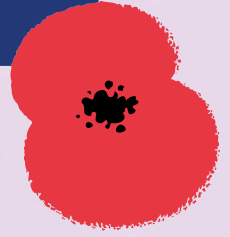


THE ROYAL BRITISH
LEGION



WWI:

Science and Innovation

KS3 / LESSONS 1-5 WORKSHEETS

IN ASSOCIATION WITH

National
Literacy
Trust

Changing life stories

Harry Brearley



Harry Brearley was born on 18 February 1871 in Sheffield. Like many children who grew up in the city, Harry was the son of a steelworker. When he left school at the age of twelve (leaving school at an early age to get a job was not uncommon in this age) he became a labourer at his father's steelworks. In later years he would be promoted to the post of general assistant in the company's chemical laboratory, where metals were turned into useful parts.

Harry worked hard at the lab but also studied at home and in evening classes, learning how to specialize in steel production techniques and chemical analysis. By his early thirties Harry had earned a good reputation in the industry.

Industrial change

All through the 19th century, Europe had seen a massive industrial transformation which helped to bring about many new scientific inventions. Developments in metallurgy (the study of metals), chemistry and electricity led to new forms of explosives, made firearms more reliable and also made communication by telegraph possible.

It was in 1908, when two of Sheffield's two biggest steelworks decided to jointly launch a new research laboratory, that Harry was asked to lead on the project. He went on to join Brown Bayley's Steel Works (also in Sheffield) and he became a director of the firm in 1925.

The science of war

Britain began manufacturing large quantities of weapons before WW1, but there was a problem when they were used in battle – the barrels of the guns eroded. As a prominent Metallurgist, Harry began researching new steels which would not erode at high temperatures. He tried adding extra chromium to the steel to see if this would help preserve the barrel casing for longer.

The accidental discovery

When at the testing stage, he discovered completely by accident that this new combination of traditional carbon steel and chromium was very resistant to chemical attack and he immediately named it 'rustless steel'.

LESSON 1: WORKSHEET

Being from Sheffield, 'The Steel City', Harry saw the potential for the new metal to be used in cutlery and household utensils. Until now, household cutlery had been made from other metals, including silver.

As well as making cutlery quite expensive, it also meant that all food that was eaten had an odd taste of metal that came with it.

Today you'll find lots of things around you made from stainless steel, like kitchen sinks, pots and pans, tools, medical equipment and even artwork – all because of Harry's accidental invention.

Charity

In 1941 Harry Brearley created a charity called The Freshgate Trust Foundation. The Foundation is a grant making charity operating in Sheffield and South Yorkshire which aims to help out people from 'modest' circumstances like himself to experience travel, education, the arts and music.



QUESTIONS

1. Where was Harry Brearley born? (1)
2. What was Harry's first job after leaving school? (1)
3. How do you think Harry became an industry expert in steel working? (2)
4. What is metallurgy? (1)
5. What did Harry try adding to the steel to improve it? (1)

EXTENSION QUESTIONS

6. What was the name of the Steel Works Harry became a director of? (1)
7. What was the original name for Harry's invention? (1)
8. Name two household items that stainless steel can now be used for. (2)
9. What is the name of the trust Harry set up after the war? (1)
10. What are the activities the trust wishes to help people with? Name at least two. (2)

Serendipity

Bad news for the snack you were saving
I hope it's a liquid you're craving.

That magnetron cooks
Everything by the book
Now we can all get microwaving!

Don't throw your attempts out the window
Your wall cleaner works don't you know –
Not to get spic and span,
It works better man,
As a fun, sticky, smelly Play Doh!

I'd like to invest in your plane goo.
Have a look at what this stuff can do!
Please share with the group,
Your bizarre looking gloop,
You've discovered a Superglue!

That spring is too wobbly and kinky
So knock it away with your pinky.
But do not despair,
As my friend you have there,
The world's greatest plaything - the slinky!

Your doggy my friend is a hero!
Grabbing nature while out on the go,
As nature got stuck,
Oh my friend you're in luck,
A fur problem known as Velcro!

PAUL JENKINS

INVENTION: MICROWAVE OVEN

DISCOVERED BY: PERCY L SPENCER

HOW DISCOVERED: Spencer was using a Magnetron in his lab and realized the radiation had melted a chocolate bar he had in his pocket. The Microwave was born!



INVENTION PLAY DOH

DISCOVERED BY: KUTOL PRODUCTS

HOW DISCOVERED: Kutol was a cleaning company that was looking for a way to clean wallpaper and invented a squishy ball to do so. When children at the company started playing with it they realized they could add colouring to quickly make it a very popular toy!

INVENTION: SLINKY TOY

DISCOVERED BY: RICHARD JAMES

HOW DISCOVERED: James was a Navy Engineer trying to use springs for sensitive instruments when he accidentally knocked one over. Instead of crashing down to the floor, it gracefully sprang downward and the slinky toy was born!

INVENTION SUPERGLUE

DISCOVERED BY: HARRY COOVER

HOW DISCOVERED: Coover was trying to use a substance he created to coat aircraft canopies. Annoyingly it stuck to absolutely everything making it useless for his job – but perfect for fixing everyday items that needed sticking together!

INVENTION VELCRO

DISCOVERED BY: GEORGE DE MESTRAL

HOW DISCOVERED: Swiss engineer George De Mestral was out walking his dog when he noticed that the small bits of plants were sticking to his dogs fur (and to his socks!) – he realized that the tiny 'hooks' on the seeds were the reason for it and Velcro was born!



LESSON 2: WORKSHEET

Stainless Steel

Teabags 

Zips

Vegetarian
Sausages

Daylight
Savings Time

Pilot
Communications

Blood Banks

Sanitary
Towels

Tissues 

Documentaries

BBC NEWS - 10 INVENTIONS THAT OWE THEIR SUCCESS TO WORLD WAR ONE

Sanitary towels...

A revolutionary new material called Cellucotton had been invented before WW1, but nobody had realised just how useful it would prove to be. The company who invented, Kimberley Clark, had been searching for a material which was more absorbent than cotton, but much cheaper to make in their factories.

They took it back to the US and trademarked it. Then, once the US entered the war in 1917, they started using Cellucotton to make the wadding for bandages at a rate of 380-500ft per minute.

But Red Cross nurses on the battlefield realised its benefits for their own personal, hygienic use, and it was this unofficial use that ultimately made the company's fortune.

"The end of the war in 1918 meant that the army and the Red Cross stopped ordering Cellucotton bandages. This meant that Kimberley Clark had a revolutionary material, but nothing to use it for, until they realised that the Red Cross nurses had already given Cellucotton a new use.

"After two years of intensive study, experimentation and market testing, the K-C team created a sanitary napkin made from Cellucotton and fine gauze, and in 1920, in a little wooden shed in Neenah, Wisconsin, female employees began turning out the product by hand," the company says.

The new product, called Kotex (short for "cotton texture"), was sold to the public in October 1920, less than two years after the Armistice.

... and paper hankies

Selling sanitary pads was not easy, as many women felt self-conscious buying them in shops in view of other people, especially men. Although more women began buying them, it was not enough to cover the cost of making them, so Kimberley Clark looked for another solution.

In the early 1920s, CA "Bert" Fourness conceived the idea of ironing cellulose material to make a smooth and soft tissue. With much experimentation, facial tissue was born in 1924, with the name "Kleenex".



© Antiques & Collectables / Alamy Stock Photo

BBC NEWS - 10 INVENTIONS THAT OWE THEIR SUCCESS TO WORLD WAR ONE

Sun lamp

In the winter of 1918, it's estimated that half of all children in Berlin were suffering from rickets - a condition whereby bones become soft and deformed. At the time, the exact cause was not known, although it was associated with poverty.

A doctor in the city - Kurt Huldshinsky - noticed that his patients were very pale. He decided to conduct an experiment on four of them, including one known today only as Arthur, who was three years old. He put the four of them under mercury-quartz lamps which emitted ultraviolet light.

As the treatment continued, Huldshinsky noticed that the bones of his young patients were getting stronger. In May 1919, when the sun of summer arrived, he had them sit on the terrace in the sun. The results of his experiment, when published, were greeted with great enthusiasm. Children around Germany were brought before the lights. In Dresden, the child welfare services had the city's street lights dismantled to be used for treating children.

Researchers later found that Vitamin D is necessary to build up the bones with calcium and this process is triggered by ultraviolet light. The undernourishment brought on by war produced the knowledge to cure the ailment.

Daylight saving time

The idea of putting the clocks forward in spring and back in autumn was not new when WW1 broke out. Benjamin Franklin had suggested it in a letter to The Journal of Paris in 1784. Candles were wasted in the evenings of summer because the sun set before human beings went to bed, he said, and sunshine was wasted at the beginning of the day because the sun rose while they still slept. Similar proposals were made in New Zealand in 1895 and in the UK in 1909, but without concrete results.

It was WW1 that secured the change. Faced with acute shortages of coal, the German authorities decreed that on 30 April 1916, the clocks should move forward from 23:00 to midnight, so giving an extra hour of daylight in the evenings. What started in Germany as a means to save coal for heating and light quickly spread to other countries.

Britain began three weeks later on 21 May 1916. Other European countries followed. On 19 March 1918, the US Congress established several time zones and made daylight saving time official from 31 March for the remainder of WW1.

Once the war was over, Daylight Saving Time was abandoned - but the idea had been planted and it eventually returned.

BBC NEWS - 10 INVENTIONS THAT OWE THEIR SUCCESS TO WORLD WAR ONE

Tea bags

The tea bag was not invented to solve some wartime problem. By common consent, it was an American tea merchant who, in 1908, started sending tea in small bags to his customers. They, whether by accident or design, dropped the bags in water and the rest is history. So the industry says.

But a German company, Teekanne, did copy the idea in the war, and developed it, supplying troops with tea in similar cotton bags. They called them "tea bombs".

The wristwatch

It is not true that wristwatches were invented specifically for World War One - but it is true that their use by men took off dramatically. After the war, they were the usual way to tell the time. But until the late 19th and early 20th Centuries, men who needed to know the time and who had the money to afford a watch, kept it in their pocket on a chain. Women, for some reason, were the trailblazers - Elizabeth I had a small clock she could strap to her arm.

But as timing in war became more important - so that artillery barrages, for example, could be synchronised - manufacturers developed watches which kept both hands free in the heat of battle. Wristwatches, in other words. Aviators also needed both hands free, so they too had to throw the old pocket watch overboard.

Mappin and Webb had developed a watch with the hole and handles for a strap for the Boer War and then boasted of how it had been useful at the Battle of Omdurman. But it was WW1 which really established the market. In particular, the "creeping barrage" meant that timing was everything. This was an interaction between artillery firing just ahead of infantry. Clearly, getting it wrong would be fatal for your own side. Distances were too great for signalling and timings too tight, and, anyway, signalling in plain view meant the enemy would see. Wristwatches were the answer.

The company H Williamson which made watches in Coventry recorded in the report of its 1916 annual general meeting: "It is said that one soldier in every four wears a wristlet watch, and the other three mean to get one as soon as they can."

Even one of today's iconic luxury watches goes back to WW1. Cartier's Tank Watch originated in 1917 when Louis Cartier, the French watchmaker, saw the new Renault tanks and modelled a watch on their shape.



BBC NEWS - 10 INVENTIONS THAT OWE THEIR SUCCESS TO WORLD WAR ONE

Vegetarian sausages

Soy sausages were invented by Konrad Adenauer, the first German chancellor after World War Two.

During WW1, Adenauer was mayor of Cologne and as the British blockade of Germany began to bite, starvation set in badly in the city. Adenauer had an ingenious mind - an inventive mind - and researched ways of substituting available materials for scarce items, such as meat.

He began by using a mixture of rice-flour, barley and Romanian corn-flour to make bread, instead of using wheat. It all seemed to work until Romania entered the war and the supply of the corn flour dried up.

From this experimental bread, he turned to the search for a new sausage and came up with soy as the meatless ingredient. It was dubbed the Friedenswurst or "peace sausage". Adenauer applied for a patent with the Imperial Patent Office in Germany but was denied one. Apparently, it was contrary to German regulations about the proper content of a sausage - if it didn't contain meat it couldn't be a sausage.

Oddly, he had better luck with Britain, Germany's enemy at the time. King George V granted the soy sausage a patent on 26 June 1918.

Adenauer later invented an electrical gadget for killing insects, a sort of rotary apparatus to clear people out of the way of oncoming trams, and a light to go inside toasters. But none of them went into production. It is the soy sausage that was his longest-lasting contribution.

Vegetarians everywhere should raise a glass of bio-wine to toast the rather quiet chancellor of Germany for making their plates a bit more palatable.

Zips

Ever since the middle of the 19th Century, various people had been working on combinations of hooks, clasps and eyes to find a smooth and convenient way to keep the cold out.

But it was Gideon Sundback, a Swedish-born emigrant to the US who mastered it. He became the head designer at the Universal Fastener Company and devised the "Hookless Fastener", with its slider which locked the two sets of teeth together. The US military incorporated them into uniforms and boots, particularly the Navy. After the war, civilians followed suit.

Stainless steel



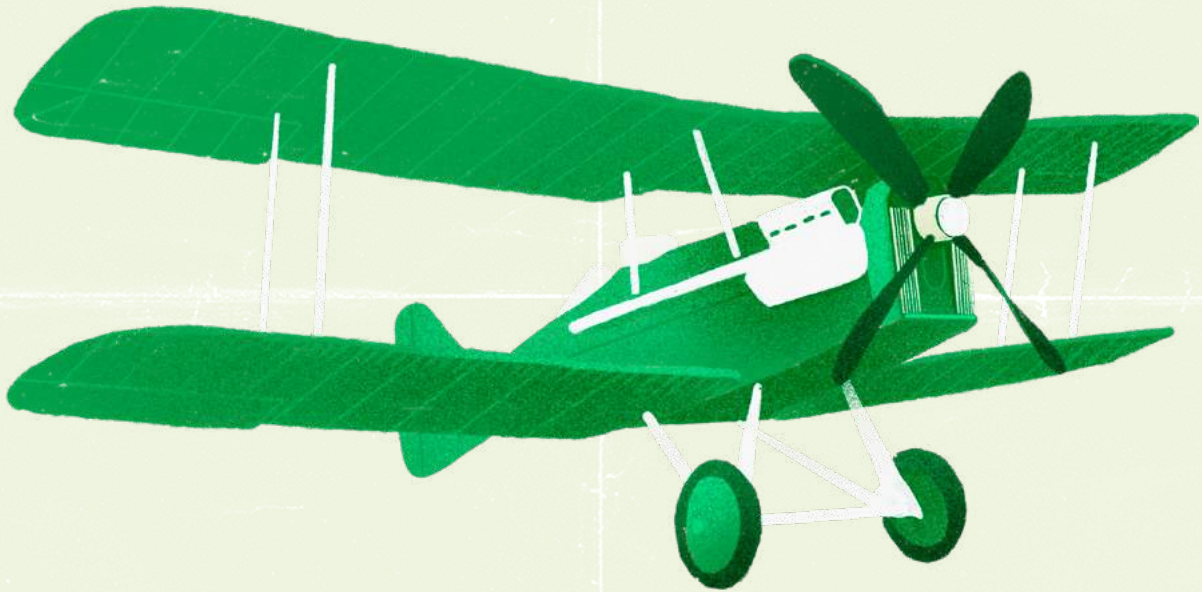
We should thank Harry Brearley of Sheffield for steel which doesn't rust or corrode. As the city's archives put it: "In 1913, Harry Brearley of Sheffield developed what is widely regarded as the first 'rustless' or stainless steel - a product that revolutionised the metallurgy industry and became a major component of the modern world."

The British military was trying to find a better metal for guns. The problem was that barrels of guns were distorted over repeated firing by the friction and heat of bullets. Brearley, a metallurgist at a Sheffield firm, was asked to find harder alloys.

He examined the addition of chromium to steel, and legend has it that he threw away some of the results of his experiments as failures. They went literally on to the scrap heap - but Brearley noticed later that these discarded samples in the yard had not rusted.

He had discovered the secret of stainless steel. In WW1 it was used in some of the new-fangled aero-engines - but it really came into its own as knives, forks, spoons and the innumerable medical instruments on which hospitals depend.

Pilot communications



Before World War One, pilots had no way of talking to each other and to people on the ground.

At the start of the war, armies relied on cables to communicate, but these were often cut by artillery or tanks. Germans also found ways of tapping into British cable communications.

Other means

of communication such as runners, flags, pigeons, lamps and dispatch riders were used but were found inadequate. Aviators relied on gestures and shouting. Something had to be done. Wireless was the answer.

Radio technology was available but had to be developed, and this happened during WW1 at Brooklands and later at Biggin Hill, according to Keith Thrower a specialist in this area of historical research.

By the end of 1916, the decisive steps forward had been made. "Earlier attempts to fit radio telephones in aircraft had been hampered by the high background noise from the aircraft's engine," writes Thrower in *British Radio Valves: The Vintage Years - 1904-1925*. "This problem was alleviated by the design of a helmet with built-in microphone and earphones to block much of the noise."

The way was open for civil aviation to take off after the war. Chocks away.

LESSON 3: WORKSHEET

BBC NEWS - 10 INVENTIONS THAT OWE THEIR SUCCESS TO WORLD WAR ONE

The wounds inflicted on millions of soldiers drove the development of new medical techniques and inventions.



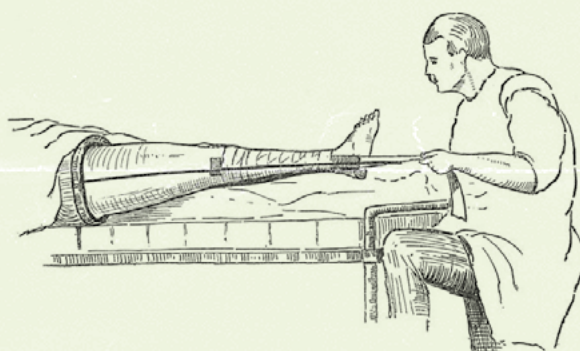
First World War blood transfusion apparatus.

Giving and storing blood

The British Army began the routine use of blood transfusion in treating wounded soldiers. Blood was transferred directly from one person to another. But it was a US Army doctor, Captain Oswald Robertson, who realised the need to stockpile blood before casualties arrived. He established the first blood bank on the Western Front in 1917, using sodium citrate to prevent the blood from coagulating and becoming unusable. Blood was kept on ice for up to 28 days and then transported to casualty clearing stations for use in life-saving surgery where it was needed most.

Technological innovation

Innovations developed in the First World War had a massive impact on survival rates – such as the Thomas splint, named after pioneering Welsh surgeon Hugh Owen Thomas, which secured a broken leg. At the beginning of the war 80% of all soldiers with a broken femur died. By 1916, 80% of soldiers with this injury survived.



The Thomas splint introduced in 1916

Speed of treatment

From January 1915 the British military medical machine moved closer to the front line. Casualty clearing stations were now better equipped and, crucially, more surgeons were closer to the battlefield. There were now fewer delays in administering potentially life-saving treatment. Soldiers with wounds that would have been fatal were now more likely to survive.

Harry Brearley



Harry Brearley was born on 18 February 1871 in Sheffield. Like many children who grew up in the city, Harry was the son of a steelworker. When he left school at the age of twelve (leaving school at an early age to get a job was not uncommon in this age) he became a labourer at his father's steelworks. In later years he would be promoted to the post of general assistant in the company's chemical laboratory, where metals were turned into useful parts.

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Industrial change

All through the 19th century, Europe had seen a massive industrial transformation which helped to bring about many new scientific inventions. Developments in metallurgy (the study of metals), chemistry and electricity led to new forms of explosives, made firearms more reliable and also made communication by telegraph possible.

It was in 1908, when two of Sheffield's biggest steelworks decided to jointly launch a new research laboratory, that Harry was asked to lead on the project. He went on to join Brown Bayley's Steel Works (also in Sheffield) and he became a director of the firm in 1925.

The science of war

Britain began manufacturing large quantities of weapons before WW1, but there was a problem when they were used in battle – the barrels of the guns eroded. As a prominent metallurgist, Harry began researching new steels which would not erode at high temperatures. He tried adding extra chromium to the steel to see if this would help preserve the barrel casing for longer.

Harry Brearley

The accidental discovery

When at the testing stage, he discovered completely by accident that this new combination of traditional carbon steel and chromium was very resistant to chemical attack and he immediately named it 'rustless steel'. Being from Sheffield, 'The Steel City', Harry saw the potential for the new metal to be used in cutlery and household utensils.

Until now, household cutlery had been made from other metals, including silver. As well as making cutlery quite expensive, it also meant that all food that was eaten had an odd taste of metal that came with it.

Today you'll find lots of things around you made from stainless steel, like kitchen sinks, pots and pans, tools, medical equipment and even artwork – all because of Harry's accidental invention.

Charity

In 1941 Harry Brearley created a charity called The Freshgate Trust Foundation. The Foundation is a grant making charity, operating in Sheffield and South Yorkshire to help out people from 'modest' circumstances like Harry to experience travel, education, the arts and music.



Harry's story (in his own words)

I never went looking to become a famous inventor. I really didn't. I mean - me! A young lad from Sheffield born into a family wi' only one room to live in on Spital Street. Son of a steel-worker, leaving school at twelve. I 'ave no business being famous! All those years of being a cellar lad or a bottle washer - I never dreamed I'd ever come up wit summat that'd still be around and being used by so many years and years later. It's unbelievable!!

Rustless steel were summat that came about completely by accident. Oh sorry, we renamed it didn't we? It's stainless steel you know it as in't it? Yes. Stainless steel. My accidental legacy.

After all me years of training and going t'night school I'd become quite a metallurgist - that's someone who deals wi' experimenting on't metals and I'd got a good job leading a team at Firth Brown's researching for the army. It were never my intention to produce something for civilian populations - I were tasked wit' making gun barrels. They were corroding see? Wasting away. That were no good for anyone, so I were given the task of finding a way to make 'em last for longer.

I remember the day it happened dead clearly. It were a summer's day - 13 August 1913. I were working in me lab and like any good scientist I were testing the metal compound I'd just created. It were regular steel but I'd decided to add some chromium to the mix to see if that helped wi' problem of everything sticking t' gun barrels. Well! As I were polishing it ready for testing - I noticed something amazing! The chemicals I were using weren't leaving marks on't metal at all. It were dead shiny. Which is not normal for steel I can tell you!

Now I'm from Sheffield - the famous 'Steel City' and we've been making cutlery for years. You know - knives, forks and what not. I immediately thought. "Hold on - this is perfect. We can use this make all sorts of things". And we did. Knives, forks, spoons, pots, pans, kitchen sinks you name it - we made it from rustless...sorry stainless steel.

It transformed me life I can tell you - so much so that when I were much older -round about 1941 I think it were, I set up a charity foundation to help lads and girls from backgrounds like mine to be able to have the same chance I got given. I were really lucky - I got to live a life where I could afford to go and get an education, travel and appreciate the arts a bit. We called it 'Freshgate' cos you know, that's what some kids will need. A new gate to go through to get a fresh start. Clever eh?

LESSON 4: WORKSHEET

Reading comprehension

Harry's story (monologue)

Harry's early life

Early work and studies

Harry's early work as a metallurgist

The invention of 'rustless' steel

Other uses of stainless steel

Harry's charity

LESSON 5: LETTER TEMPLATE

Writing letters

When you are writing a letter to someone, there are a number of things you will need to remember. You will be creating a friendly letter of thanks, so some of the language may be quite informal, but the letter itself is a formal correspondence from you on behalf of the people at your school, so will need to be laid out in an official manner.

Below is an example of how your letter should probably look.

The address of the person you are writing to – in this case you can use the address of the Freshgate Foundation. This address should be written on the left, starting below your address.

Harry Brearley,
Freshgate Foundation Trust
Europa Link
Sheffield Business Park
Sheffield
S9 1XU

If you did not know the name of the person you are writing to, you would use 'Dear Sir/Madam' but in this case you know the name of the person.

Dear Harry,

I am writing to you to say a massive thank you for all your work that did in your laboratory working on gun barrels for the army. From that we know that you made the exciting discovery of stainless steel and...

We have learned a lot about you and your work in setting up the Freshgate Trust Foundation in our class and think that your work was...

Thank you!

Yours sincerely,

If you did not know the name of the person you would use 'Yours Faithfully' but in this case, as you know Harry's name, you should use 'Yours Sincerely'.

Sam Brown

Sign your name, then print it underneath the signature.

Sam Brown
The National Literacy Trust School
Imagination Road
Madeupville
England
NLT19 WW1

11th November 2019

The date goes on the right hand side of the page below your address. Make sure you write the month as a full word.

Content – the main body of your letter.