TOP TRUMPS
PLAY • DISCOVER

VOLCANOES TOP TRUMPS

MAGMA-IFICENT WORKSHEET BOOKLET

AN EXPLOSIVE GIFT, JUST FOR YOU...

This pack of Volcanoes Top Trumps is a gift for you to play with from the team at Volcanoes Top Trumps and Top Trumps HQ. If you have access to the internet you can find us here:
www.volcanoestoptrumps.org

The instructions for how to play are in one of the cards inside the pack! Each card has a number in a red circle which also corresponds to the number shown on the map. This shows you where in the world our 30 'Top Trumps' volcanoes are. There are more than 1400 volcanoes that could erupt around the world and 800 million people live close by.

This workbook has some questions and tasks on it that you can use to help you find out a bit more about volcanoes and where they are found. The volcano team have designed the questions so that you should be able to answer them using the cards, workbook and diagram sheet. You might like to play the card game a few times first.

You can use the worksheet over a few days, we have split it into parts so you can do a little at a time. You should have room for all your answers on the paper.

OFF YOU FLOW...

SECTION 1

FINDING FACTS ABOUT THE VOLCANOES ON THE CARDS

1: Which is the only Top Trumps volcano that has a Volcanic Explosivity Index (VEI) of 8? Does it erupt very often?

2: Some of the volcanoes with very big eruptions (VEI 7) look like holes in the ground instead of mountains. Can you think why that might be?

3: Our cards give a score for 'Deadliness'. The card with the highest score for 'deadliness' is also our Top Trump card. What is the volcano's name and how many people did its 1883 eruption kill?

4: How long has Stromboli in Italy been erupting for?

5: Wow! Factor is a matter of opinion. The volcanoes Top Trumps team used their opinion to decide these scores. Looking at the cards, which volcano is the most 'Wow' for you and why?

SECTION 2

THE LOCATIONS OF VOLCANOES

For this section , you'll be using Figure 1 (which is on the diagram sheet) this shows the locations of the Top Trumps volcanoes:

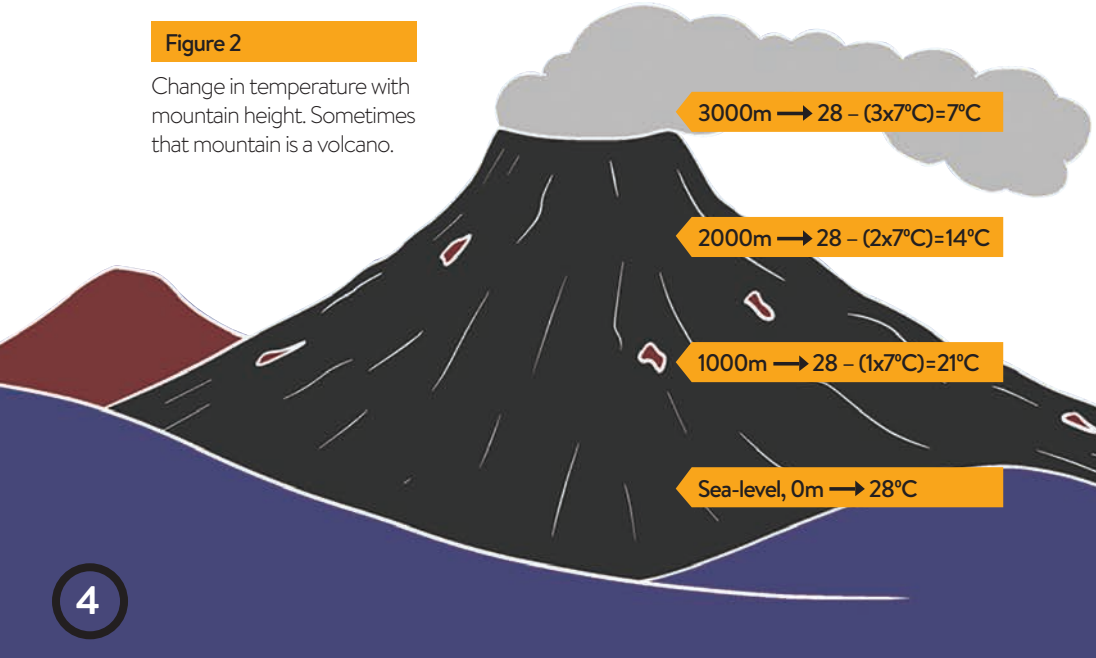
1: How many of the 30 'Top Trumps' volcanoes are near plate boundaries? How would you express that as a percentage?

2: What percentage of the Top Trumps volcanoes are found near subduction zones?

3: Globally, around 80% of historical eruptions occurred near subduction zones. Is the proportion of Top Trumps volcanoes that are at subduction zones a good representation of this global proportion?

Figure 2

Change in temperature with mountain height. Sometimes that mountain is a volcano.



SECTION 3

VOLCANOES AND CLIMATE

Weather describes the day-to-day variation of the atmosphere (sun, rain, wind) but climate describes the average (mean) weather conditions over long periods of time. Climate is modified by latitude (See **Figure 1** on the diagram sheet) but is also affected by proximity to the sea, and the presence of mountains. These can affect both rainfall and temperature. Volcanoes are often mountains, so have a different climate at their peak, relative to sea-level at that latitude. Broadly speaking anywhere >66° north or south of the equator has a polar climate. The temperate zone is found between 23.5° and 66° north and south of the equator, and the tropical zone extends for around 30° either side of the Equator. Temperature is lowered by around 7°C for every 1000 m of extra height above sea-level. **Figure 2**, (below, left) shows the change in temperature.

1: Cotopaxi, Erebus, Eyafjallajökull, Villarica, Fuji and Mount St Helens are often snow covered, even though they are in different climate zones. Mark these volcanoes on the map using the information on the cards. Why might each of these be snow covered?

2: Assume that the temperature at sea-level in Ecuador is 30°C. What is the temperature at the top of Cotopaxi? *(HINT: use the relationship between temperature and height above sea level. You can either make an equation from this relationship or take the approach shown in Figure 2, but remember the last height will be a fraction of 1000 metres.)*

3: Which climate zone has the most Top Trumps volcanoes? *(HINT: use the map!)* Why do you think this is?

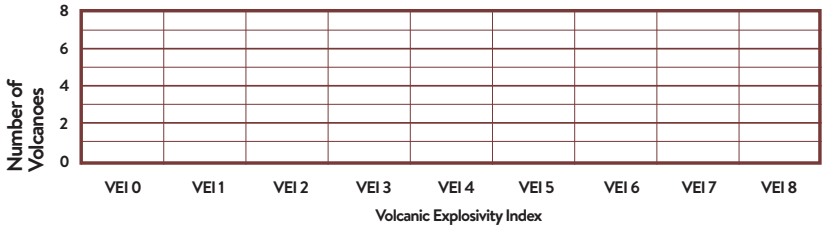
4: Using your knowledge of magma and lava, what do you think will happen to the snow on the top of volcano when it erupts?

SECTION 4

VOLCANIC EXPLOSIVITY INDEX

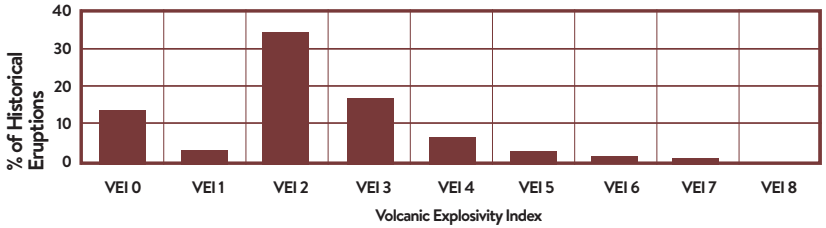
Volcanic Explosivity Index (VEI) is a measure of the 'size' and explosivity of an eruption. On the cards we have shown the maximum VEI eruption that each volcano has had.

1: On the axes below, draw a bar chart to show the distribution of the maximum VEI of the volcanoes on the Top Trumps cards.



This is a bar chart showing the distribution of VEI for all known historical eruptions.

Number of eruptions = 5936



2: Look at the two bar charts. Do you think that the VEI of volcanoes on the Top Trumps cards is a good sample of the overall distribution of volcanic eruptions? Why do you think this is?

TASKS

In the following activities you will explore and look for patterns in types of volcanic eruptions and different tectonic plate boundaries. Using things you can find at home and your Volcanoes Top Trumps you should be able to think about the density of materials, properties of magmas and how these things relate to volcanoes and the changing surface of the Earth.

***Tasks are highlighted in BLUE** and there are clues to the answers **highlighted** throughout the text and within the diagrams.*

TASK 1

PLATE TECTONICS AND PLATE BOUNDARIES

The Earth's surface is made up of a number of tectonic plates. The map in **Figure 1** (see diagram sheet) shows them as they would be looking from above, but **Figure 3**, on the diagram sheet shows a cross-section of the plates looking sideways into the interior of the Earth. These plates are generally made up of oceanic lithosphere or continental lithosphere depending on the type of crust that makes up the uppermost part of the plate.

Oceanic crust is typically thinner but denser, whereas continental crust can have more than 3x greater depth, but is less dense. The plates move very slowly around the planet due to heat coming from the Earth's core, they move at about the same rate your fingernails grow.

FINGER NAIL EXPERIMENT

Watch your fingernails *really closely* for 1 minute...can you see them growing?

Although plate motion is very slow, over millions of years this motion can build and destroy continents, mountain ranges and deep oceans.

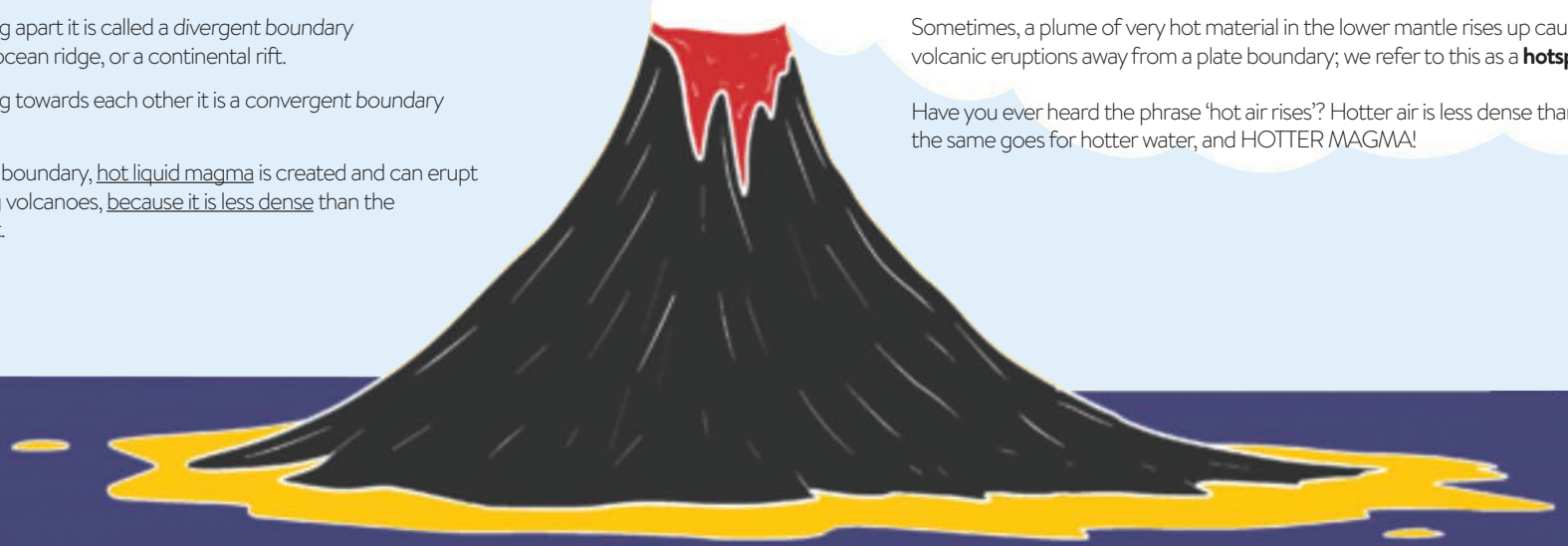
Now look at the diagram sheet at **Figure 3** it shows you the different types of plate boundaries where volcanoes can form.

Where two plates meet, we call it a plate boundary.

If the plates are moving apart it is called a *divergent boundary* – this could be a mid-ocean ridge, or a continental rift.

If the plates are moving towards each other it is a *convergent boundary* – a subduction zone.

At both types of plate boundary, hot liquid magma is created and can erupt at the surface forming volcanoes, because it is less dense than the tectonic plate above it.



TASK 2

DENSITY

Experiment with density by filling a large bowl (or the sink or bath) with water, find some objects made of the following materials and hold them at the bottom of the water one at a time, then let go. Does the object float? Try an object made of something else.

Object	What is it made of?	Does it float?
	wood	
	plastic, solid	
	plastic, hollow	
	stone	
	metal	

Objects that rise to the surface and then float are **less dense**. The **greater the difference in density** between the object and the water, **the easier** it is for the object to **rise to the surface**.

Sometimes, a plume of very hot material in the lower mantle rises up causing volcanic eruptions away from a plate boundary; we refer to this as a **hotspot**.

Have you ever heard the phrase 'hot air rises'? Hotter air is less dense than cooler air, the same goes for hotter water, and HOTTER MAGMA!

TASKS 3 & 4

VOLCANIC ERUPTIONS

Find all the Top Trumps cards that show a volcano erupting, by locating them on the map on **Figure 1** (see diagram sheet) write down what type of plate boundary they are forming at in the table below.

LAVA & ASH CLOUDS

Is there lava? Can you see ash clouds? Does this look like a big explosion? Or can you see a fire-fountain or runny flow? Add your observations to the table below.

Volcano name	Plate boundary	What does the eruption look like?

Volcano name	Plate boundary	What does the eruption look like?

Do you notice a pattern between the type of plate boundary and what the volcanic eruption looks like? If so what is it?

TASK5

PLATE BOUNDARIES, MAGMA PROPERTIES & ERUPTIONS

When the plates have greater depth (like the continental lithosphere in **Figure 3**) magma can get stuck, crystallise a bit and change its composition. In turn this changes how easy it is for magma to flow when it finally emerges. Depending on this, and how cooled it is, magma that erupts at the surface as lava can be runny (like honey) or thick (like toothpaste). When runny lava erupts at the surface we usually see **glowing lava flows or fire-fountains**.

When thick lavas erupt they can create **huge explosions** of ash and rock, or they may just squeeze out of the top of the volcano making a big pile of hot rocks and lava, this type of lava doesn't flow very far.

Find a jar of honey, syrup or a bottle of oil, with the lid on, tip it and see how quickly the contents move. Now do the same for some ketchup or jam, or squeeze a little bit of toothpaste onto a plate and hold it at an angle. Does one move more quickly than the other, do some not move at all? Of the things you found, which one is thickest?

Write your observations in the table below:

Food item	How quickly does it move?

As **oceanic lithosphere** has **less depth** and its crust **very dense** compared to the rising magma, the molten rock can usually **rise to the surface quite quickly**, meaning it erupts while it is **hotter and runnier (like honey)**.

Continental lithosphere has much **greater depth** and the crust is **not as dense**, so the **rising magma can get trapped for longer** meaning by the time it reaches the surface it can be much **cooler and thicker (like toothpaste).**

TASK6

MAGMA ON THE MOVE?

Look at the diagram of the plate boundaries again **Figure 3.**

Using the tasks you have done, and the information on the sheet, rank the different types of plate boundary by how easily the molten magma can reach the surface.

Consider the **thickness of the lithosphere and crust**, and **how easily** the molten magma will rise through it. (HINT: hot (low density) magma rises more easily through thin, high density crust)

Put the plate boundary where it is **easiest** for the magma to rise to the surface at 1, the most difficult at 5:

1.	2.	3.
4.	5	

At which type of plate boundary would you expect to find the thickest lava erupting?

Does this help you explain the patterns you saw between what the eruptions looked like, and the type of plate boundary that volcano sat on?

Are there eruptions at any volcanoes that don't look the way you might expect?

Can you think of any reasons why this might be?

Wondering about what causes these differences is part of being a volcano scientist....

TASK7

COLOURING MATHS

Another part of being a volcano scientists is solving problems!

Can you solve for x in each of these zones of our volcano drawing and use that to colour in the picture!

= 6

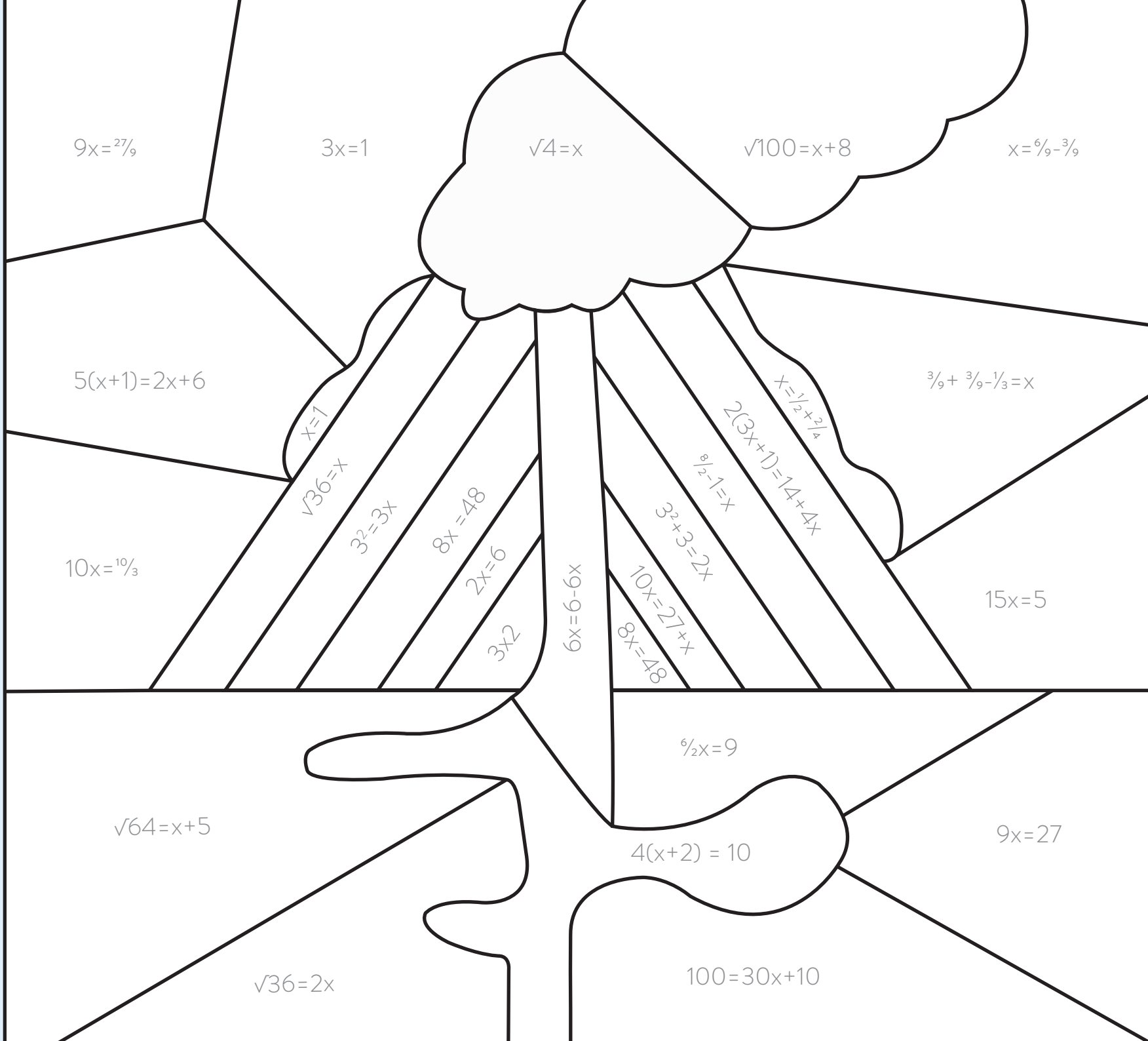
= 3

= 1

= ½

= ⅓

= 2



NOW THAT YOU'VE COMPLETED THIS BOOKLET, YOU'RE A VOLCANO SCIENTIST TOO!

WELL DONE!

ENQUIRIES

This workbook was produced as a collaboration between researchers at the University of East Anglia. Questions and tasks were conceived, designed and refined by Bridie V Davies, Jade Eyles, Jenni Barclay and Nicola C Taylor.

Volcanoes Top Trumps are a collaboration between TopTrumps HQ and researchers at the University of East Anglia, Plymouth University and the University of Oxford. All of our royalties go to fund projects to benefit children and communities impacted by volcanic eruptions.

Website here: volcanoestoptrumps.org

For more volcano activities, check out volcanoutreach@uea.ac.uk