HW 7

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Interiors of rocky planets

Answer the following questions.

1. Compute the average density of a hypothetical planet whose composition is 65% metals and 35% non-metals.

$$average \ density = \frac{8000 \times 65 + 3500 \times 35}{100} = 6425 \ \text{kg/m}^3$$

2. Use the NASA Planetary Fact Sheets to obtain the average densities of Venus, Earth, and Mars. Compute the percentage of metals and non-metals in each. Present your reasoning and calculations by imitating the example paragraph above.

Venus

The planet Venus has density $5243 \ \text{kg/m}^3$. This density is in-between the densities of metallic rock and non-metallic rock. Therefore, Venus is composed of a mixture of metallic rock. Let f represent the percentage of metals. Thus $100 - f$ represents the percentage of non-metals. We can form the equation for average density and compute the value of f.

$$5243 = \frac{8000 \times f + 3500 \times (100 - f)}{100}$$

$$= \frac{4500 \times f + 350000}{100} = 45 \times f + 3500$$

$$\implies 1743 = 45 \times f$$

We solve that $f = 38.73$.

Therefore we get that the planet Venus is 38.73% metals and 61.27% non-metals.

Earth

The planet Earth has density $5514 \ \text{kg/m}^3$. This density is in-between the densities of metallic rock and non-metallic rock. Therefore, Earth is composed of a mixture of metallic rock. Let f represent the percentage of metals. Thus $100 - f$ represents the percentage of non-metals. We can form the equation for average density and compute the value of f.

$$5514 = \frac{8000 \times f + 3500 \times (100 - f)}{100}$$

$$= \frac{4500 \times f + 350000}{100} = 45 \times f + 3500$$

$$\implies 2014 = 45 \times f$$

We solve that $f = 44.76$

Therefore we get that the planet Earth is 44.76% metals and 55.24% non-metals.

Mars

The planet Mars has density $3934 \ \text{kg/m}^3$. This density is in-between the densities of metallic rock and non-metallic rock. Therefore, Mars is composed of a mixture of metallic rock. Let f represent the percentage of metals. Thus $100 - f$ represents the percentage of non-metals. We can form the equation for average density and compute the value of f.

$$3934 = \frac{8000 \times f + 3500 \times (100 - f)}{100}$$

$$= \frac{4500 \times f + 350000}{100} = 45 \times f + 3500$$

$$\implies 434 = 45 \times f$$

We solve that $f = 9.64$

Therefore we get that the planet Mars is 9.64% metals and 90.36% non-metals.

3. Discuss cause and effect: how did the clearing phase of planet formation lead to Mars having a lower percentage of metals than Venus and Earth?

Earth and Venus formed closer to the sun, in the part of the accretion disk where there was more materials (especially metals). Since Earth and Venus already had a lot of this metal material before the clearing phase, they had higher metal content. In contrast, Mars didn't, so it has less.

Citations

"Planetary Fact Sheet." NASA. Accessed March 19, 2025.
https://nssdc.gsfc.nasa.gov/planetary/factsheet/index.html.