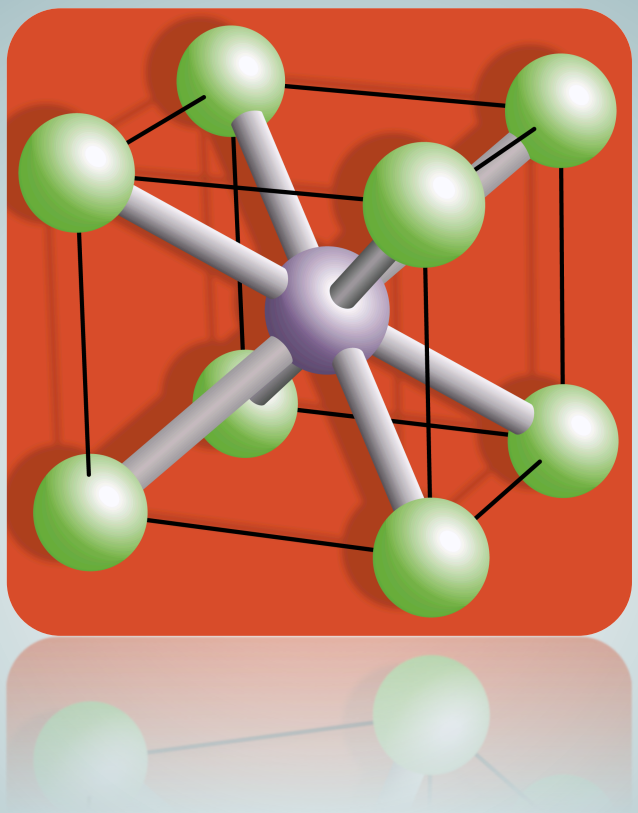
Materials

Exercises Topic 9. Oxidation



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OXIDATION

1. Calculate the percentage of volume variation from metal to oxide (Pilling-Bedworth percentage) for the Aluminum oxidation to Aluminum oxide (Al_2O_3). Aluminum density equals to 2,70 g/cm^3 and Aluminum oxide 3,70 g/cm^3.

2. The following data represent the weight facing the time in an oxidation process of a certain metal at high temperature:

W (mg/cm^2)	1,10	4,40	22,00
tiempo (horas)	50	200	1000

This metal is used to manufacture the circular cover of an autoclave that is going to work with oxidizing atmospheres. This item dimensions are 2 meters of diameter and 20 mm of thickness. Supposing that just the inner face of the cover contacts the oxidizing atmosphere and that this metal density equals ρ = 7,2 g/cm^3, estimate its life in service if it must be replaced when its mass had increased 2% by security reasons.

3. A thermoscales is a device that registers the weight of a certain specimen at different temperatures. One of this devices has a steel wire (density ρ = 7.85 g/cm^3) of 3 mm of diameter and 200 mm long, from which a 3 Kg container where the samples to be weighed are placed (1 kg = 9.81 N) is hanged. It was proved that, after 10.000 hours at 180ºC, the thermos-creep deformation in steady state of the wire, due to the weight of the container, is of 2.8×10^{-3} %. If the temperature is increased up to 250ºC, the creep rate of the wire is 2.2×10^{-6} hours^{-1}.

Regular operating conditions for the thermoscales is 200 ºC, and the specimens placed in the container have an average mass of 30 Kg. The creep behavior of the wire material follows a law of the type:

$$\dot{\varepsilon}_{ss} = \frac{1}{AT}\sigma^2 e^{-Q/RT}$$

Where A is a characteristic constant of the material, Q is the Energy of Activation for the creep process, R = 2 cal/mol·K is the universal constant for ideal gases, and T is the absolute temperature. In these conditions:

1) Estimate the energy for activation of the creep process in the wire.
2) Derive the complete creep law for this material determining the value of the constant A.
3) If by safety requirements, the maximum deformation allowable in the wire is 5% and it must be replaced when its mass has increased 15% by oxidation at high temperature, estimate its life in service and indicate the cause that will motivate its replacement, knowing that just the lateral area of the wire is exposed to the oxidizing atmosphere, and that the kinetics of the oxidation of the material for the service temperature is given by the attached graph.