

Volcanoes Top Trumps Learning Sheet – Answers.

Answers 1a Yellowstone – no, it last erupted 70,000 years ago! 1b really big eruptions erupt so much magma they sometimes leave a large hole in the ground behind them. We call this a caldera. In the case of Campi Flegrei some of that hole is hidden beneath the sea. 1c. Krakatau, around 26,000 people died immediately but in fact many thousands more died from starvation after the volcano ruined all the crops and killed animals for hundreds of kilometres. 1d. Stromboli has been erupting for more than 2000 years! 1e. there is no right (or wrong) answer here.

2a. The total number of volcanoes here is 30. Erebus, Kilauea and Teide are the volcanoes not obviously near a margin. This is 3 from 30.

The fraction is $\frac{3}{30} =$ (simplify) $= \frac{1}{10}$. Expressing this as a % needs multiplying by 100 = 10%

If you included Nyiragongo this would be $\frac{2}{15} \times 100 = 13.33\%$

2b. There are 25 volcanoes near subduction zones (areas where plates are moving towards one another).

$$\frac{25}{30} \times 100 = \frac{5}{6} \times 100 = 83.3\%$$

2c. With just 30 volcanoes here 83.3% is not a bad representation of the correct proportion, 24 cards would have been exactly 80% but since its only 'around' 80% our proportion is pretty good.

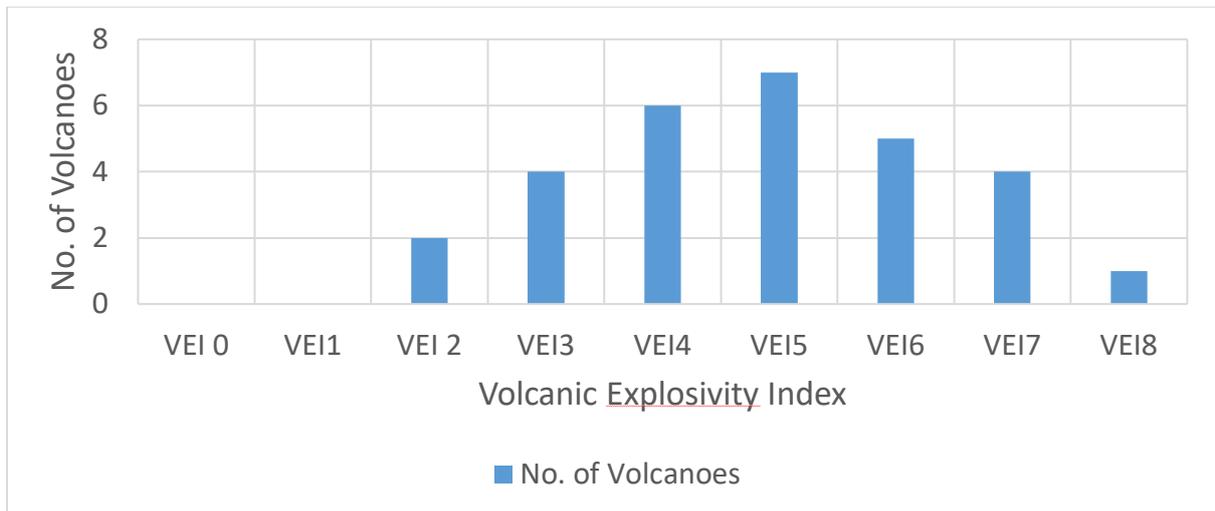
3a. Erebus and Eyafjallajökull are in the polar regions, so this makes sense. Cotopaxi is in the tropics but it is pretty high and Villarica, Fuji and Mt St Helens are also relatively high up. This must mean their average temperature is low enough to have snow.

3b. Cotopaxi is 5,897 m. This means that there is $\frac{5897}{1000} \times 7^{\circ}\text{C}$ change in temperature from sea-level. This is 41°C! This implies the temperature at the top of Cotopaxi is 30-41 = -11°C! That is pretty cold.

3c. The Tropics have the most volcanoes. Looking at the tectonic plates, they are smaller in this region and so have more boundaries – which means more volcanoes!

3d. The snow will be rapidly melted. Snow melts at 0°C, and typically volcanic material is erupted between 500-1000°C, that is a lot of extra heat energy to melt the snow!

(4)



Our sample is clearly biased towards larger eruptions! Undoubtedly we wanted to highlight some of the more exciting volcanoes – and we saw ‘exciting’ as the ones that had larger eruptions. But, there is also another explanation for this!

Almost all volcanoes vary in the size and explosivity of eruptions they produce! This can vary during the course of an eruption and between eruptions. Our category for the cards is *maximum* VEI, so represents the biggest eruption we know that volcano has had. This would make us seem to bias our sample to bigger eruptions.

In fact the eruptive record of volcanoes is hard to tell, geologists unravel it by looking at deposits around the volcano and interpreting the eruption that produced them. This also means our record is biased! It is much more likely we will preserve the bigger eruptions!

TASK 1: FINGERNAIL EXPERIMENT

Your fingernails grow VERY SLOWLY....only about 2.5 mm a month! So if you wanted to see them get longer you’d have to wait very patiently.

The tectonic plates move at about the same rate, on average they move 3-5 cm per year. Some move faster and some move slower, but we still can’t see it with our eyes. We use satellite measurements to track these very small movements of the plates.

Although it is very slow, the movement of the plates can make BIG changes to the planet. For example, Scotland was positioned close to the equator around 400 million years ago!

Can you imagine what it would be like to live in the sub-tropics? Nice and hot!

TASK 2: DENSITY

Water has a density of 1 g/cm³ this means that 1 cubic centimetre of water would weigh 1 gram. Objects made from wood usually float, because their density is lower whereas stone and metal are likely to sink. This is because these materials are denser – the building blocks that make up materials like metal are packed much closer together so they have more mass per cm³.

Did you get the results you expected? Try as many objects as you can and see if you can work out which objects & materials are the densest.

TASK 3 AND 4: VOLCANIC ERUPTIONS & ASH CLOUDS

Here are the ones we spotted, and some of our observations, yours may be a little different. That's okay, in science we use lots of different way to describe things.

Compare your answers with ours, see if there are any you missed, or any WE missed!

Volcano name	Plate boundary	What does the eruption look like?
KRAKATAU	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	Big ash cloud, makes a mushroom shape
MT ST HELENS	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	Big ash cloud explosion
PINATUBO	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	Huge ash cloud eruption
COLIMA	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	Small ash cloud and gasses
NEVADO DEL RUIZ	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	Grey ash clouds coming down the side of the volcano
SANTA MARIA	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	Small plume of ash straight up in the air
ETNA	CONVERGENT - SUBDUCTION	Black ash plume, into the air and down the side of the volcano.
YASUR	CONVERGENT – OCEANIC-OCEANIC SUBDUCTION	Red and orange glowing fire fountain of lava.
EYJAFJALLAJÖKULL	INTRA-PLATE / HOT SPOT	Tall red lava fountains, glowing, erupting along a straight line.
STROMBOLI	CONVERGENT - SUBDUCTION	Red and yellow glowing fire fountains of lava.
KILAUEA	INTRA-PLATE/ HOT SPOT	Black and red flowing lava, crinkly on top, smooth at the front, small fountains of lava.
NYIRAGONGO	DIVERGENT – CONTINENTAL RIFT	Black lava surface (this is the lava lake in the volcano crater!) with red glowing cracks where molten lava breaks through; some white gasses are rising to the sky. Some small lava fountains.
SOUFRIÈRE HILLS	CONVERGENT – OCEAN-OCEAN SUBDUCTION	The top of the volcano has grey rocks (a dome of lava with a cooled outer crust), there are glowing red cracks showing where hot lava is forcing its way out. You can see some white gasses coming off the hot dome.

TUNGURAHUA	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	White plume of gasses and ash
You may not have thought the following volcanoes were erupting, magma hasn't made it to the surface in these photos, but there are still signs that these volcanoes aren't quite dead yet!		
YELLOWSTONE	INTRA-PLATE / HOT SPOT	White steam coming from the floor. (this is an example of a geyser, water below the ground is heated due to the closeness of hot magma and shoots out of the ground!)
VILLARRICA	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	White steam/gasses from the top of the volcano (infact Villarica is erupting in 2020)
EREBUS	DIVERGENT – CONTINENTAL RIFT	Steam and gasses from the crater. It has a lava lake in its crater!
MERAPI	CONVERGENT – OCEAN-CONTINENT SUBDUCTION	Gasses rising from the crater.

TASK 5: PLATE BOUNDARIES MAGMA PROPERTIES AND ERUPTIONS

Oil and water will move much more quickly than honey, ketchup and syrup. But, jam and toothpaste should move VERY slowly. This is because they are more VISCOUS. If something is viscous it means it doesn't like to flow.

A good way to think about it is the difference between walking through water compared to air, now imagine walking through a big pool of custard or thick toothpaste. It would be MUCH HARDER, because they are more viscous, they don't want to flow, so they RESIST your legs and arms as you move through them.

(don't try filling your bath with custard at home!)

TASK 6: MAGMA ON THE MOVE

1. DIVERGENT / MID OCEAN RIDGE
2. DIVERGENT / CONTINENTAL RIFT
3. INTRA-PLATE / HOT SPOT
4. CONVERGENT/ OCEAN – OCEAN SUBDUCTION
5. CONVERGENT/ OCEAN CONTINENT SUBDUCTION

Part 2:

We would expect the thickest (or more viscous) lava to erupt at an ocean-continent subduction zone. Here the magma has to rise through a lot more rock before it can get to the surface. This means it has cooled more, and has more crystals in it, this makes it thicker (more viscous) when it erupts.

Some of the volcanoes at Ocean-continent subduction have fire fountain-style eruptions when we might expect them to produce ash clouds or thick blocky lava domes.

