Name _____ Date _____ Period _____

**Project Xtal Radio**

**Mathematical Computations and Completion Dates**

**Coil:** **Due Date: _March 9, 2007 _____**

1. Diameter of coil in inches _____
2. Length of windings in inches _____
3. Number of turns of wire _____

Inductance Calculated _____

**Capacitor:** **Due Date: _March 23, 2007 _____**

1. Dielectric constant _____
2. Plate separation _____
3a. Area of plate (max) _____
3b. Area of plate (min) _____
4. Number of plates _____

Maximum capacitance _____
Minimum capacitance _____

**Tuning range of radio:**

1. Inductance _____
2a. Capacitance (max) _____
2b. Capacitance (min) _____

**Final answer:**
Tuning range of my radio is from _____ to _____

**Completed Radio:** **Due Date: _ April 6, 2007 _____**

On this day radios will be taken to the antenna sight and tested. This project will count as a test grade. Radios completed early and working before due date receive a 10 point bonus. Radios completed after the due date will receive a 50 point deduction.

**Project Xtal Radio – Mathematical Computations**

**Objectives:** 1. Calculate the inductance for the coil
2. Calculate the minimum and maximum capacitance of your capacitors
3. Calculate the tuning range of your radio.

Be precise and accurate with your measurements. Avoid parallax. Make all measurements to the nearest $10^{th}$ of an inch.

An **inductor** consists of a coil of wire to establish a magnetic field. **Inductance** is the characteristic of an electrical circuit that opposes the starting, stopping, or a change in value of current. The symbol for inductance is **L** and the basic unit of inductance is the **Henry** (**H**). One Henry is equal to the inductance required to induce one volt in an inductor by a change of current of one ampere per second.

Use the following formula for calculating the value of the inductor: $L\ (\mu H) = \frac{d^2 n^2}{18d + 40l}$

**L** = value of inductor in microhenrys (**ìh**)
**l** = coil length in inches
**d** = coil diameter in inches
**n** = number of turns

A **capacitor** is a device constructed of parallel metal plates and capacitors are used for storing electrical energy. There is never a continuous flow of current in a capacitor because the plates are insulated from each other. The symbol for capacitance is **C** and the basic unit of capacitance is the **Farad** (**F**). Since the capacitor used in the radio is variable, minimum and maximum values must be determined for the tuning range of the radio. **A** is the area of one side of one plate (foil) in square inches that is parallel with the adjacent plate (aluminum can). The maximum area between the foil and the can will yield the maximum capacitance. The minimum area between the foil and the can will yield the minimum capacitance. Why can't a value of zero be used for the area? For practical application (which approximates a realistic tuning environment), do the minimum value calculation with a 3% area overlap between the foil and the can. If the material between the foil and can is the acetate transparency, set **K** to 2.3 and **d** (thickness of the material) to .009 inches. If the material between the foil and the can is construction paper, set **K** to 1.7 and **d** to .017 inches.

Use the following formula for calculating the value of the capacitor: $C(pF) = 0.224\ \frac{KA}{d}\ (n-1)$

**C** = value of capacitor in picofarads (**pf**)
**K** = dielectric constant of material between the plates
**A** = area of one side of one plate in square inches
**d**. = separation of plate surfaces in inches
**n** = number of plates

After calculating the inductance and capacitance, now calculate the tuning range of your radio. The received frequency of your radio is controlled by the values of capacitance and inductance. As the value of the capacitor changes, so does the frequency received. Two calculations for frequency are needed, one for the maximum value of the capacitor and another for the minimum value of the capacitor.

The formula for calculating frequency is: $f\ (kHz) = \frac{10^6}{2p\sqrt{LC}}$

**f** = frequency in kilohertz (kHz)
**L** = inductance in microhenrys (ìh)
**C** = capacitance in picofarads (pf)