Unit 20 · Electrons

WORKSHEET

Full marks 34

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 34

1 Key words [4]

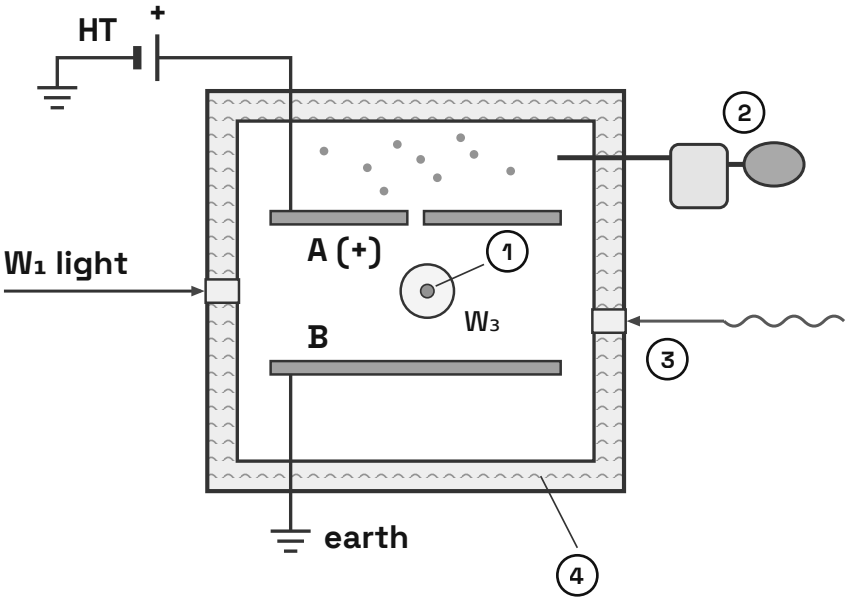
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

electron volt	**neutron**	**parabola**	**photon**	**quantized**	**specific charge**	**terminal velocity**
velocity selector	**viscous drag**	**X-rays**				

Every charge is a whole number of times the charge of an electron: charge is _____. In Millikan's experiment a drop soon falls at a steady speed, its _____, when its weight is balanced by the upthrust and the _____ of the air. The drops are charged, or their charge changed, by a beam of _____. An electron beam entering a uniform electric field at right angles to it bends along a _____. The charge of a particle divided by its mass is its _____. Crossed electric and magnetic fields that let through only particles of speed E/B make a _____. The energy an electron gains in moving through a p.d. of 1 V is one _____.

2 Label the diagram [2]

The diagram is a sketch of Millikan's apparatus. Write the label that belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [5]

Choose the correct option for each of the following questions. Take $e = 1.6 \times 10^{-19}$ C and the mass of an electron 9.1×10^{-31} kg.

i. An electron starting at rest is accelerated through a p.d. of 250 V. Its speed becomes about: [1]

a. 2.2×10^{6} m/s **b.** 9.4×10^{6} m/s

c. 8.8×10^{13} m/s **d.** 6.6×10^{6} m/s

ii. Which of these could **not** be the charge on an oil drop? [1]

a. 3.2×10^{-19} C **b.** 2.4×10^{-19} C

c. 8.0×10^{-19} C **d.** 1.6×10^{-19} C

iii. In crossed fields of $E = 3.0 \times 10^{4}$ V/m and $B = 2.0 \times 10^{-3}$ T, the electrons that pass straight through have a speed of: [1]

a. 6.0×10^{1} m/s **b.** 6.7×10^{-8} m/s

c. 1.5×10^{7} m/s **d.** 1.5×10^{4} m/s

iv. An electron beam enters the uniform field between two charged plates, moving at right angles to the field. Between the plates its path is: [1]

a. a straight line **b.** a circle

c. a parabola **d.** a helix

v. One electron volt is: [1]

a. the charge of an electron **b.** 1.6×10^{-19} J

c. 1 J/C **d.** the speed an electron gains through 1 V

4 Short answers [6]

Write short answers to the following questions.

a. Why does an oil drop falling between Millikan's plates, with no field, soon move at a steady speed? [2]

b. After it leaves the plates, an electron beam that was bent between them travels in a straight line. Why? [2]

c. Thomson found that the specific charge of cathode-ray particles was far larger than that of a hydrogen ion. What did this suggest? [2]

5 Long answer [4]

Write a long answer to the following question.

An electron of mass m and charge e enters the uniform field E between two parallel plates with speed v, at right angles to the field. Show that its path between the plates is a parabola, and find its sideways deflection after it has gone a distance x along the plates.

6 Numerical problems [10]

Solve the following problems. Show your working. Take $e = 1.6 \times 10^{-19}$ C, the mass of an electron 9.1×10^{-31} kg, its specific charge 1.76×10^{11} C/kg and $g = 9.8$ m/s^2.

a. An oil drop of radius 1.5×10^{-6} m and density 900 kg/m^3 is held still between two horizontal plates 8.0 mm apart by a p.d. of 1560 V. Ignoring the upthrust of the air, find the charge on the drop and the number of extra electrons on it. **[3]**

Answer:

b. Electrons moving at 2.0×10^7 m/s enter midway between two parallel plates 4.0 cm long and 2.0 cm apart, with a p.d. of 100 V between them, moving parallel to the plates. Find i. their acceleration, ii. the time they spend between the plates, iii. their sideways deflection as they leave, and iv. the angle their path then makes with the plates. Do they leave the plates? **[4]**

Answer:

c. In a Thomson-type tube, electrons are accelerated through 2000 V. Find their speed. The deflecting plates are 1.0 cm apart with 600 V across them: what magnetic field lets the beam through undeflected? **[3]**

Answer: _____

7 Think **[3]**

In a Millikan-type experiment, Nabin holds a drop still with 2400 V. A burst of X-rays changes its charge, and he now needs only 1600 V to hold it still. What happened to its charge? If it carried 2 extra electrons at first, how many does it carry now? Why must he keep the water jacket's temperature steady?

8 Activity: Charging an electroscope in steps (Activity 20.1) (not marked)

Charge a comb on wool and touch it briefly to an electroscope's top, a few times. Then touch the top briefly with a key in your hand, a few times.

After	How far apart the leaves are
the first touch with the comb	
the second touch	
the third touch	
a touch with the key	

Does this activity prove that charge comes in single electrons? Why?