Final Problem 3 – Hobbits and Volcanoes

Volcanoes are widely considered to be a great tool for the destruction of mythical rings that could doom the entirety of middle earth.

A young Hobbit, we'll call him Frodo (Because that's his name), is making his way to a volcano to destroy one such mythical ring. It is made of gold and if it is similar to a normal gold band ring it weighs 8g.

The temperature of magma (assuming the ring was forged inside the volcano it is magma) is between 700 – 1300 degrees celsius depending in its proximity to the surface.

The melting point of gold is 1064 degrees C, the density of gold is 19 grams per cubic centimeter, gravity is 10 meters per second downwards, the mass of our pure gold ring is 8g and it is 0.01m tall. Magma has a density of 3 grams per cubic centimeter and its temperature increases 50 degrees every meter deeper. Assume the ring instantly become 700 degrees C when it hits the surface of the lava and gets 50 degrees hotter every 1m deeper it sinks. How deep does the ring sink before it melts?

An objects buoyancy is the force being applied upwards by the displacement liquid is it in it while gravity is a force being applied downwards. The sinking speed of an object is the net downwards force. Using the density of gold: 19 g/cm^3 and the density of molten rock: 3g g/cm^3, how long does it take for the ring to sink to a depth that it melts at?

Unfortunately for Frodo one of his friends, Smeagle, decided he didn't want the ring to be destroyed and fell in after the ring. If "people" have a density of 1.1g/cm^3 does smeagle sink into the lava? How long does it take for smeagle to melt (this is gruesome ignore if you want)?

Active volcanoes can be surprisingly fragile: sudden changes in mass or temperature have the potential to cause eruptions. Eruptions occur when there are changes in pressure within a volcano. If you have ever dropped a stone into water you can see that as it sinks the water it displaces creates pressure changes that can cause a burst of water to be expelled upwards (that drop of water that seems to hang over the surface of the water). The size of the burst of water is proportional to the amount of water displaced by the object as it moves through the water and the speed at which it travels. In order to achieve what some might call a volcanic eruption we would need to eject 100m^3 of lava. The amount ejected is the displaced fluid X (10 X the speed the object travels through the fluid but decays by 4% for every extra m/s). How much material in units of Smeagles or rings would it take to set off the volcano? Research the current value of gold per gram, what is the

net worth of the gold being destroyed in the volcano to set it off? If an orc can be paid off to not fight for Sauron with £100 how many orcs could be paid to fight on the good guys side instead?

In the event that enough material was thrown into the volcano to cause an eruption there has been some argument about the use of extra-large eagles for the extraction of Frodo away from an erupting volcano. The velocity of a bird is directly related to it's wingspan and whether it is laden with any weight (such as a coconut, or some hobbits). Velocity is related to how much distance they can cover. If a volcano erupts it tends to spew out hot ash, lava and red hot chunks of rock in a fairly large area, mount st helens flattened trees 300km in all directions. If we assume mount doom will blast to at least 50km on all sides and it took 5 minutes for it to erupt fully model how far and fast eagles of different wingspans would get in 5 minutes and whether they would escape the eruption. A bird's speed increases by 75km/h per m of wingspan, wings weigh 1.5kg per m. speed is slowed by the proportion of weight that a bird carries. Every 10:1 of carry weight to eagle weight slows down the bird by 10%. How large were the eagles that got the hobbits out bigger? Thorondor, the king and largest of all the eagles in middle earth had a wingspan of 55m (for reference the height of the sheledonian is only 26m), how much larger or smaller was our rescue eagle? The largest eagles on planet earth have around a 2m wingspan, how much larger was our eagle than that?

Scientifically, how realistic was the ending of lord of the rings?