

# The Heated Wire Experiment

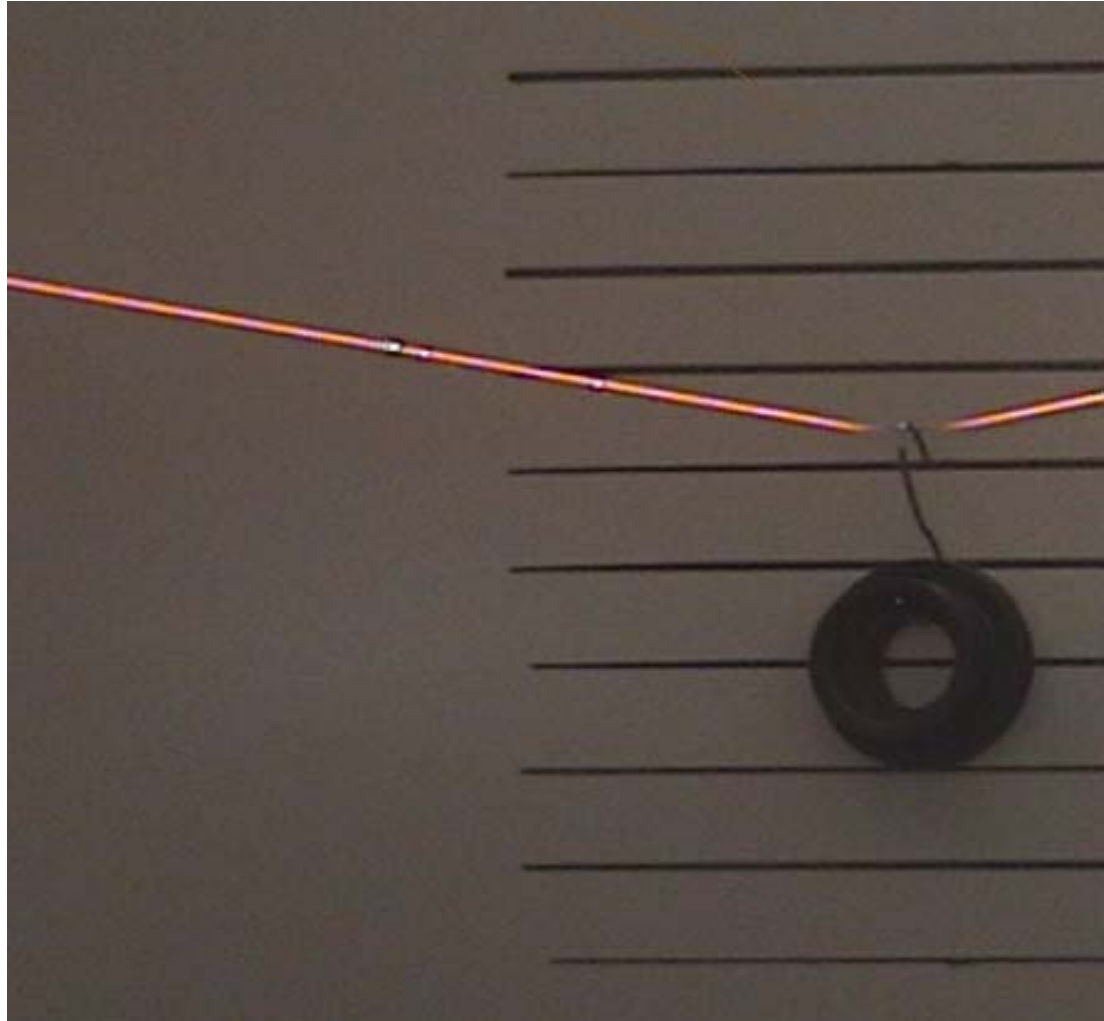
**A Low Carbon Steel Wire is Heated With alternating Electric Current. The Heated wire expands and lengthens, and its resistance increases.**

**This causes a decrease in the current and an increase in the voltage. The wire becomes red hot.**

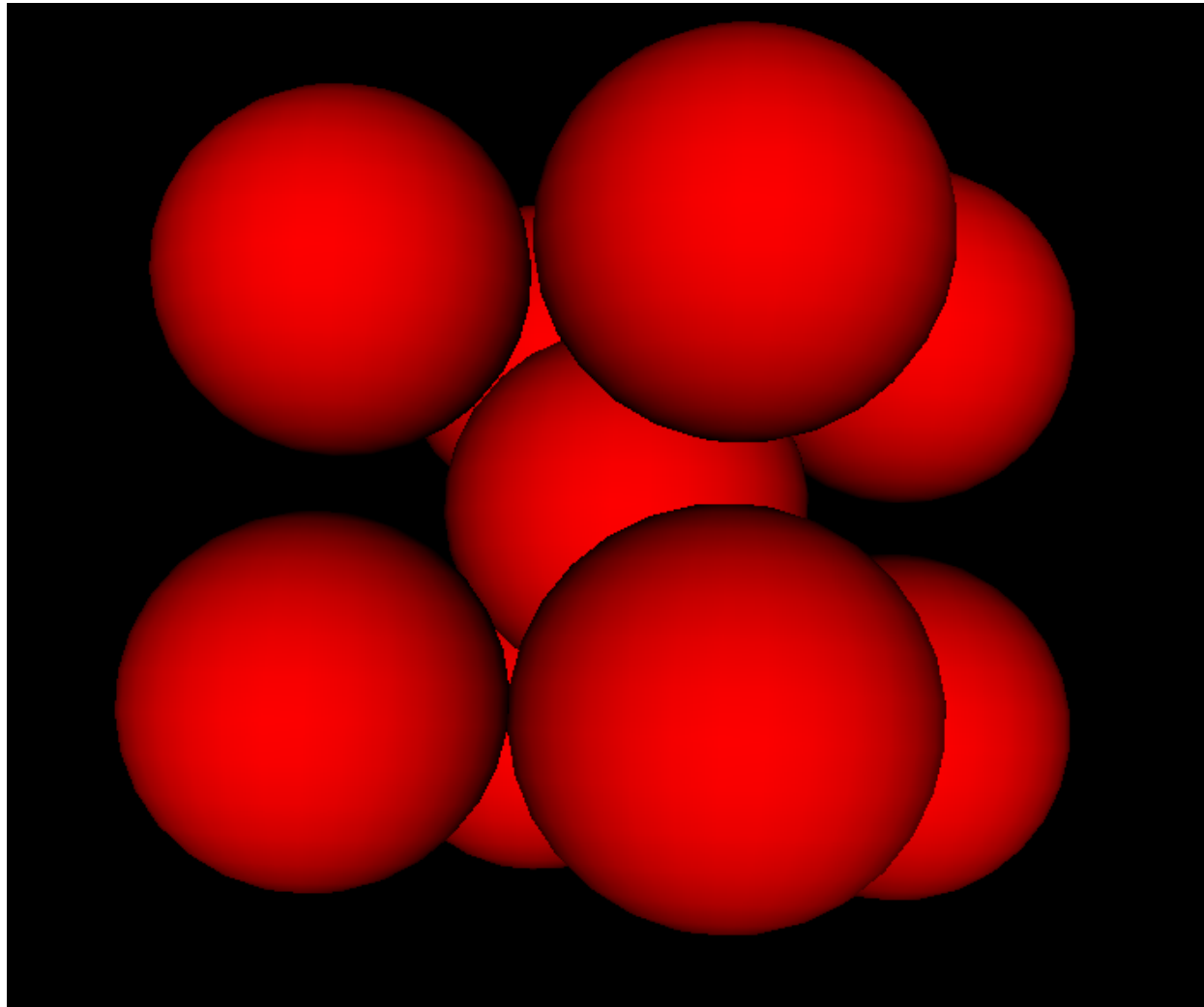
**Then when the current is turned off, the wire cools and the weight rises. But unexpectedly, the weight lowers again a bit, before resuming its rise.**

**This brief lowering is caused by a phase change in the Iron.**

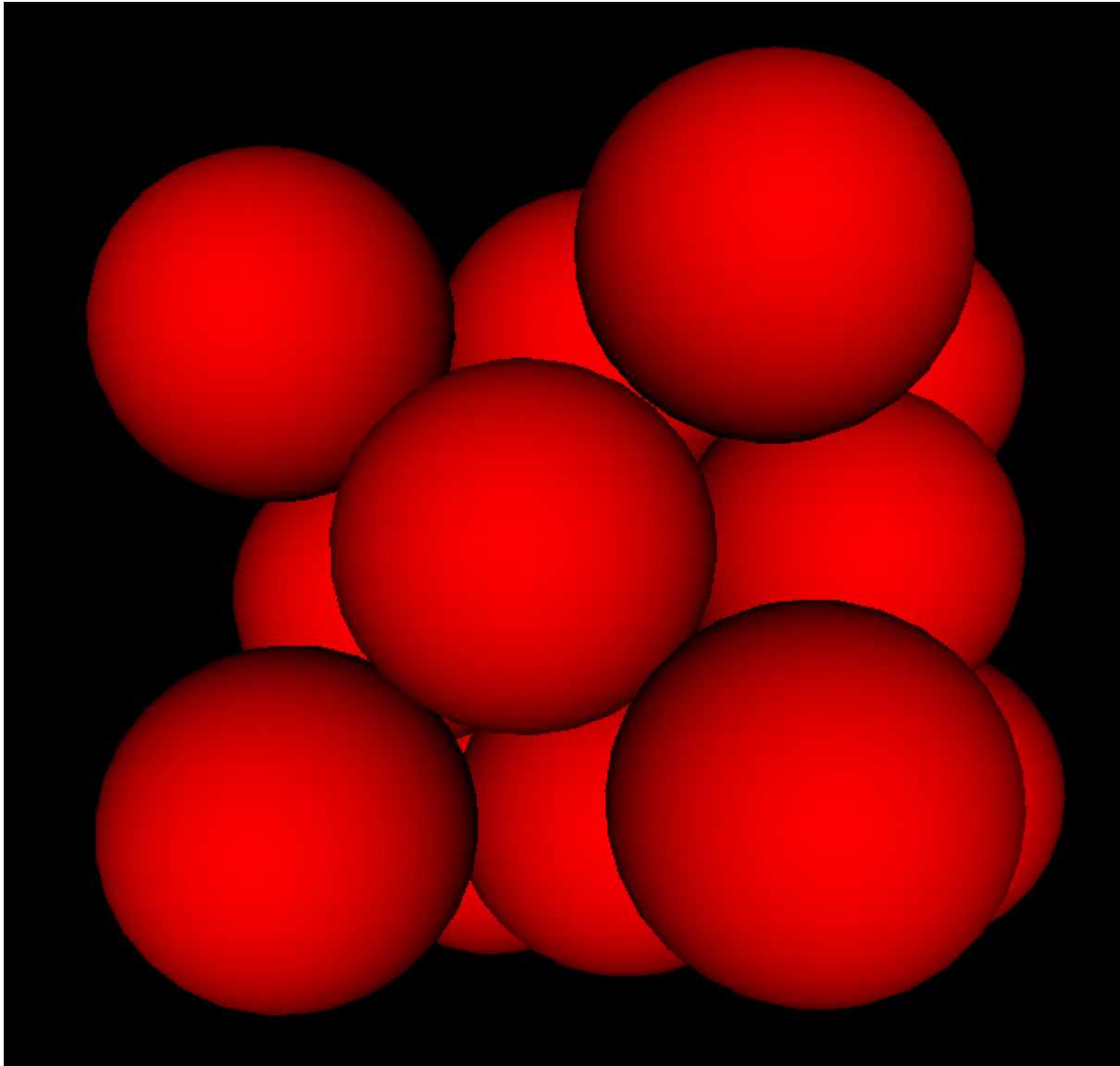
# Wire Video



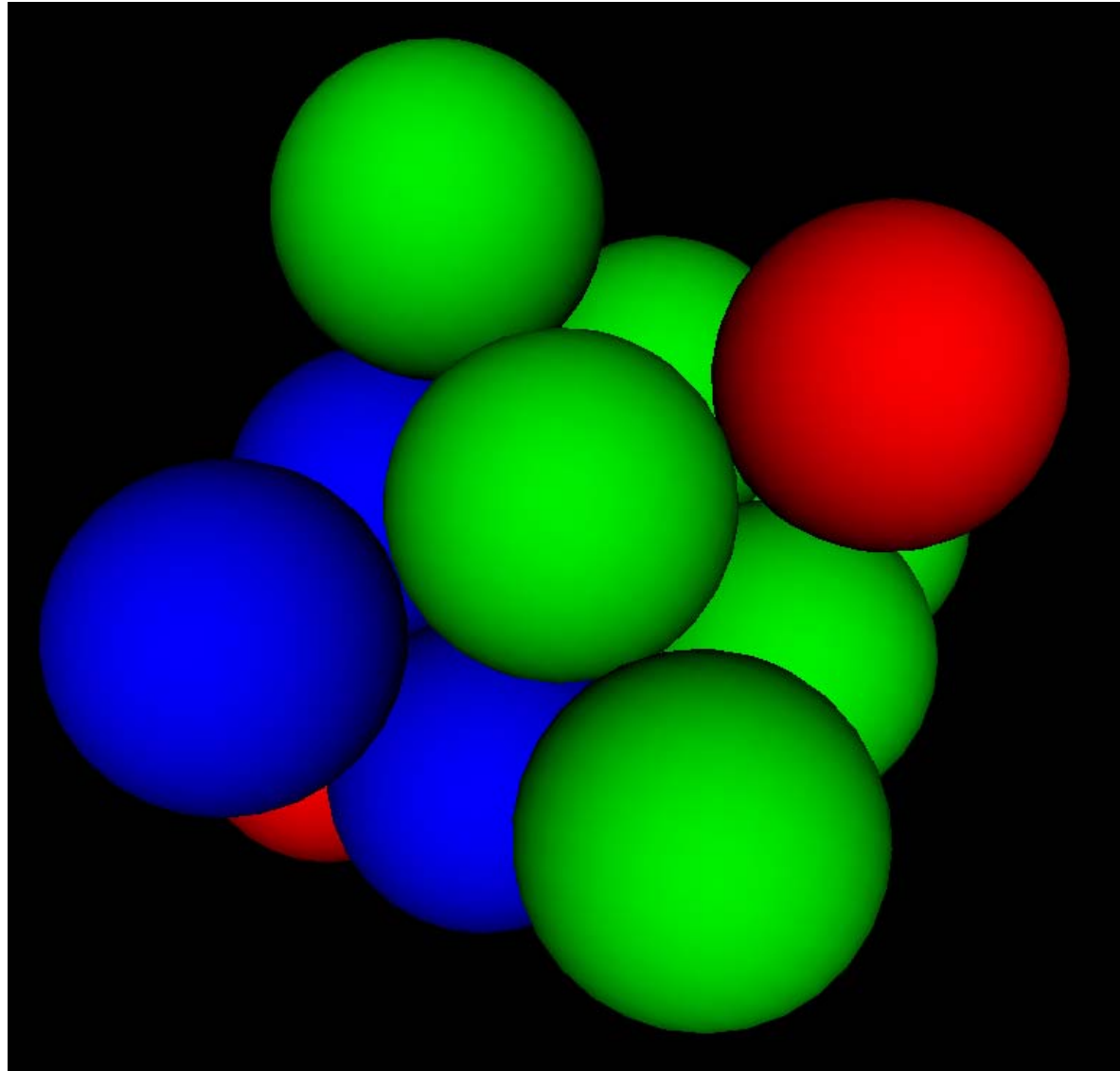
# Body Centered Cubic (BCC)



# Face Centered Cubic (FCC)



# FCC Showing Close Packed Planes, In Green and Blue.



# FCC Is More Dense Than BCC

**The Face Centered Cubic structure of Austenite is more dense than the Body Centered structure of Ferrite. Iron takes the Ferrite form at low temperatures and the Austenite form at high temperatures.**

**The Face Centered Cubic structure features close packed octahedral planes of atoms, colored green and blue.**

**The density ratio of FCC to BCC is 1.08**

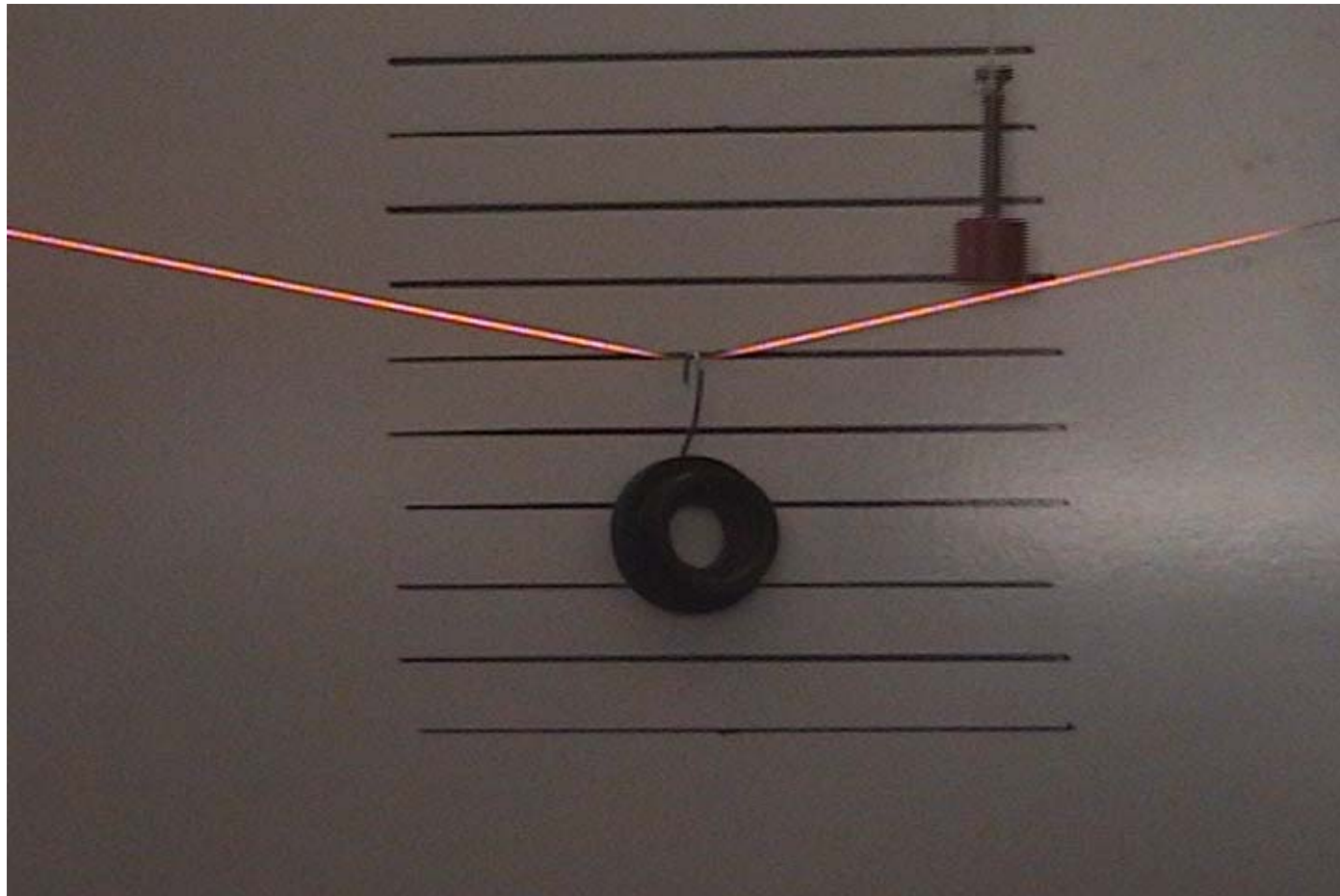
# Curie Point

**The Curie Point is the temperature at which Iron becomes nonmagnetic.**

**The Curie point is 770 C.**

# Curie Point Video

Showing a magnet not able to attract the wire.



# Close Packed Stacking of Spheres

**A second layer of spheres above a first layer of close packed spheres is started by positioning a first sphere. This sphere may be placed in one of the six spaces around a given sphere in the first layer. Numbering the spaces as 1,2,3,4,5,6, the first sphere can be placed in position say 1. Then a second sphere can not be placed in position 2 or 6 because there is no room. So three spheres may be placed around the sphere in the first layer either in the order 1,3,5, or 2,4,6. These are two different arrangements. In the third layer again we have two different starting arrangements. If the starting sphere is above a sphere in the first layer, we get a layer structure ABABAB... Otherwise we get a second close packed structure ABCABC ... The ABCABCABC... structure is the Face Centered Cubic Structure. The ABABAB... structure is the Hexagonal Close Packed structure**

# A Picture of a Frame Containing Spheres Modeling Atoms



The second layer of spheres can be stacked in two equivalent ways.



## Third Layer

If in the third layer, a sphere falls directly over a sphere in the first layer, then we get the close packed stacking ABAB... occurring in close packed hexagonal structure, otherwise we get the structure ABCABC...occurring in the Face Centered Cubic lattice



# Electrical Connections.

Two 1200 Watt electric heaters are first connected together in parallel. Then they are connected in series with the wire. Initially the heaters get most of the 120 AC volts, but later the wire gets 30 to 40 volts as the resistance of the heated wire increases.

# Electrical Measurements

**The voltage is measured with a digital multi-meter, and the current with an AC clamp meter.**

# Electrical measurement video



# The Clamp Meter

**An explanation of the operation of an AC clamp meter provides an excellent illustration of Maxwell's Equations.**

# Maxwell's Equations

$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t},$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t},$$

$$\nabla \cdot \mathbf{D} = \rho,$$

$$\nabla \cdot \mathbf{B} = 0.$$

# Other Measurements

The experiment can be used to determine the linear temperature coefficient of expansion, and the coefficient for increase of resistance with temperature.