling joyful rather than feeling stressed or anxious. A 2012 survey of thousands of British adults found that having regular contact with **10 or more friends** had a significant impact on an individual's happiness level. Making more money makes us happier - up to a certain extent. A recent study from Princeton University found that once your salary hits **$75,000 (≈ £55,000)**, making more money won't have much of an effect on your day-to-day happiness. When a friend who lives less than a mile from you becomes happy, your chance of getting happier increases by **25%.** Various studies and surveys have found **33, 55** and the **70s** to be the happiest age.

30-something birthday scored big because it's a time when people tend to have energy, wisdom, and money all at once. In another study, researchers found that people in their mid-fifties tend to smile the most. And in a third study researchers found that people's happiness is lowest around **44** then starts to build gradually until it peaks in the **70s**. It's an oversimplification to say that every single person can control exactly **40%** of their happiness, but scientists have determined that your happiness level is a result of a complex interaction of genes, behaviours, and life circumstances. ■

For references and further reading visit, **www.thisimaths.co.uk**

Click on the "Literacy" page to see more presentations on happiness.

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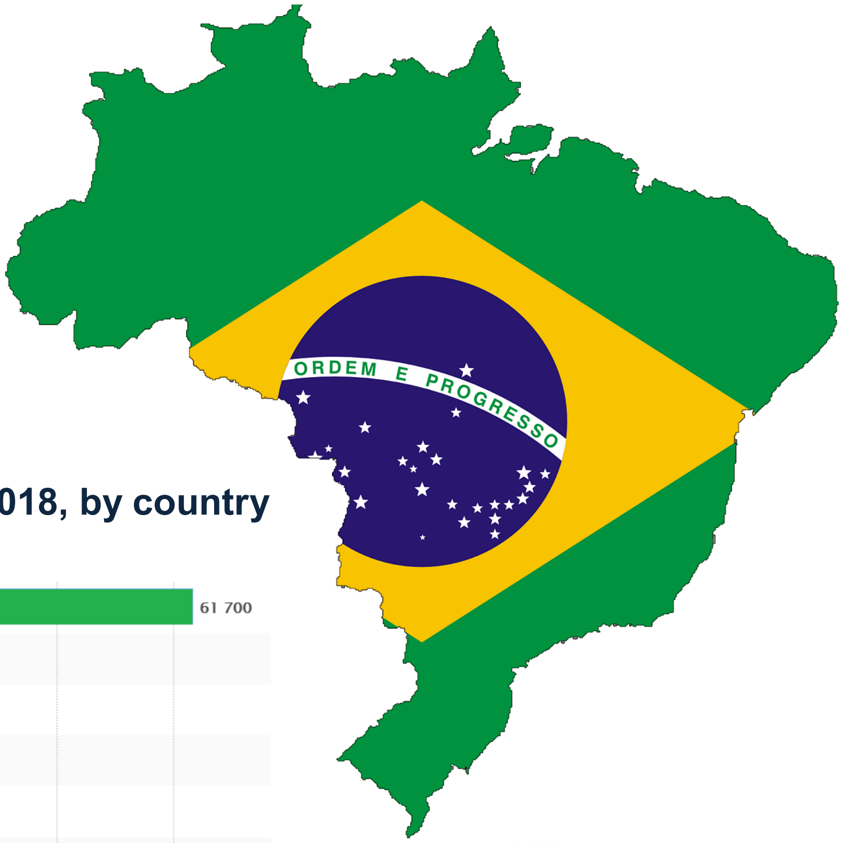
Created by a Priory school student.

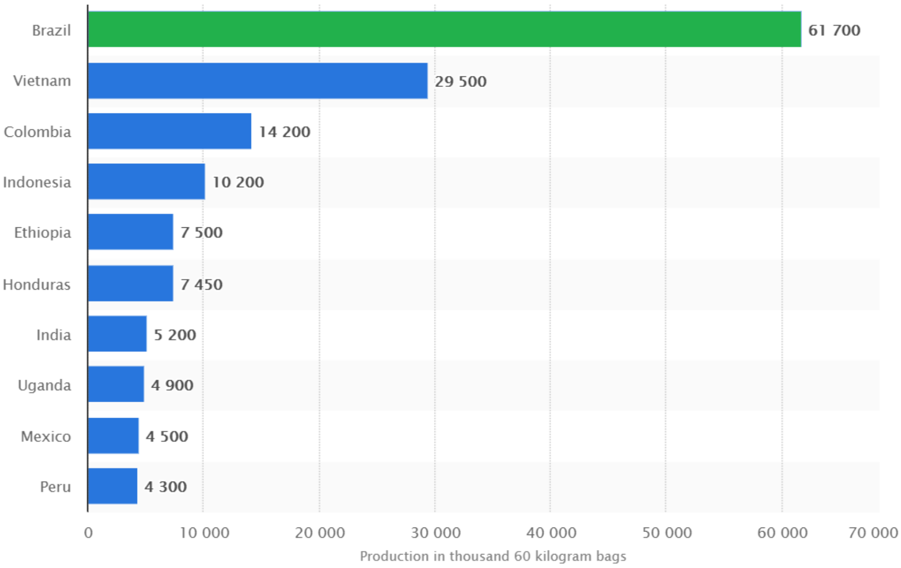
BRAZIL

Above: Christ the Redeemer above Rio De Janeiro.

Right: The Brazilian flag in the shape of the country. "ORDEM E PROGRESSO" means order and progress.



Coffee production worldwide in 2018, by country
(in 1,000 60 kilogram bags)



Graph source:

statista

Brazil covers an area of **8,515,767 km^2** and has a population of over **209,000,000**.

It is the largest country in South America and the **5th largest** country in the world.

The country produces over **30%** of the world's coffee.

The longest border is shared with Bolivia and is **3,400 km** long.

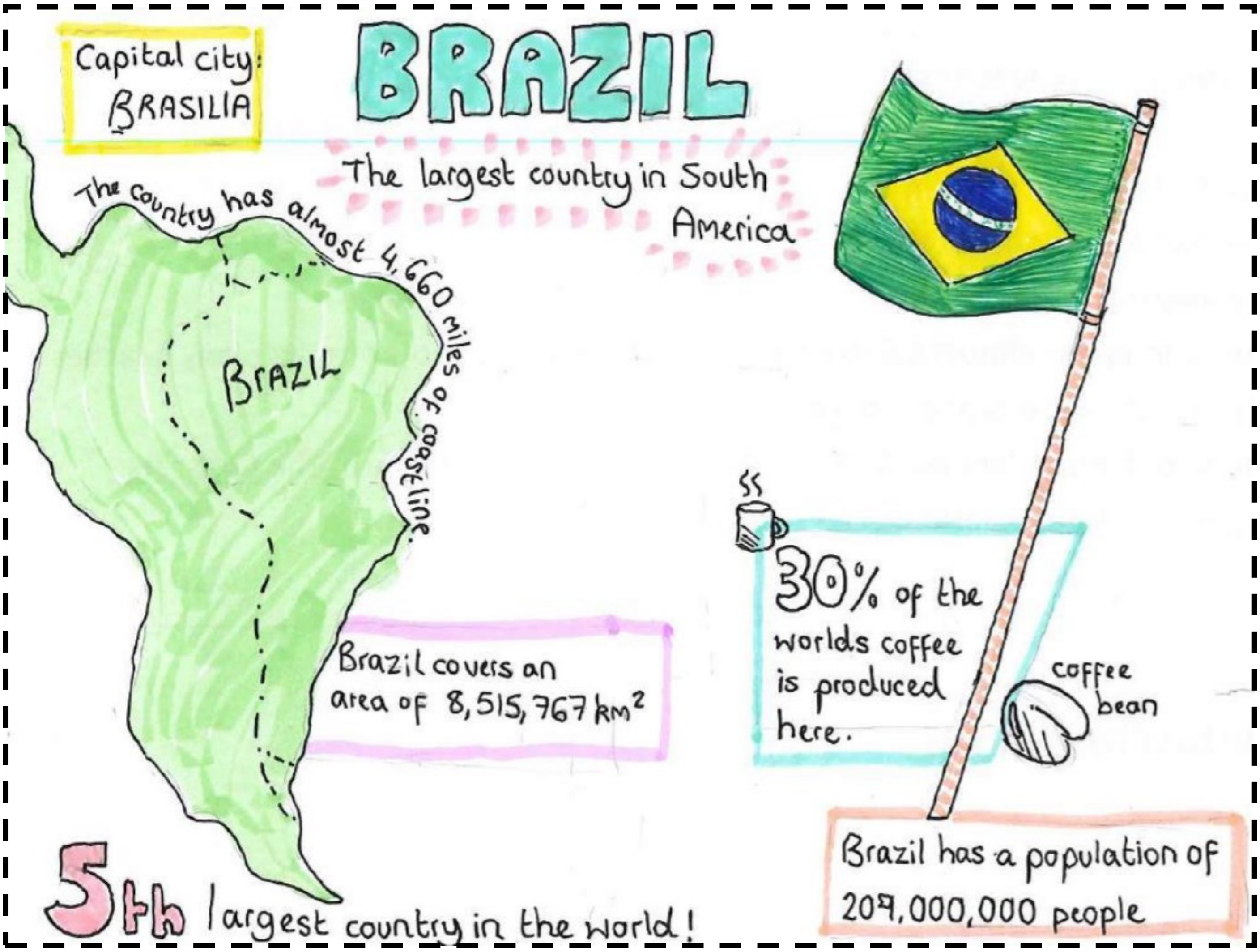
The country has almost **4,660 miles** of coastline and is known for its many beaches.

Brazil's capital city is Brasilia.

Life expectancy in Brazil is **76 years**.

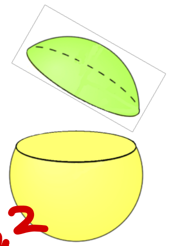
The most famous landmark of Brazil is located in Rio de Janeiro. The Christ the Redeemer statue overlooks the city and Sugarloaf mountain.

Created by a Priory school student.



Spherical cap

Hold on! This is difficult. The questions are at a level of higher GCSE and above. In the GCSE maths exam you will need to know the formula for the volume of a sphere. You do not need to know the formula for a spherical cap, but you will need to be able to substitute into a formula, rearrange a formula, and problem solve. If you are in year 7 or 8, or doing the foundation GCSE but are willing to give this a go then caps off to you.



$6V = \pi h(3a^2 + h^2)$

$\frac{6V}{\pi h} = 3a^2 + h^2$

$\frac{6V}{\pi h} - h^2 = 3a^2$

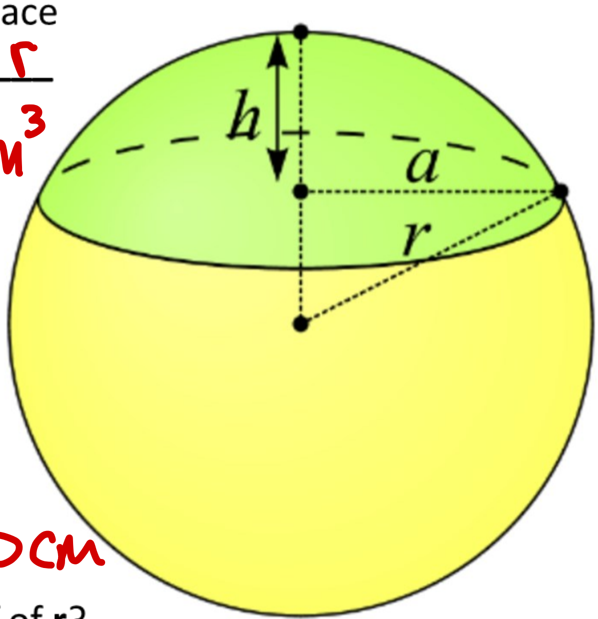
$\frac{6V}{3\pi h} - \frac{h^2}{3} = a^2$

$$V_{sphere} = \frac{4}{3}\pi r^3$$

$$V_{cap} = \frac{1}{6}\pi h(3a^2 + h^2)$$

1 Calculate the volume of the sphere when **r = 4cm**. $\frac{4}{3} \times \pi \times 4^3 = 268cm^3$

2 Place the letters **a**, **h** and **r** in the blank space so they are in order of length. h < a < r



3 Calculate the volume of the cap when **a = 5cm** and **h = 2cm**. $= 83cm^3$

$V = \frac{1}{6} \times \pi \times 2 \times (3 \times 5^2 + 2^2)$

4 Rearrange V_{cap} to make **a** the subject.

$a = \sqrt{\frac{6V}{3\pi h} - \frac{h^2}{3}}$

5 Calculate the length of **a** when **h = 10cm** and **V = 4058cm²**.

$a = 50cm$

6 What is the ratio of **r** and **a** when **h** is half of **r**?
Give your answer in the form r : $\sqrt{a}$

$r^2 = a^2 + (0.5r)^2$

$r^2 = a^2 + 0.25r^2$

$0.75r^2 = a^2$

$3r^2 = 4a^2$

$\sqrt{3}r = 2a$

$2 : \sqrt{3}$

The Internet - How does it work?

Today, over half the global population use the Internet. We rely on it for everything from watching videos to teaching students remotely. But how does it work?

Back in the old days, when computers were text-only, buildings contained large mainframes with a single wire going to each terminal. Employees would use these to work. However, this system was inefficient, because every person needed their own cable linking them to the computer. This had two effects: firstly, it was difficult to manage the cables. If someone new joined the company and needed a terminal, they would have to route the wire either under floors or in walls. Secondly, if someone outside the building needed to access the computer, a physical cable would have to be sent to the other person. This was difficult, as you might expect.

Another problem is that networks sent messages in one go: if anything stopped even a single bit, the entire message would be unreadable. In 1965, Donald Davies at the UK's National Physical Laboratory (NPL) invented *packet switching*. This is a system whereby the message is put into packets, which can take any route possible to the destination, instead of going via one wire. This meant that physical problems would not affect transmission.

These two factors led, in 1969, to the creation of the US Department of Defense's ARPANET. This was a system to link military and academic institutions in America, from universities such as Stanford, Harvard and Berkeley to places like the Pentagon. ARPANET enabled professors and government employees to talk to each other across the US. There was even a cable in the Atlantic connecting London to ARPANET. Since this connected multiple networks it was dubbed an example of an *internetwork*, or internet for short.

Back in the UK, in 1967, researchers at the NPL created an internetwork to connect the various disciplinary departments' networks. SERCnet was created to link research and education establishments. This became JANET, which is still in use today. In France, the CYCLADES system (1973) used new methods to create a much simplified model.

The next step in the history of the Internet was the International Packet-Switched Service (IPSS). This was initially a collaboration between the British Post Office and two US companies to link networks in the US and across Europe. By 1981, the IPSS had grown to include Canada, Hong Kong and Australia. By the 1990s, it covered almost the whole world.

In 1973, Robert Kahn of ARPANET and Vinton Cerf of Stanford University collaborated to create a system to enable communication between networks using different protocols. Out of this collaboration came TCP and IP, both still used today. Under IP, every computer has an address which can be used to send data to it. The network itself takes care of ensuring that data goes to the right person. TCP is a system for arranging packets so that they can be compiled again on the destination computer.

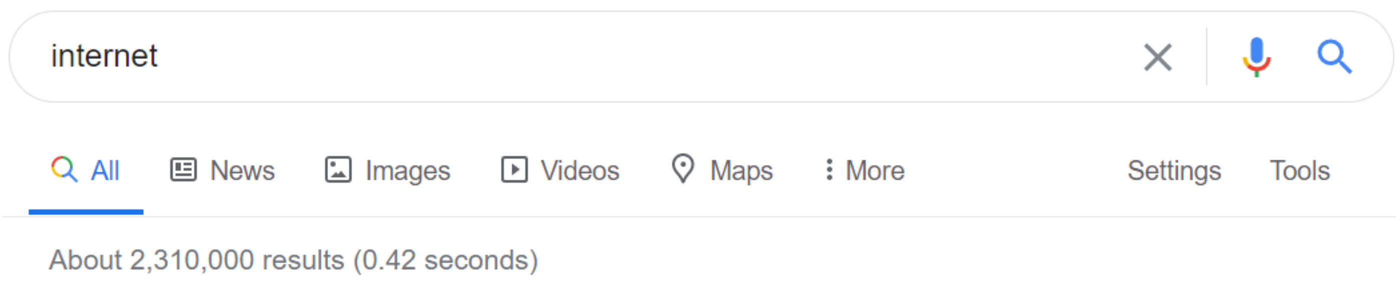
By the 1970s, it had become difficult to ensure that who you were talking to was who you thought it was. As a solution, maths came to the rescue with RSA (Rivest-Shamir-Adleman). This was a system whereby the way something was *en*crypted was different to the way something was *de*crypted. This enabled secure communication, and is widely used today.

In 1989 CERN opened their intranet to the rest of Europe. This effectively meant that the whole of Europe and North America were linked, as were parts of Australia and Asia. From there, it didn't take long before the World Wide Web took off, and communication between opposite sides of the world was achieved.

So how does this help us understand the modern internet? Well, today's system is a precarious edifice built on old technology: most of the ideas used are at this point 30-50 years old. As an example, let's see what happens when I ask my computer to go to wikipedia.org. Firstly, my computer broadcasts that via radio waves to my house's router. This sends it on copper wires and/or fibre optic cables to an exchange which routes it to my Internet Service Provider (ISP). This sends that to a Domain Name Server (DNS, invented in 1985) which tells me that I need to go to the IP address (1977) 91.362.174.192. This comes back to my computer, which sends a request once more to my ISP via the exchange. The ISP sends this request via TCP (1977) and HTTPS (1989 and 1994) to that IP address. An exchange of numbers proceeds (one that was invented in 1977 and made part of regulations in 1995 and later in 1999). This ensures that both I and the server are who we say they are. Then, the server sends content in HTML, CSS and Javascript formats (1990, 1996 and 1995 respectively) to my computer. This then renders it in my web browser (1990). And that's only for a web page. It gets more confusing quickly when designers of programs come up with their own special protocol for their app.

The Internet is like a pyramid of ideas, where the oldest ideas make up the bulk of the structure. If it weren't for key people like Tim Berners-Lee, Claude Shannon and Joseph Licklider, we wouldn't have the Internet as we know it today. ■

Written by a Priory school student.



Type "Internet" into google and it comes back with **4,870,000,000** results in just over half a second, **0.51 seconds** to be exact. You can filter these results by clicking on the tool button. I filtered it to "Past hour" and the results were reduced down to **2,310,000** in **0.42 seconds.**

1. What is **4,870,000,000** in standard form? 4.87×10^9
2. What unit of time does the **2** represent in **0.42 seconds**? $\frac{2}{100}$ of a second
3. What is **2,310,000 ÷ 0.42**? **Put the calculator down!** 5,500,000 — $\frac{231,000,000}{42}$ → $\frac{115,500,000}{21}$ → 21) 115500000 = 5500000
4. What single word has the highest number of results?
5. Are there words with a single result?

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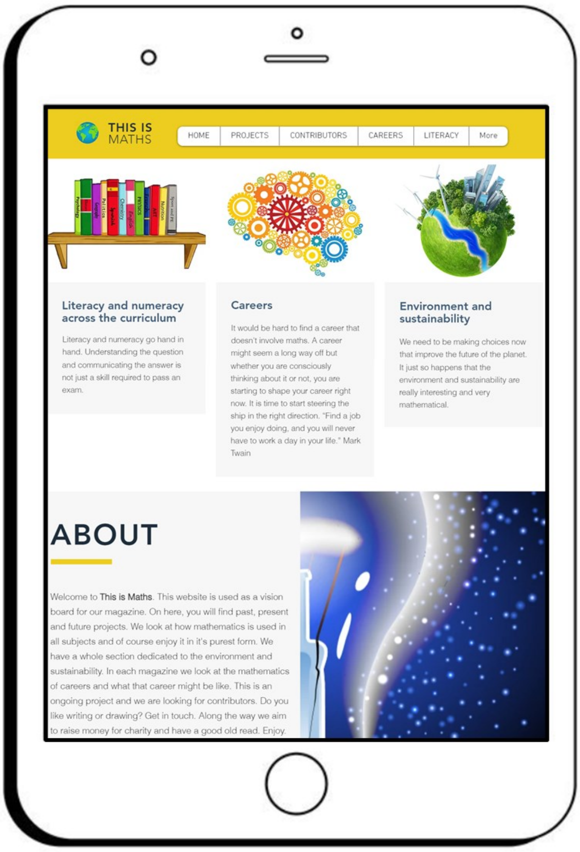
Website



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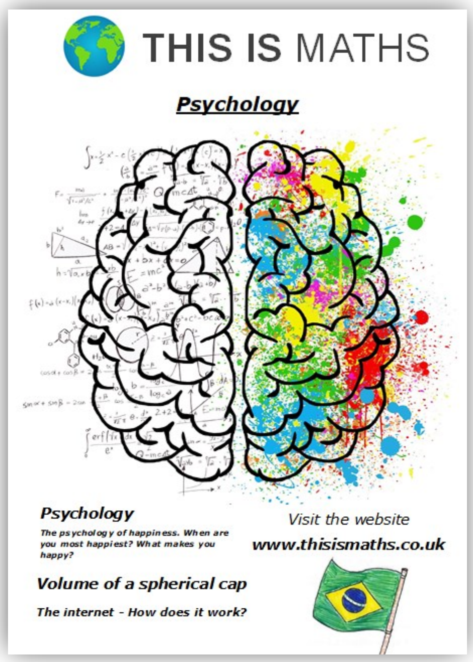


Next issue - March

Thank you to everyone who has contributed.

MATHS QUESTIONS

1 $365 + 36.5 + 3.65 =$ 405.15

2 $685 - 68.5 - 6.85 =$ 609.65

3 $239 \times 23.9 =$ 5712.1

4 $\frac{1}{400} + \frac{1}{40} + \frac{1}{4} =$ $\frac{1}{400} + \frac{10}{400} + \frac{100}{400} = \frac{111}{400}$

5 $0.2 + 0.3 \times 0.4 - 0.5 =$ $0.22 - 0.5 = -0.28$

6 $10 \times 9 \times 8 \times 7 \ldots 0 \ldots -7 \times -8 \times -10 =$ 0

7 $6! =$ $6 \times 5 \times 4 \times 3 \times 2 \times 1 = 720$

8 Find area of a rectangle with a length of **5m** and a width of **5cm.**

$2500\,cm^2$ or $0.25\,m^2$

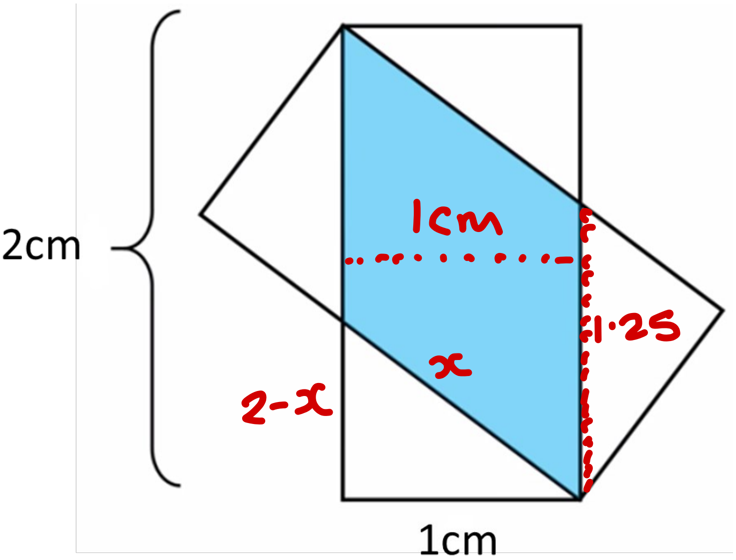
9 What is the height of a triangle that has an area of $2m^2$ and a base of 40cm?

$\frac{0.4 \times h}{2} = 2$

$0.4 \times h = 4$

$h = 10m.$

10 **Difficult!!** Two congruent rectangles overlap.
Find the area of the shaded parallelogram.



$(2-x)^2 + 1^2 = x^2$

$4 - 4x + x^2 + 1 = x^2$

$4x = 5$

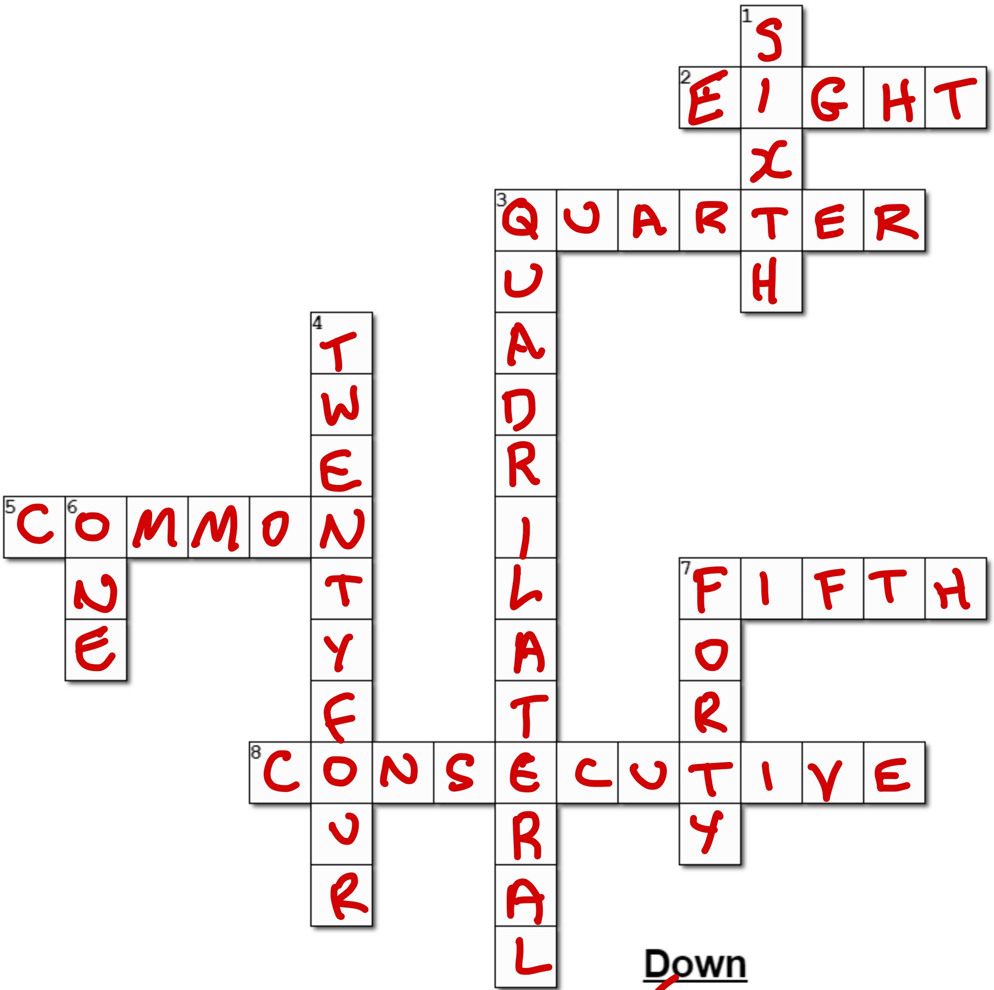
$x = 1.25$

Parallelogram → A = b×h

Area = 1×1.25

$= 1.25\,cm^2$

Crossword



Across

2. The difference between 6 and -2
3. 15 minutes
5. H _ F and L _ M
7. 20% as a fraction
8. Next to, in a row

Down

1. Half of a third
3. Four sided shape
4. Add all the factors of 15
6. The mean of -3.5, 3 and 3.5
7. The product of 5 and 8

Sudoku

6			2			5		
				8	7			6
	9				1	4	2	8
7	8				4	2	3	9
				7				
3	4	5	9				8	7
2	6	3	8				1	
4			7	1				
		1			6			3

Knight's tour

*Check your answers at **www.thisismaths.co.uk***