1 In an Oil-drop experiment, a drop of oil with mass 4.1×10^{-15} kg is held motionless between two parallel plates, 2.0 cm apart, with a Voltage difference of 500.0 V. What is the net charge on the oil drop?

2 By using a Mass Spectrometer, the charge to mass ratio for an electron is found to be approximately 1.8×10^{11} C/kg. Given that the charge on an electron is 1.6×10^{-19} C, what is the mass of the electron found in this experiment?

3 In an Oil-drop experiment, a drop of oil with mass 8.2×10^{-15} kg is held motionless between two parallel plates, 4.0 cm apart, with a Voltage difference of 500.0 V. What is the net charge on the oil drop?

4 By using a Mass Spectrometer, the charge to mass ratio for an electron is found to be approximately 1.7×10^{11} C/kg. Given that the charge on an electron is 1.6×10^{-19} C, what is the mass of the electron found in this experiment?

5 What is the energy of a photon with a frequency of 5.0×10^5 Hz?

6 What is the energy of a photon with a wavelength of 6.0×10^{-3} m?

7 What is the frequency of a photon carrying energy of 3.5×10^{-18} J?

8 What is the wavelength of a photon with energy of 7.3×10^{-17} J?

Students type their answers here

9 What wavelength is the maximum contributor to an object's color at a temperature of 3800 K?

10 A photoelectric surface has a work function of 3.7×10^{-19} J. What is the minimum frequency of photons that will eject electrons from the surface?

11 A photoelectric surface has a work function of 3.7×10^{-19} J. What is the maximum wavelength of photons that will eject electrons from the surface?

12 A metal has a work function of 3.7×10^{-19} J. What is the maximum kinetic energy of photoelectrons if the incident light has a frequency of 9.4×10^{14} Hz?

13 In a photoelectric experiment the threshold frequency is 5.3×10^{14} Hz.

a. What is the work function?

The surface is exposed to light with a frequency of 6.6×10^{14} Hz.

b. What is the maximum kinetic energy of photoelectrons?

14 What is the energy of a photon with a frequency of 4.0×10^{18} Hz?

15 What is the energy of a photon with a wavelength of 9.0×10^{-9} m?

16 What is the frequency of a photon carrying energy of 8.6×10^{-20} J?

17 What wavelength is the maximum contributor to an object's color at a temperature of 4200 K?

Students type their answers here

18 A photoelectric surface has a work function of 3.4×10^{-19} J. What is the minimum frequency of photons that will eject electrons from the surface?

19 A photoelectric surface has a work function of 7.5×10^{-19} J. What is the maximum wavelength of photons that will eject electrons from the surface?

20 A metal has a work function of 8.3×10^{-19} J. What is the maximum kinetic energy of photoelectrons if the incident light has a frequency of 3.4×10^{15} Hz?

21 In a photoelectric experiment the threshold frequency is 6.2×10^{14} Hz.

a. What is the work function?

The surface is exposed to light with a frequency of 7.5×10^{14} Hz.

b. What is the maximum kinetic energy of photoelectrons?

22 What is the wavelength of a photon with energy of 5.1×10^{-16} J?

23 In the hydrogen atom an electron is excited to an energy level n = 4 then it falls down to the level n = 2.

a. What is the wavelength of the emitted photon?

b. What type of electromagnetic radiation is this photon associated with?

c. What is the next possible transition?

d. What is the wavelength associated with this transition?

24 The electron in a hydrogen atom has an energy of -13.6 eV on the ground level.

a. Calculate the first five energy levels (n=1 to n=5).

b. Draw the energy diagram including the ground level.

c. The electron is on the n=4 level; draw all possible transitions

25 In the hydrogen atom an electron is excited to an energy level n = 5 then it falls down to the level n = 3.

a. What is the wavelength of the emitted photon?

b. What type of electromagnetic radiation is this photon associated with?

c. What are the next possible transitions?

d. What are the wavelengths associated with these transitions?

26 The electron in a helium atom has an energy of -54.4 eV on the ground level.

a. Calculate the first five energy levels (n=1 to n=5).

b. Draw the energy diagram including the ground level.

c. The electron is on the n=3 level; draw all possible transitions

27 A bowling ball of mass 6.0 kg is moving with a speed of 10.0 m/s. What is the wavelength of the matter associated with the ball?

28 An electron travels at speed of 6.0×10^7 m/s. What is the de Broglie wavelength?

29 An asteroid of mass 5.4×10^3 kg is moving with a speed of 7.0 km/s. What is the wavelength of the matter associated with the asteroid?

30 A proton travels at speed of 4.8×10^7 m/s. What is the de Broglie wavelength?

31 An electron's momentum is measured with an uncertainty of 3.0×10^{-32} kg m/s. How precisely can its position be determined at the same time?

32 A car is traveling down the road with a momentum of 2.8×10^4 kg m/s (equivalent to a compact car moving at 50 mph). How precisely can its position be determined at the same time?

33 An electron's momentum is measured with an uncertainty of 2.5×10^{-32} kg m/s. How precisely can its position be determined at the same time?

34 A pickup truck is traveling down the road with a momentum of 5.1×10^4 kg m/s (the pickup truck is moving at 50 mph). How precisely can its position be determined at the same time?

35 A mass spectrometer was used in the discovery of the electron. In the velocity selector, the electric and magnetic fields are set to only allow electrons with a specific velocity to exit the fields. The electrons then enter an area with only a magnetic field, where the electron beam is deflected in a circular shape with a radius of 8.0 mm. In the velocity selector, E = 400.0 V/m and B = 4.7×10^{-4} T. The same value of B exists in the area where the electron beam is deflected.

a. What is the speed of the electrons as they exit the velocity selector?

b. What is the value of e/m of the electron?

c. What is the accelerating voltage in the tube?

d. How does the electron radius change if the accelerating voltage is doubled?

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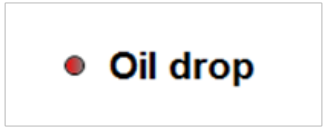
36 In an oil-drop experiment a negatively charged oil drop has a mass of 3.0×10^{-15} kg and is held at rest between two parallel plates separated by a distance of 2.0 cm. The potential difference between the plates is 460 V.

a. On the diagram below, show all the applied forces on the drop. Do not include the buoyant force of the air on the oil drop.



b. What is the strength of the electric field between the plates?

c. What is the net electric charge on the drop?

d. How many excess electrons are on the drop?

e. The potential difference between the plates is increased to 470 V; what happens to the oil drop?

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37 A group of physics students perform a Photoelectric effect experiment. They use a light source with varying frequency. In the experiment they found the photocell is sensitive to light with a frequency greater than 6.0×10^{14} Hz.

a. What is the threshold frequency for this photocell?

b. What is the work function of the metal?

The frequency of the incident light is changed to 7.5×10^{14} Hz.

c. What is the maximum kinetic energy of the photoelectrons emitted by the cell?

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38 An experiment is conducted to investigate the photoelectric effect with a Barium plate. When the wavelength of the incident light is less than 500.0 nm the plate starts emitting electrons.

a. What is the threshold frequency of the Barium plate?

b. What is the work function of Barium?

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c. What is the kinetic energy of the photoelectrons?

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39 In an X-ray tube, below, an accelerating voltage of 7.0×10^4 V is applied to accelerate electrons to high energies. ($e = 1.6 \times 10^{-19}$ C, $m_e = 9.1 \times 10^{-31}$ kg).

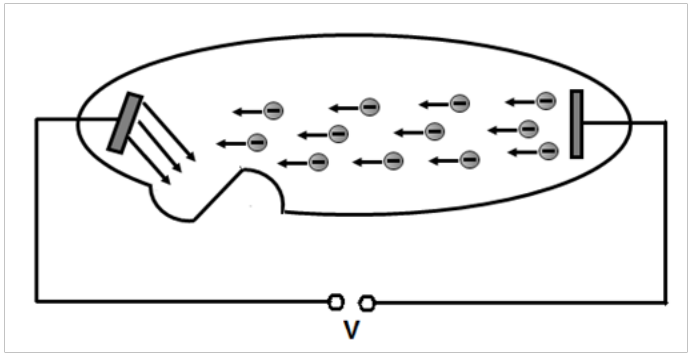
a. What is the maximum kinetic energy of the accelerated electrons?

b. What is the maximum speed of the accelerated electrons?

c. What is the maximum energy of the emitted X-ray photons?

d. What is the frequency of the emitted X-ray photons?

e. What is the wavelength of the emitted X-ray photons



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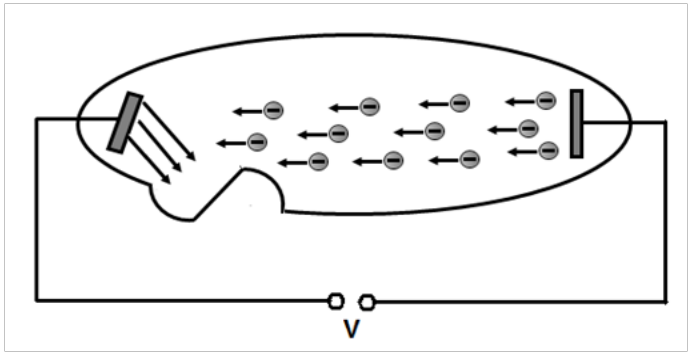

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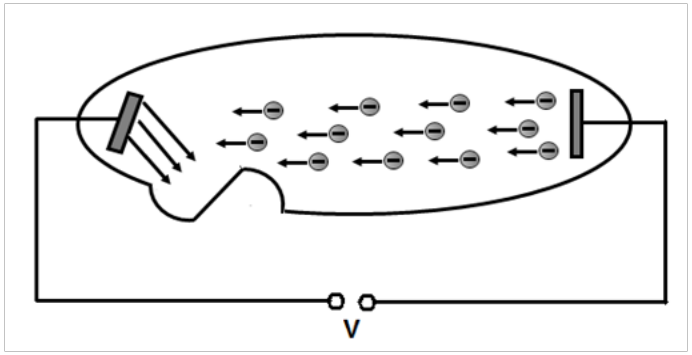

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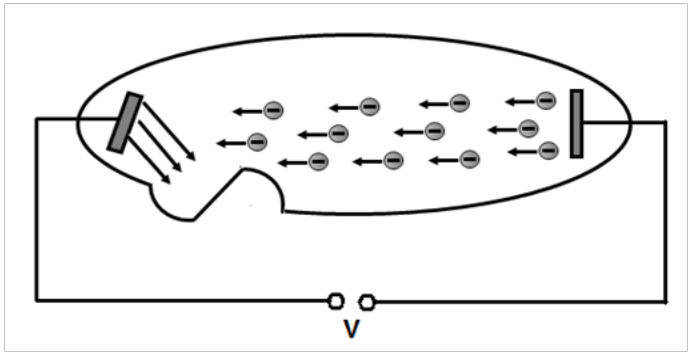

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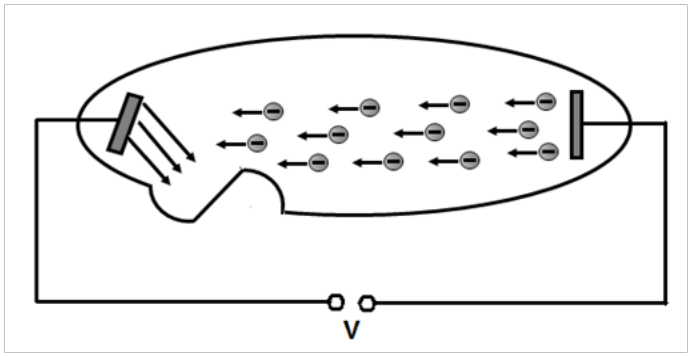

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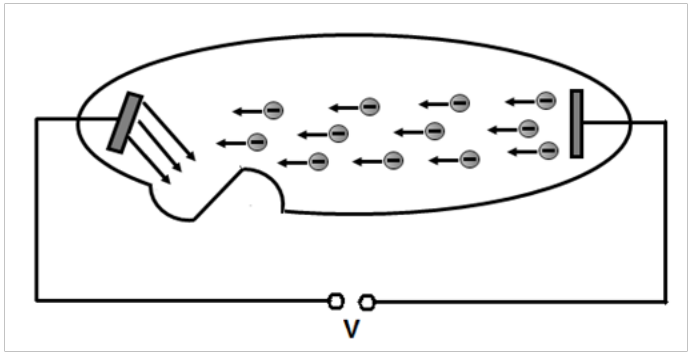

40 The atomic energy levels can be determined by the following formula $E_n = Z^2E_1/n^2$ where Z = atomic number; E_1 = -13.6eV (ground state of the hydrogen atom, n=1).

a. What are the energy levels, for n=1, 2, 3 and 4 of the hydrogen atom?

b. What is the frequency of the emitted photon if an electron makes a transition from the n = 3 level to the n = 2 level?

c. What is the wavelength of the photon for the same transition?

d. Would the emitted photon be visible?

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a. What are the energy levels, for n=1, 2, 3 and 4 of the singly ionized (only one electron present) helium atom (Z=2)?

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