Wonders of Science

Science & Technology

The print-ready entries below may be used as class discussions or as thinking-writing activities.

Beach Sand

Q: Some beaches have very white sand while others do not. Why is this?

A: The sand is made of different minerals.

White sand beaches (such as those near Perth, the Bahamas, and many other places) are composed of bits of shell and corals which were brought from the ocean shelf to the shore by waves. These shells and corals are made of pure calcite which is nearly always white.

Beaches whose sand is not white (say a yellowy-brown colour) are formed by quartz sand -the raw material for glass- and a few other minor minerals which were eroded from the land and brought to the shore by rivers.
Pure quartz is clear, but there are commonly impurities and coatings on the grains, and with the other minor minerals the sand looks yellowy-brown.

Task:
Find the meanings of the following words...
a) calcite *b) quartz* *c) mineral* *d) eroded* *e) impurities*

Think about or Write about:
White, fine-grained beach sand is pleasant to look at and feels good to walk upon.
Do you prefer such a beach or one that is not made up of white sand but instead is covered with many thousands of small shells of different colours, shapes and sizes? What are the pros and cons of these two kinds of beaches?

Blood to the Brain

Your heart works against gravity to pump blood to your brain. If you do a handstand -thereby putting yourself upside down- gravity works *with* the heart to carry blood to the brain. This results in an increase in blood pressure in the brain which can make you feel a little 'funny' and even cause a black-out.

Why doesn't a giraffe, with its extremely long neck, black-out when it bends over to take a drink of water? *...see under pic for the answer.*

It's because a giraffe has an extra-large, very strong heart –needed to pump blood up its long neck to its brain against the force of gravity. When a giraffe's head is lowered, in spite of the tremendous increase in pressure from the large strong heart pumping blood forcefully to the brain, together with gravitational forces, the animal does not black-out because it has evolved certain adaptations; these include extremely elastic blood vessels, special valves in their neck veins and a network of tiny veins to compensate for the sudden increase in blood pressure.

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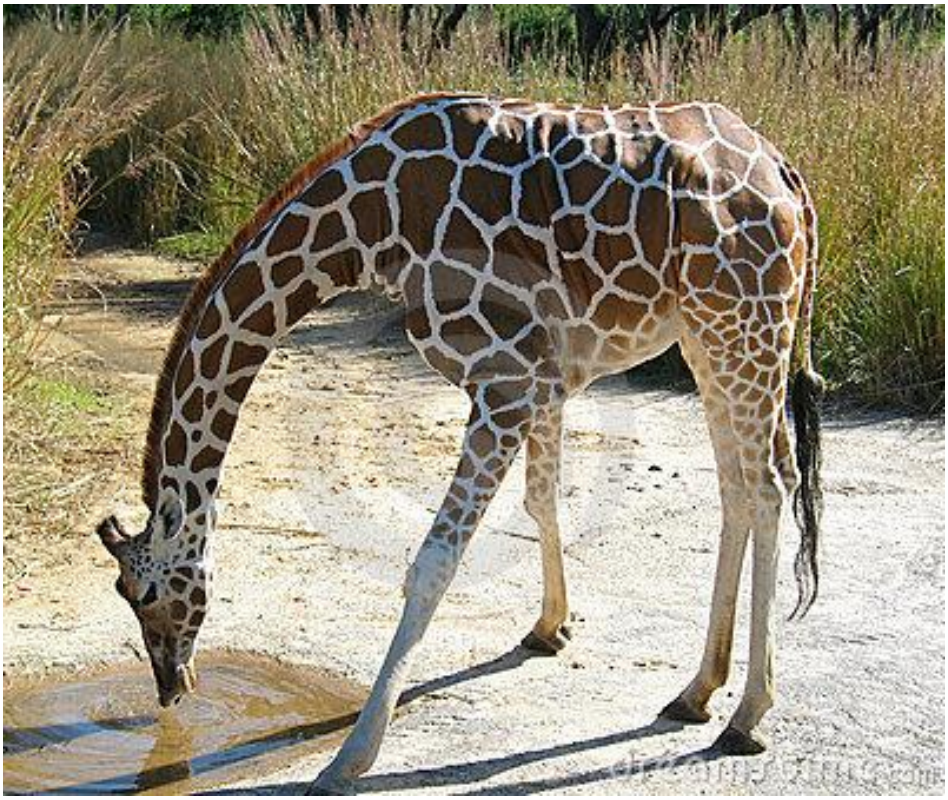

Not all animals have these kinds of adaptations. A rabbit for example will die if held head upwards, since it simply can't pump blood to its brain in that unnatural posture.

Talk about or Write about

1. This article talks about two of our most important organs, the brain and the heart. You know that the brain relies on the heart to provide it with blood but the heart needs the brain just as much. How might it be that the heart relies upon the brain in order to function?

2. Some people have a condition called *high blood pressure* while there are others whose blood pressure is low. From what you read above do you think you could guess possible causes for both these medical ailments?

3. Giraffes have evolved special adaptations to enable them to keep their head lowered. Rabbits, though, haven't acquired the ability to keep their head raised…why have they not?

How to tell if an Egg has been Boiled

Question: How you might you tell whether an egg is boiled or not without breaking the shell, or using any equipment other than a flat surface?

Answer: Place your egg on a flat surface and spin it. A cooked egg will revolve much faster and continue turning longer than a raw one. Indeed it is difficult to make the raw egg turn. The difference between these two behaviours is, not surprisingly, because the boiled egg is solid and the raw egg contains liquid.
It is easy to spin a rigid body like the boiled egg, because it turns as a whole. Nearly all of the force you apply to the cooked egg contributes to the rotation of the egg.
The raw egg, however, has liquid contents. The liquid centre of the egg, attempting to stay at rest, resists rotation and acts as a brake on the rotation of the egg. Thus the energy you give to the egg is lost in overcoming friction between the liquid contents and the shell, rather than contributing to the rotation of the egg as a whole.

Think about or Write about:
The Earth spins on its axis, one rotation taking 24 hours. (23 hours, 56 minutes, and 4.2 seconds to be exact).
As you know, most of the Earth's surface is water (oceans, seas, lakes). Also, lying just below the Earth's crust there is a layer of molten rock - composed mainly of liquid iron and nickel.
So in this way our planet is not unlike the raw egg with its liquid contents. If the Earth's surface was completely solid do you think it would spin easier and perhaps faster than it does? *(do some research and see what you can find out)*

Famous Scientist: **Archimedes**

Archimedes was born in Syracuse, the largest Greek settlement in Sicily, in 287BC. He was a physicist and mechanical engineer but was best known in the ancient world as an inventor.

Archimedes proved the law of the lever and invented the compound pulley. With these machines, it is possible to move a great weight with a small force. Archimedes reportedly once boasted to Hiero, King of Syracuse: “Give me a place to stand on, and I will move the entire earth.” He was referring to the way levers and pulleys can help people move objects many times their own size. The king challenged him to prove his boast. Archimedes is said to have used a system of pulleys to move a ship fully loaded with passengers and freight.

In his investigations of force and motion, Archimedes discovered that every object has a *centre of gravity*. This is a single point at which the force of gravity appears to act on the object.
Archimedes did much of his work for King Hiero. In one famous story, the king suspected that a goldsmith had not made a new coin of pure gold, but had mixed in some less costly silver. The king asked Archimedes to find out if the goldsmith had cheated.

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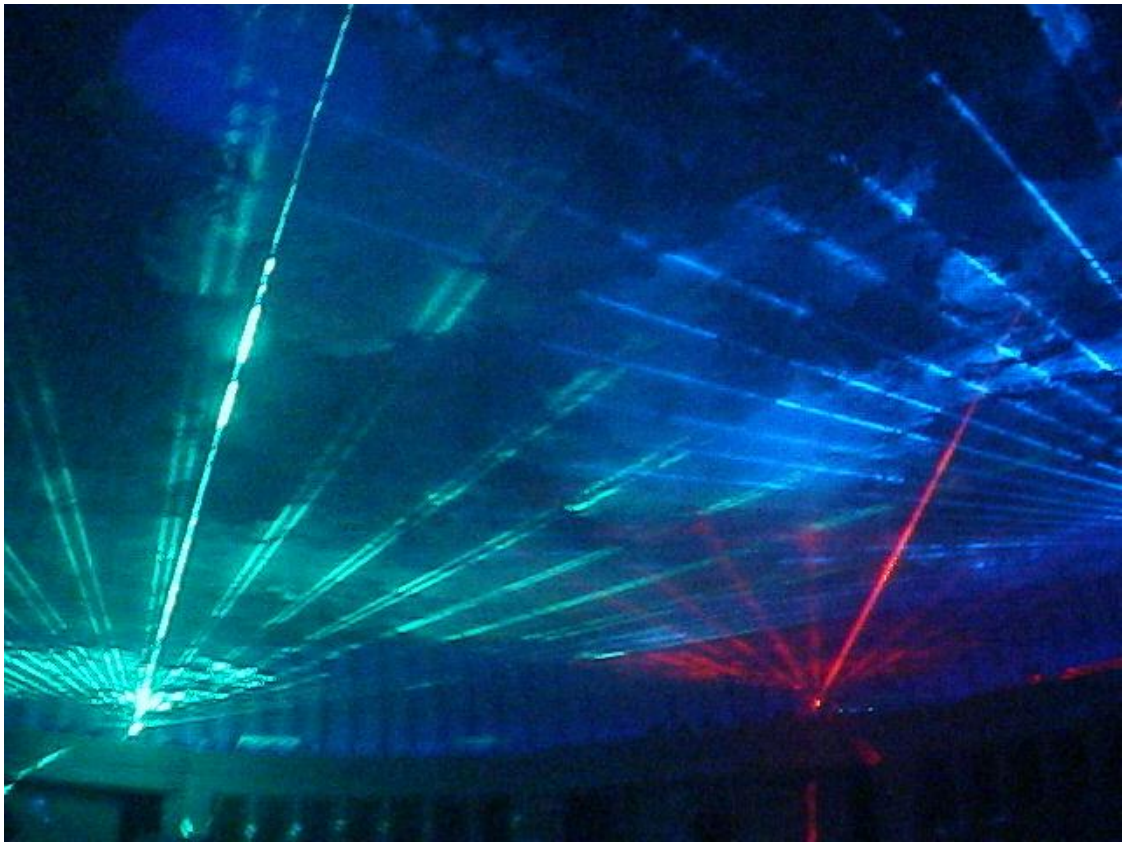
Archimedes found the answer to this problem while taking a bath. Archimedes noticed that water spilled out of a bath as he placed his body into it. By measuring the amount of water his body displaced, he could measure his body's volume. He concluded that any object placed in the bath would displace a volume of water equal to its own volume. Archimedes compared the amount of water displaced by the coin to the amount of water displaced by an equal weight of pure gold. The coin displaced more water, and so it was not pure gold. The goldsmith had cheated.
Archimedes was so excited when he found the answer that he ran into the street without dressing, shouting "Eureka!"

Talk about or Write about

1. Would you say that the centre of gravity of planet earth is at earth's centre?
2. If an object is made of a heavy substance at one end and a light substance at the other end is its centre of gravity nearer the heavier end or the lighter end?
3. Give definitions for lever and pulley.
4. Archimedes found that the coin made of pure gold displaced a different amount of water from the coin that was made of a gold-silver mixture, even though the coins weighed the same. This is because the coins were of different density. What is density?
5. Providing they both sink, is it possible that a small, heavy object could displace as much water as a lighter object that is twice its volume?

Laser



Gordon Gould was born in New York City in 1920. As a child, he idolized the great inventor Thomas Edison. Later, Gould himself would conceive and design one of the most significant inventions of the 20th century, the laser.

In 1957 Gould was working in the Physics Department at Columbia University, USA. One Saturday night, he was inspired "in a flash" with a revolutionary idea: '**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation', or the 'laser'.
Gould reasoned that a light-wave amplifier would be much more powerful than a maser (which amplifies microwaves), since every photon of light has a hundred thousand times more energy than a photon of microwave energy.

By the end of that weekend, Gould had designed a device that he predicted could heat a substance to the temperature of the sun's surface in a millionth of a second.

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By the time the first of his laser patents was issued in 1977 Gould's laser technology was already being used in countless practical applications, including welding, scanning and surgery.

Talk about or Write about

1. There are some people who are wary of using microwave ovens to heat food. Why do you suppose this is?

2. Why might it have been so long (20 years) from the time of Gould's idea to the time his first laser patent was issued?

3. Which of the following laser applications would you think will most benefit humanity: *welding*, *scanning*, *surgery*?

4. What similarities are there between microwaves and lasers?

5. What differences are there between microwaves and lasers?

Does the Moon affect life on Earth?

If there were no moon, the tides would be only about 30% of what they are now ...and the tide cycle would perfectly match the daylight cycle (explanation below).

Tides are the rises and falls of large bodies of water (oceans, seas, lakes and rivers); they are caused mainly by the gravitational interaction between the Earth and the moon (the sun has a smaller effect on tides). The oceans bulge out in the direction of the moon. Since the earth is rotating while this is happening another bulge occurs on the opposite side, since the Earth is also being pulled toward the moon (and away from the water) on the far side. So two tides occur each day.

Notice that the tidal cycles have nothing to do with the day-night cycles we experience. Tides are caused by the moon's pull; day-night cycles are caused by Earth's rotation on its axis -now *we* get the sun's light, soon *people in places west of ours* will get it (and we'll experience night). Many of the most primitive animals live in tidal zones of the ocean, and depend upon the tide cycles being out of tune with the day-night cycles to survive; so if there were no moon, ocean life would be affected. Some animals would perish without a moon; newer life forms -able to adapt to the two cycles being more 'in sync'- may well evolve.

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The moon enables nocturnality (night time activity, daytime sleep) which is important for both predators and prey. Without nocturnality our Earth at night would be a different place for many species (mammals, reptiles and birds among them); hunting, feeding and sleeping habits would be altered.

So yes, the moon certainly does affect life on Earth.

Talk about or Write about

1) The moon's pull on Earth's large bodies of water is greater than that of the sun. Given that the sun is much bigger (far greater mass) than the moon how can that be?

2) Our large expanses of water 'move toward' the moon. What stops solid materials (mountains, rocks etc) from also moving?

3) Many of the most primitive animals live in tidal zones of the ocean. What would you say is meant by *tidal zones*?

4) Which ocean creatures would you say are least affected by the moon?

5) What would you say 'in sync' means?

6) Which of a nocturnal animal's five senses do you think would be the most highly evolved?...explain. Which other senses may also be more highly evolved than ours?

7) Here is some real 'food for thought'! Would it be harder for diurnal animals (squirrels, songbirds...) to have to adapt to permanent night time living or harder for nocturnal animals (koala, possum...) to be forced to adapt to permanent daytime living?

Force

This lesson is designed to train children to observe what happens when a force is increased and to introduce the idea of the force of gravity that causes the mass of objects.

A force is a push or a pull. A force can make an object start moving, stop or change direction. In this lesson you will use forces to start things moving and find out why they stop moving.

1. Put a coin on a flat table. Will it move sideways by itself? *[No]* What can make it move sideways? *[A force]* Pick up the coin. Can it move by itself? *[No]* Let it go. What happens? *[It falls]* Why did it move? Did you make it move with a force? *[No]* Did anything push it? *[No]* Did anything pull it? *[Yes, it was pulled down by the force of gravity]*

2. Slide the coin down a ruler that's on a slight slope. Why does the coin slide down? *[It is pulled down by the force of gravity]* Why does it slide slowly? *[There is some push on the coin by the sloping ruler]* Make the slope steeper. Slide the coin down. Why does the coin slide down more quickly? *[The coin is pulled down by the force of gravity. The sloping ruler pushes up less on the coin]* With the coin on the ruler, turn the ruler over. What happens to the coin? *[It falls very fast]* Why does it fall so fast? *[It is pulled down by the force of gravity; the ruler does not push up on it at all so there is nothing to stop the coin from falling]* An object falls down when the force pushing up on it is less than its mass.

3. The earth pulls all things towards it. This pull is called the force of gravity.

4. When you hold a coin in your hand is there a pull down on the coin? *[Yes]* What do you call this force? *[The mass of the coin]* The mass of the object is the pull down caused by the force of gravity. Does the coin move down? *[No]* Why not? *[The coin does not move down because your hand pushes up the coin. The pull down on the coin is equal to the push up by your hand, so the coin does not move]* When an object does not move this is because the pull down is equal to the push up on it.

Extra Activity:

Make a slope with a ruler. Slide a 20 cent coin down a slope to hit a 10 cent coin that's been placed on the table near the bottom of the ruler. Note the height of the slope and how far the 10 cent coin moves. Change the height of the slope a few times but keep the 10 cent coin in the same place near the bottom of the ruler.

Make a Table of Results... Height of slope Distance 10 cent coin moves

What did you notice about the speed of the 20 cent coin when the height of the slope increased? *[It moved faster]* What did you notice about the distance the 10 cent coin moved when the height of the slope increased? *[It moved farther]* Why did these increases occur? *[The force of the 20 cent coin hitting the 10 cent coin increased as the height of the slope increased]*

Repeat the experiment above but use a 10 cent coin sliding down to hit a 20 cent coin. What do you see? *[The 20 cent coin is pushed less distance along the table]*

Can you explain why a ripe mango or orange fruit drops to the ground from the tree?

Talk about or Write about

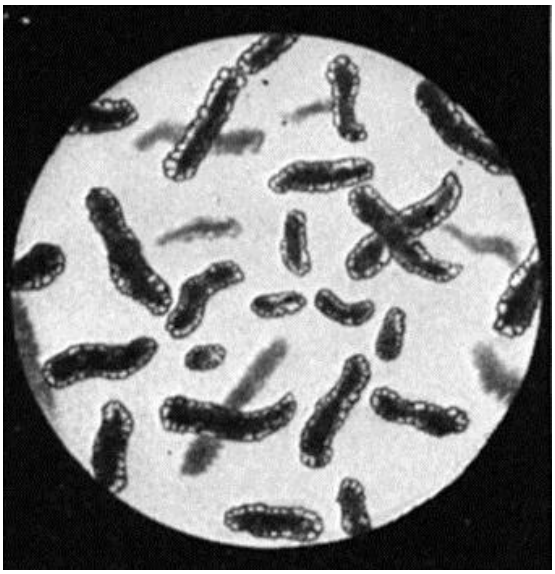
1. What is a force? [A push or a pull] 2. Can a force start things moving? [Yes] 3. Can a force stop things that are moving? [Yes] 4. Can a force make a moving thing change direction? [Yes] 5. Which ball hits your hand with the greatest force, a heavy ball or a light ball? [A heavy ball] 6. A ball thrown high or ball thrown low? [High] 7. Coconut on a tree... is there a force pulling down the coconut? [Yes] 8. What is the force called? [Mass] 9. Is there a force pushing up? [Yes] 10. What is pulling it up? [The tree] 11. Which force is bigger? [If the coconut stays on the tree then, force down = force up]

Reproduction: *An Interesting Fact*

In former times -before the great advances in medicine- it was not uncommon for babies to survive just weeks, days or even minutes.
To reach puberty (reproductive age) then, was something of a feat, especially during times of widespread disease.

In 1665/66 the Great Plague of England killed 100 000 people but the most devastating pandemic in human history -the Black Death- had occurred earlier, between 1348-1350; it wiped out about a third of Europe's entire population.
Now, there are around 7 billion people inhabiting our planet at this time. Each of these 7 billion -including you- can truthfully say, *"Every single one of of my ancestors survived to reproductive age."* (If just one had not, you could never have been born).

Bacteria



In 1674, using a single-lens microscope of his own design, Anton van Leeuwenboek was the first to observe bacteria.
Bacteria are single-cell micro-organisms. They are usually a few micrometres long (a micrometre is a thousandth of a millimetre) and have many different shapes including spheres, rods and spirals.

Bacteria live in every possible habitat on the planet including soil, underwater, deep in the earth's crust and even such environments as acidic hot springs and radioactive waste. There are about a million bacterial cells in a millilitre of fresh water.

Not all bacteria are harmful. Bacteria are vital in recycling nutrients and are important in processes such as wastewater treatment and the production of antibiotics (in laboratories) and certain chemicals. There are 10 times more bacterial cells than human cells in the human body, with large numbers of bacteria on the skin and in the digestive tract. Although the great majority of these bacteria are harmless (or even helpful), a few can cause infectious diseases, including cholera and anthrax. The most common bacterial disease is tuberculosis.

Questions *(red answers may be erased by teachers)*

1. What is a micro-organism? *an extremely tiny life-form*
2. *A little bit of maths for you*….about how many bacteria are there in a litre of fresh water? *about a billion (a thousand million)*
3. The first line of the 2nd paragraph contains the word *vital*. What does this mean? *necessary, essential, extremely important*
4. There is a large number of bacteria in the *digestive tract*. What is the digestive tract? *the path in our body through which food passes*

The Human Heart

When you drink a glass of water you consume, let's say, 250 ml.

Four glasses, then, contain a litre *(think of the litre of milk you buy at the supermarket)*. Imagine, and try to 'see', sixteen glasses of water, placed alongside one another in a row; these sixteen glasses contain 4 litres of water.

Forty glasses of water placed alongside one another contain 10 litres of water.

One hundred and sixty glasses of water placed alongside one another contain 40 litres of water *(40 litres of petrol would take you a long way in a car)*. Try to visualize these one hundred and sixty glasses of water side by side in a straight line.
Now let's do a little multiplying.

Visualize *ten* such rows of one hundred and sixty water-filled glasses; that's a lot of glasses -1 600 - (400 litres of water).
Now try to see *one hundred* such rows of 160 glasses -16 000 - (4 000 litres of water).
Lastly, see how you go at imagining *one thousand* such rows of 160 glasses; that's 160 000 glasses, containing 40 000 litres.
OK, we're going to change the contents of these 160 000 glasses from water to..... blood.

We now have 160 000 blood-filled glasses...40 000 litres. A lot of blood? Yep, sure is...

And that's how much blood the adult human heart pumps around the body each day!

– 40 000 litres of petrol would power the average car around the world 10 times -