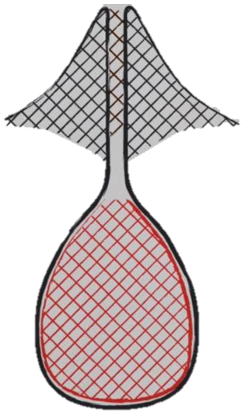
Suitable for UK KS4 or ages 14-16

Pressure in Liquids

Student worksheet

Introduction

Understanding the pressure within magma chambers below a volcano can be crucial in determining the timing and type of future eruptions. The following worksheet explores the concept of pressure in volcanoes. You will be required to use equations to perform calculations and explain phenomenon.

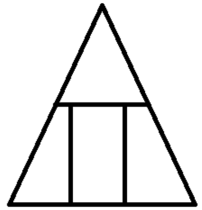


www.oxfordsparks.ox.ac.uk/scienceoutthere

Pressure Questions

Pressure and depth

1 - What is the equation that links pressure with depth within a body of liquid?



State the units used for each component of the equation

-
-
-
-

2 - Use your equation to explain why the greatest pressures are within a magma chamber are found at the bottom.

____

____

____

____

3 - Calculate the pressure in a magma chamber at a depth of 2km. Assume the density of magma is 2650kg/m^3 and gravitational field strength is 9.8N/kg. (Ignore atmospheric pressure)

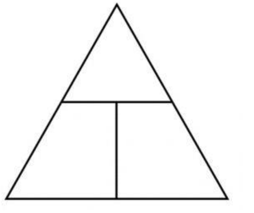
4 - Calculate the difference in pressure between magma at a depth of 6km and at a depth of 9km. Again, assume the density of magma is 2650kg/m^3 and gravitational field strength is 9.8N/kg.

5 - The density of magma can have an effect on the pressures that develop within the magma chamber. Explain why.

6 - What would the pressure at a depth of 2km be if the magma chamber contained a more dense magma with a density of 2.81g/cm^3.

Pressure and force

7 - State the equation that links pressure with force and area



State the units used for each component of the equation

Fluids (gases and liquids) exert pressure on the walls of their container. They do so in all directions as the particles in fluids are able to move randomly. In the case of volcanoes, the fluid magma within a magma chamber exerts a force on the walls of the magma chamber.

8 - State the direction of the force exerted by the liquid magma on the walls of the magma chamber

____

____

9 - Use your answers from the previous section to explain whether the magma chamber walls at the top or bottom of the chamber experience a greater pressure.

____

____

10 - At the bottom of a magma chamber/storage zone (10km down) the pressure can be in excess of 250,000kPa. Calculate the force applied by the magma on an area of the magma chamber wall $10m^2$.

____

____

____

____

11 - At less depth within the magma chamber/storage zone, pressures are lower. At a depth of 2.1km the pressure is 52.5MPa. Calculate the area of magma chamber wall that would experience the same force as that exerted on $10m^2$ of chamber wall at a depth of 10km.

____

____

____

____

12 - When a volcano is active but not exploding or extruding magma onto the surface, pressure within the magma storage area can still result in a force being applied to the 'lid' of the magma vent. If the 'lid' of the vent remains stationary, what can we assume about the size and direction of the force exerted by the 'lid'?

____

____

13 - Using both the pressure equations you have practised above, explain whether an object would experience more upthrust if (theoretically!) submerged in a more or less dense magma.

Pressure and volume

Boyle's law describes a relationship between the pressure and volume of gases.

14 - State Boyle's law and given equations that represent it.

Boyles law can be used to predict the volume of a gas at known pressures.

15 - For example, a sample of gas at standard temperature and pressure (STP: 1atm or 100,000Pa & 0˚C) has a volume of $350cm^3$. Calculate the volume of the gas sample if pressure was increased to 182,000Pa.

Inversely, Boyles law can be used to help predict the pressure of a gas sample if its volume is known.

16 - For example, a sample of gas at standard temperature and pressure (STP: 1atm or 100,000Pa & 0˚C) has a volume of $802cm^3$. Calculate the pressure the gas sample is under when its volume is exactly $1dm^3$.

17 - Suggest why Boyle's law cannot be used to predict the volume of a gas bubble within a magma chamber, even if the pressure and volume of an equal mass of gas are known at STP.