UNIT – 2

SIGNAL RECORDERS

Cathode Ray Oscilloscope (CRO)

1. CRO stands for __________.

    Current Resistance Oscillator
    Capacitance Resistance Oscilloscope
    Central Resistance Oscillator
    Cathode Ray Oscilloscope

2. A function generator is a multipurpose signal source, it can generate:

    Square Wave
    Triangle Wave
    Sine Wave
    All of above

3. An advantage of Oscilloscope over multimeter is that

    We can measure accurate value of voltage
    We can see the wave shape of voltage
    We can measure accurate value of current
    We can measure accurate resistance

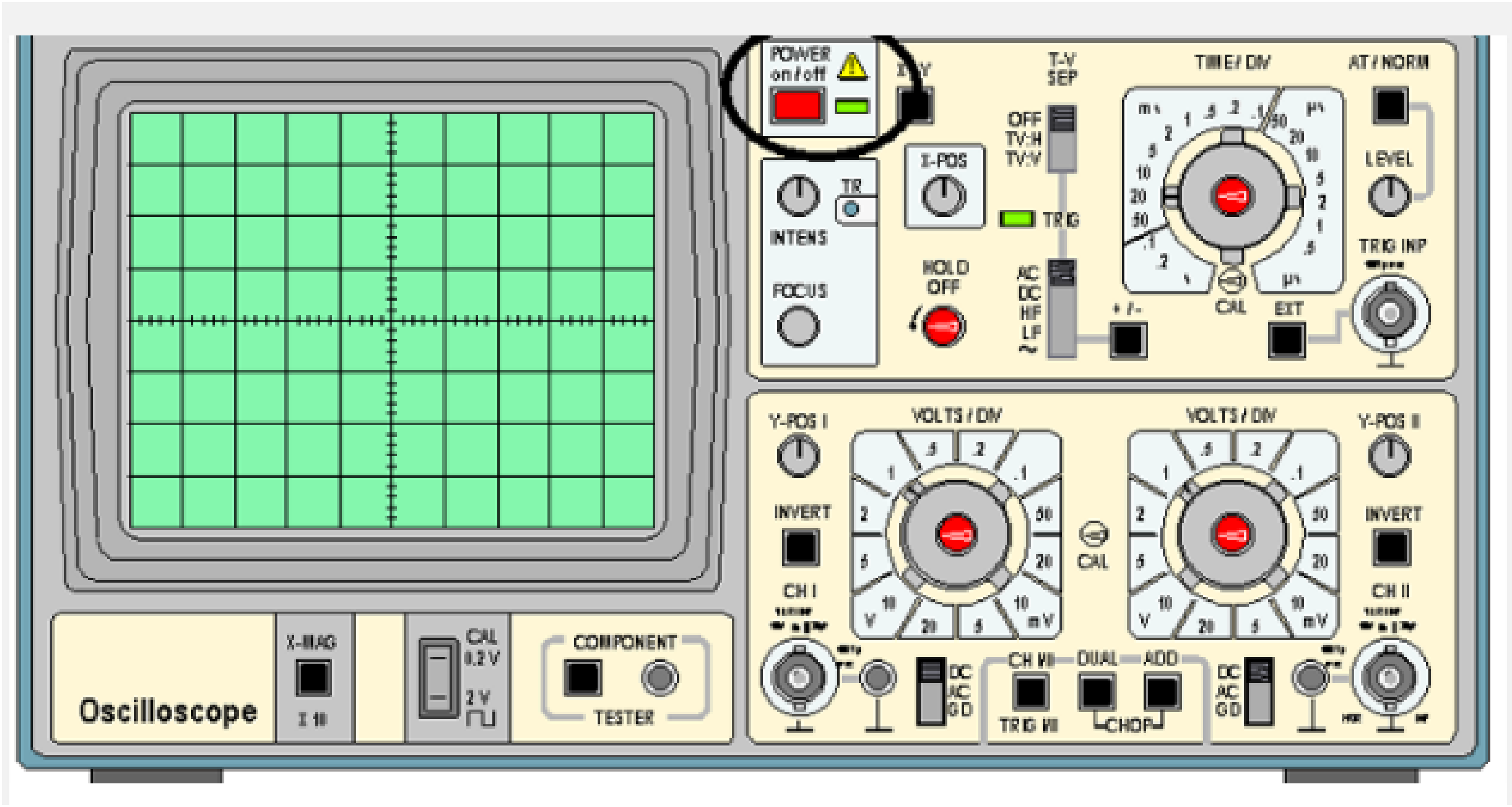
4. The graticule of an oscilloscope, which has a grid pattern graduated in

- **Square centimeters**
- **Millimeters**
- **Centimeters**
- **None of these**

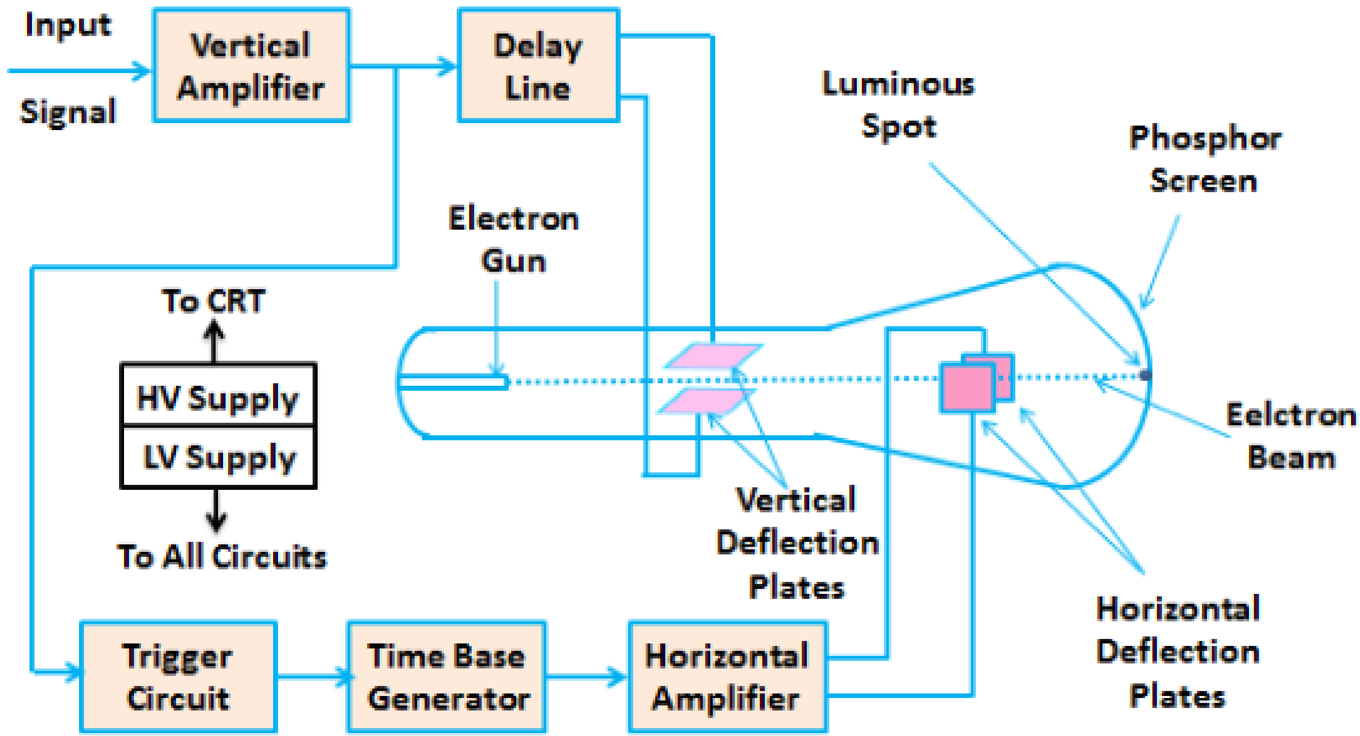
5. If the vertical sensitivity is set to 0.5 volt per division and occupies 4 divisions, then peak-to-peak voltage is

- **4 volt**
- **5 volt**
- **2 volt**
- **20 volt**

Cathode Ray Oscilloscope (CRO)

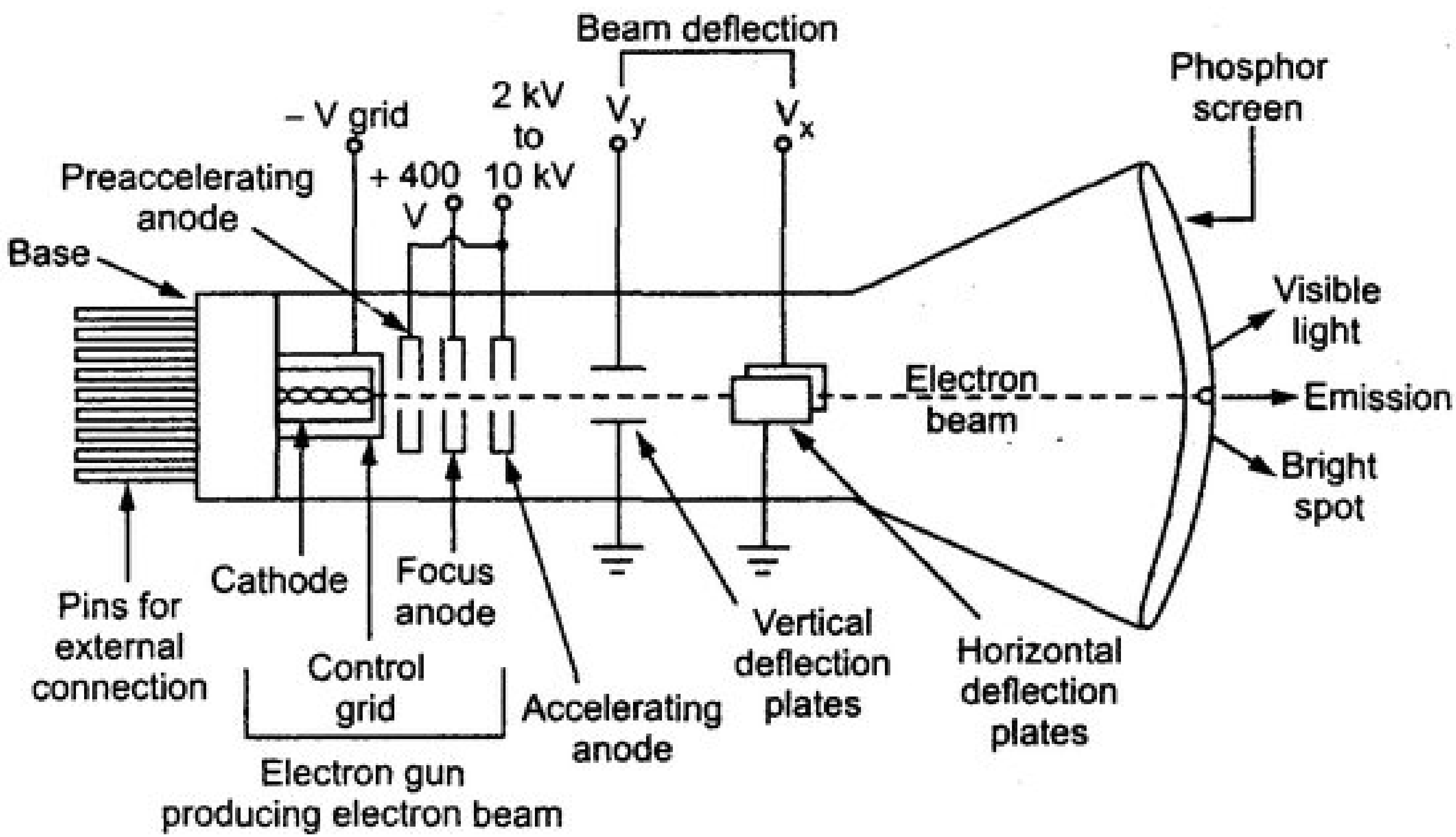


Block Diagram



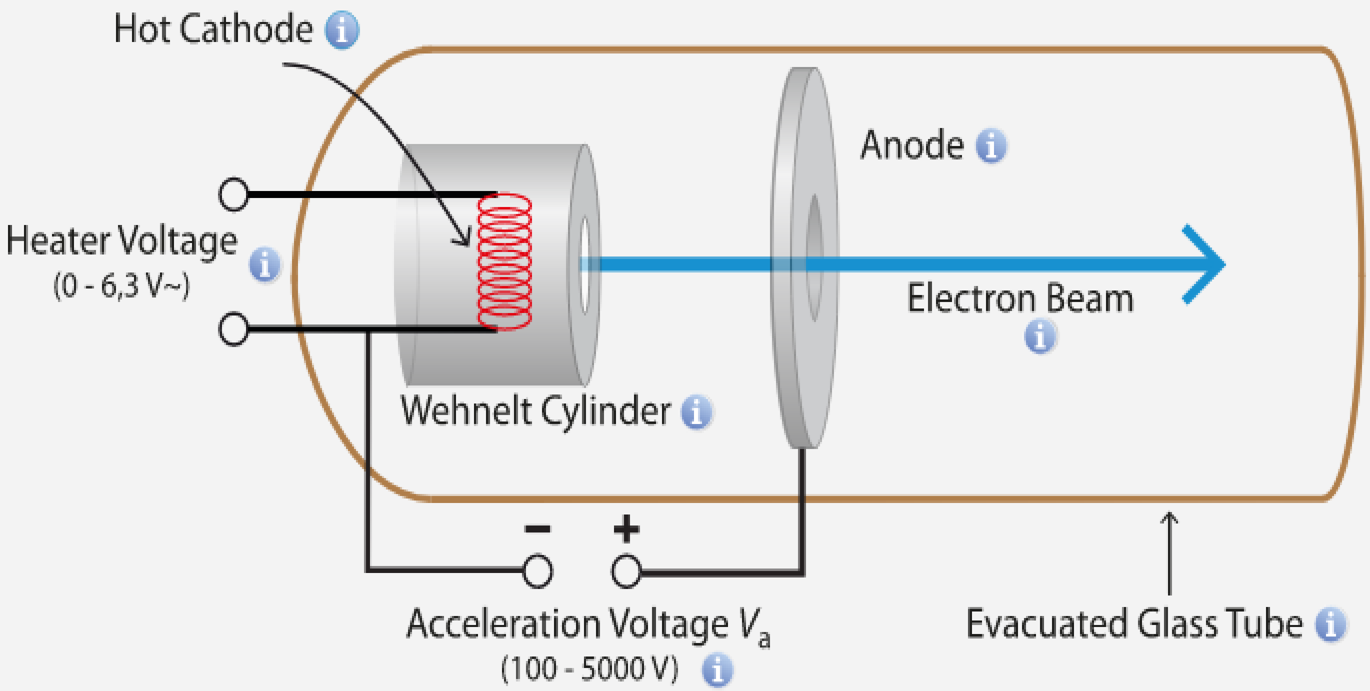
Block Diagram of Cathode Ray Oscilloscope (CRO)

Cathode Ray Tube



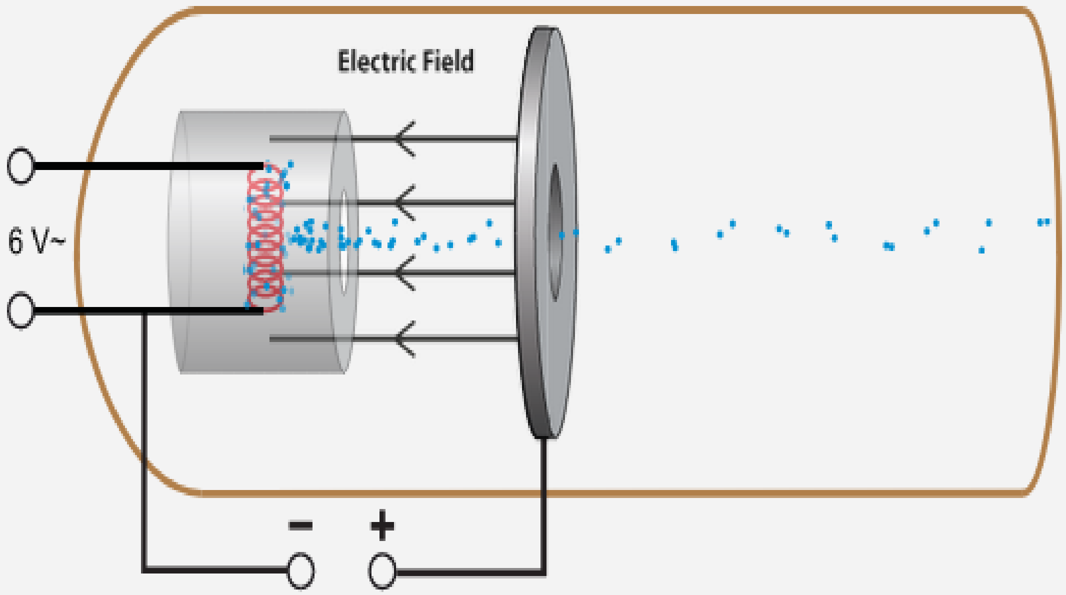
Electron Gun Setup:

For information about the function click on the items of the Electron Gun.



Function of an Electron Gun

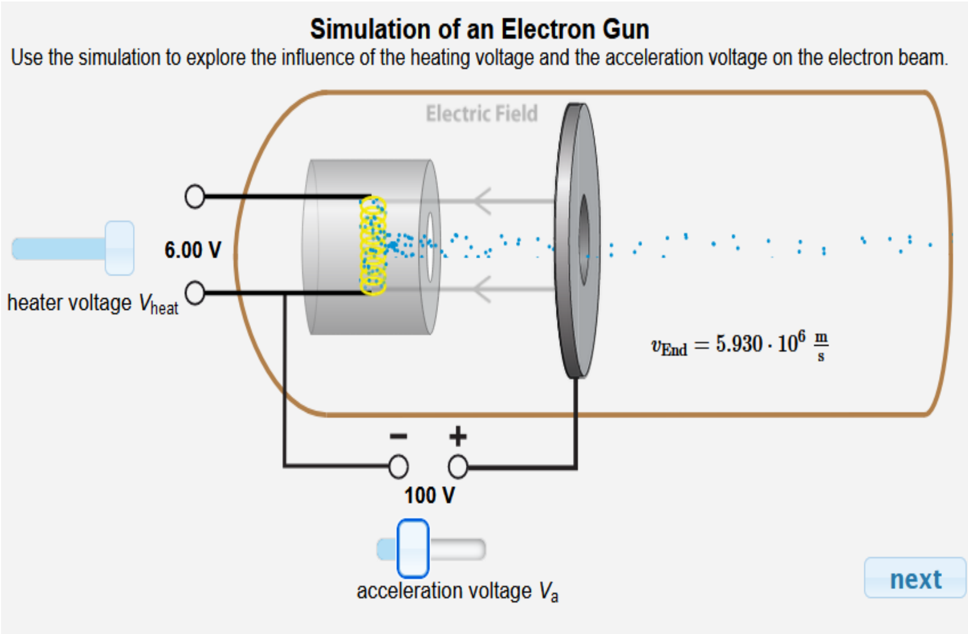
The heater voltage V_{heat} causes a current flow via the filament. This current heats the filament and because of the thermionic emission (thermal electron emission) electrons get out of the metal. So an electron cloud is set up around the hot cathode.

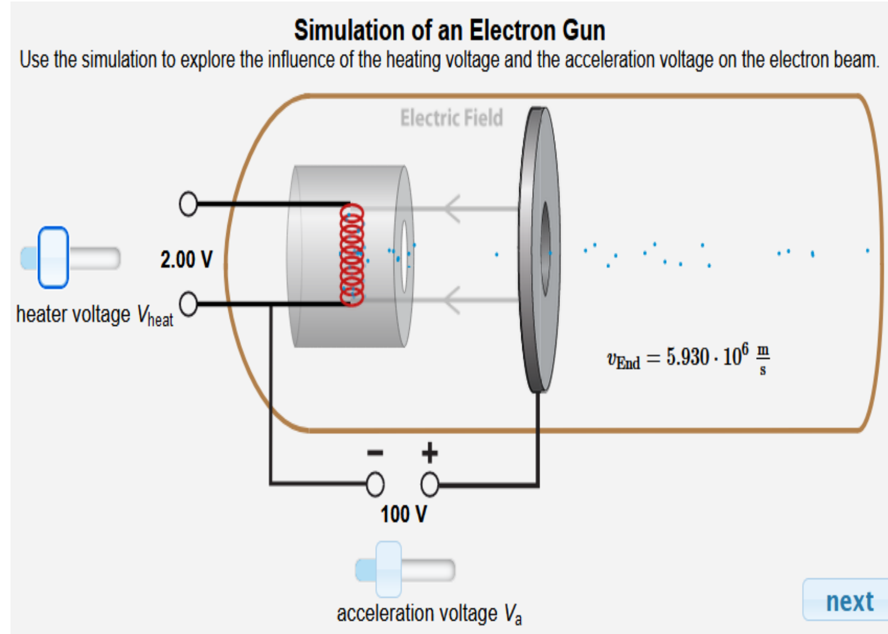


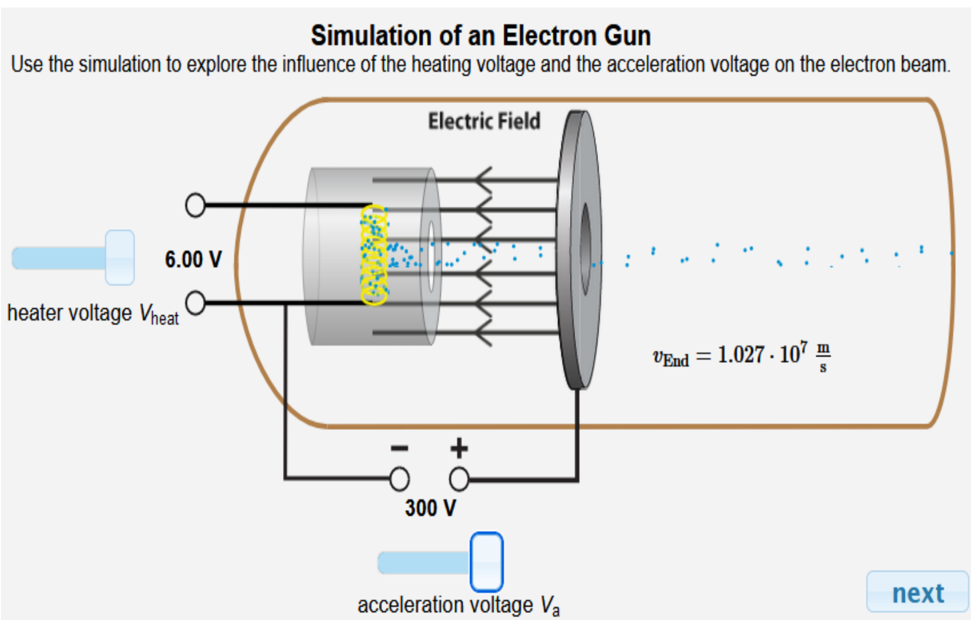
The acceleration voltage V_a generates an electric field between the hot cathode and the anode. This field accelerates the free electrons from the hot cathode to the anode.

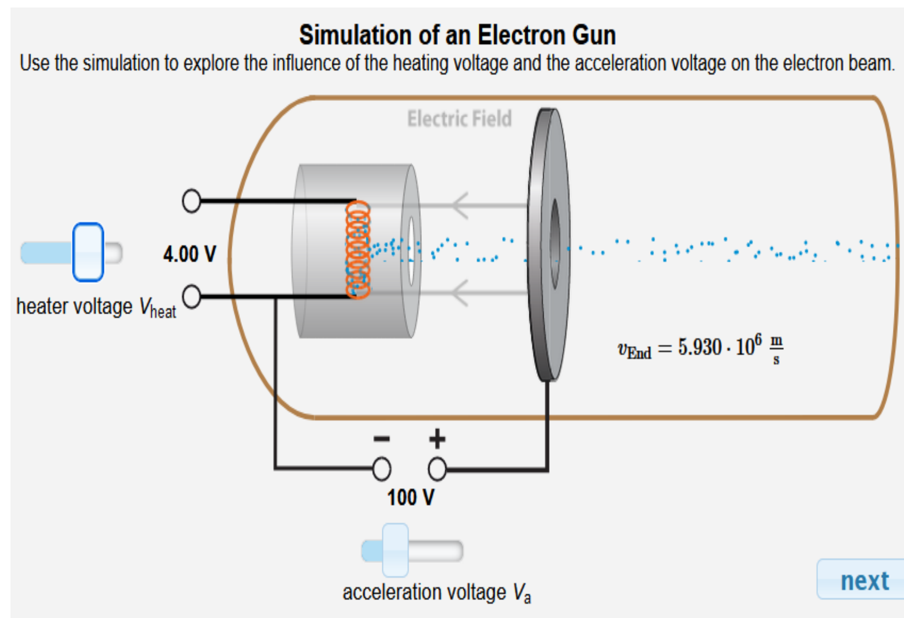
After passing the anode the electrons move forward with constant speed in a straight direction. Everything happens in an evacuated glass bulb, so that the electrons does not clash with air molecules.

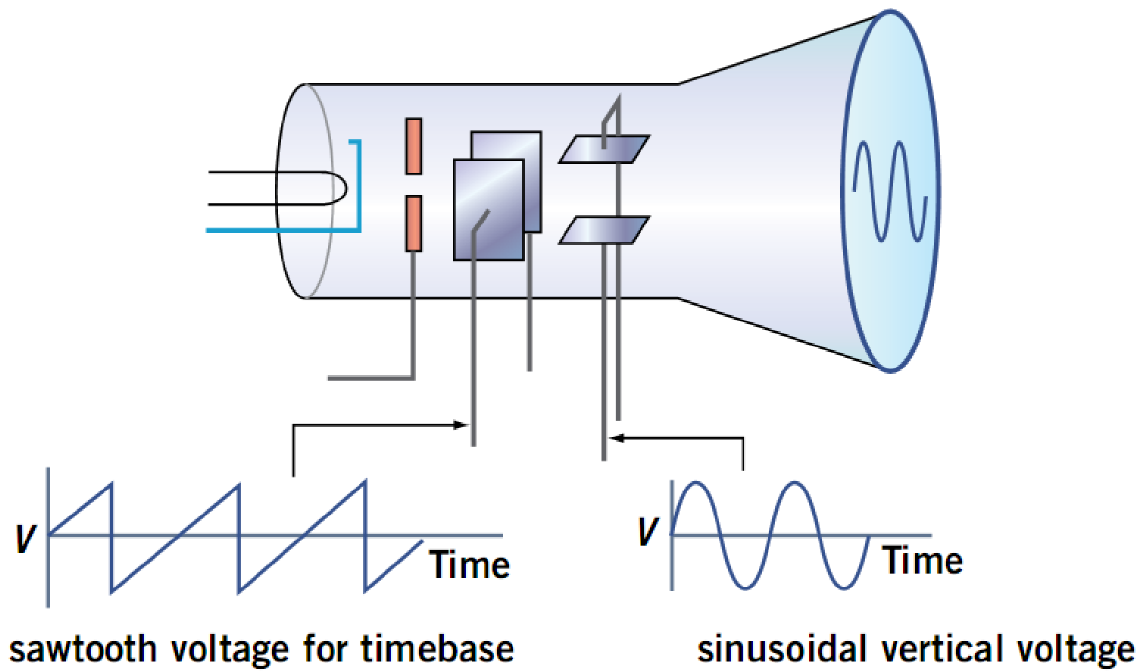
next

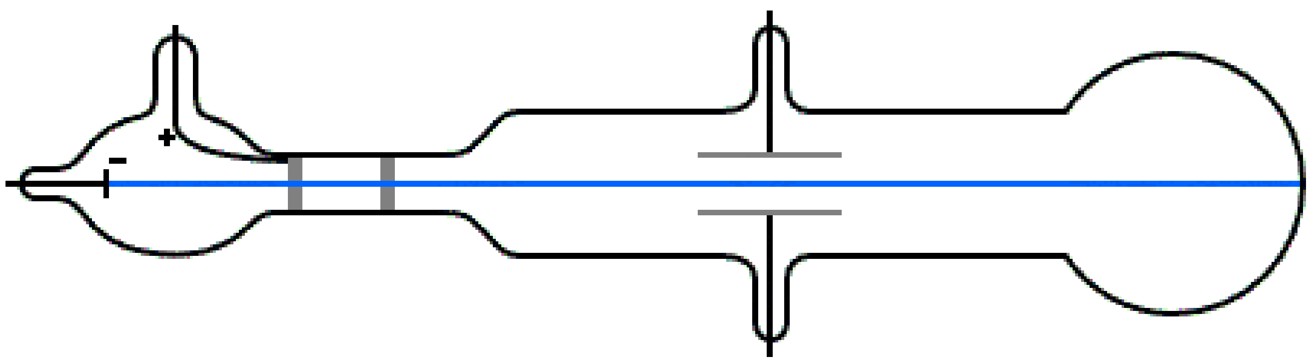

Simulation of an Electron Gun
Use the simulation to explore the influence of the heating voltage and the acceleration voltage on the electron beam.
Electric Field
6.00 V
heater voltage V_{heat}
$v_{End} = 5.930 \cdot 10^6 \ \frac{m}{s}$
−
+
100 V
acceleration voltage V_a
next


Simulation of an Electron Gun
Use the simulation to explore the influence of the heating voltage and the acceleration voltage on the electron beam.
Electric Field
2.00 V
heater voltage V_{heat}
$v_{End} = 5.930 \cdot 10^6 \ \frac{m}{s}$
−
+
100 V
acceleration voltage V_a
next


Simulation of an Electron Gun
Use the simulation to explore the influence of the heating voltage and the acceleration voltage on the electron beam.
Electric Field
6.00 V
heater voltage V_{heat}
$v_{End} = 1.027 \cdot 10^7 \ \frac{m}{s}$
−
+
300 V
acceleration voltage V_a
next


Simulation of an Electron Gun
Use the simulation to explore the influence of the heating voltage and the acceleration voltage on the electron beam.
Electric Field
4.00 V
heater voltage V_{heat}
$v_{End} = 5.930 \cdot 10^6 \ \frac{m}{s}$
−
+
100 V
acceleration voltage V_a
next


V
Time
sawtooth voltage for timebase
V
Time
sinusoidal vertical voltage


+
–

Cloze test about the function of an Electron Gun

Drag the words!

A ________ causes a current through the hot cathode. The cathode starts glowing. Because of the ________ emission some ________ can leave the wire and build a cloud of so called ________ around the glowing wire. To produce a fine electron beam these electrons must be forced to the center of the glowing wire. For this a ________ is used. The cylinder is charged ________ and forces the electrons in the center of the cylinder.

In addition, a high voltage is applied between the filament and the circular ________. Here the filament is charged negative, the anode ________. This voltage causes an ________ field between hot cathode and anode. This field accelerates the electrons ________ and causes a motion towards the anode. In the center of the anode is a small ________, so the electrons can pass through the anode. A fine electron beam is created. When passing through the anode the electrons leave the electric field between filament and anode. So there is no more ________ and the electrons move forward with ________ velocity.

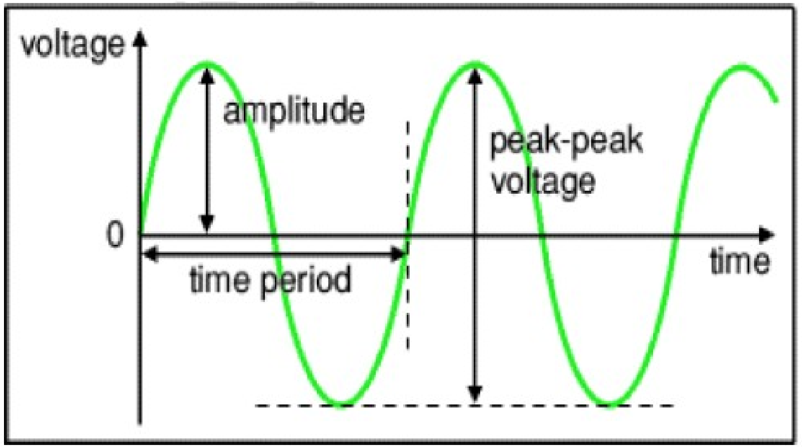
- filament voltage
- opening
- thermionic
- uniformly
- electrons
- negative
- electrical
- constant
- Wehnelt cylinder
- positive
- free electrons
- anode
- acceleration

Cloze test about the function of an Electron Gun

Drag the words!

A [ ] filament voltage causes a current through the hot cathode. The cathode starts glowing. Because of the [ ] thermionic emission some [ ] electrons can leave the wire and build a cloud of so called [ ] free electrons around the glowing wire. To produce a fine electron beam these electrons must be forced to the center of the glowing wire. For this a [ ] Wehnelt cylinder is used. The cylinder is charged [ ] negative and forces the electrons in the center of the cylinder. In addition, a high voltage is applied between the filament and the circular [ ] anode. Here the filament is charged negative, the anode [ ] positive. This voltage causes an [ ] electrical field between hot cathode and anode. This field accelerates the electrons [ ] uniformly and causes a motion towards the anode. In the center of the anode is a small [ ] opening, so the electrons can pass through the anode. A fine electron beam is created. When passing through the anode the electrons leave the electric field between filament and anode. So there is no more [ ] acceleration and the electrons move forward with [ ] constant velocity.

- filament voltage
- opening
- thermionic
- uniformly
- electrons
- negative
- electrical
- constant
- Wehnelt cylinder
- positive
- free electrons
- anode
- acceleration



Amplitude is the maximum voltage reached by the signal. It is measured in volts. **Peak voltage** is another name for amplitude.

Peak-peak voltage is twice the peak voltage (amplitude). When reading an oscilloscope trace it is usual to measure peak-peak voltage.

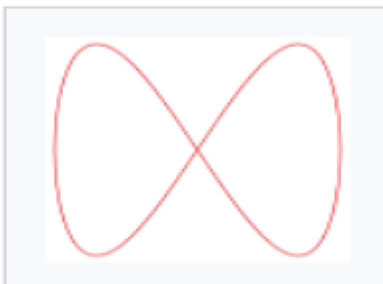
Time period is the time taken for the signal to complete one cycle. It is measured in seconds (s), but time periods tend to be short so milliseconds (ms) and microseconds (μs) are often used. 1ms = 0.001s and 1μs = 0.000001s.

Frequency is the number of cycles per second. It is measured in hertz (Hz), but frequencies tend to be high so kilohertz (kHz) and megahertz (MHz) are often used. 1kHz = 1000Hz and 1MHz = 1000000Hz.

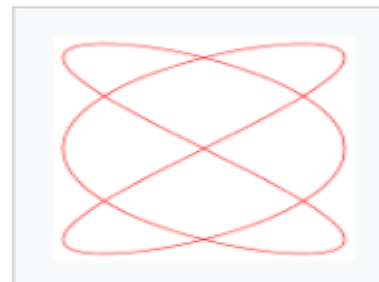
Lissajous Figure

oscilloscope, suppose x is channel 1 and y is channel 2, A is the amplitude of channel 1 and B is the amplitude of channel 2, a is the frequency of channel 1 and b is the frequency of channel 2, so $\frac{a}{b}$ is the ratio of frequencies of the two channels, and δ is the phase shift of CH1.
The following figure shows some of the possible curves that can be drawn by varying the frequency and phase of the sinusoidal functions.

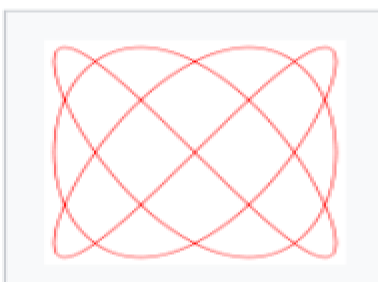
(a) $\delta = \frac{\pi}{2}$, a = 1 and b = 2, (1:2)



(b) $\delta = \frac{\pi}{2}$, a = 3 and b = 2, (3:2)



(c) $\delta = \frac{\pi}{2}$, a = 3 and b = 4, (3:4)



(d) $\delta = \frac{\pi}{2}$, a = 5 and b = 4, (5:4)