Worksheet: Electric Potential Energy of a Charged Particle

Q1: An ion with twice the charge of an electron is accelerated from rest to a kinetic energy of 32.0 keV by the electric field between two parallel conducting plates. If the plates are separated by a distance of 2.00 cm, what is the electric field strength between the plates?

Question Video

Proton charge is $+1.60 \times 10^{-19}$ C.

A 5.00×10^{5} V/m

B 2.50×10^{5} V/m

C 12.5×10^{5} V/m

D 8.00×10^{5} V/m

E 1.60×10^{5} V/m

Q2: A negative hydrogen ion is a hydrogen atom containing two electrons. An electron and a negative hydrogen ion are accelerated through the same potential. Find the ratio of their speeds after acceleration, assuming the speeds are non-relativistic. Use a value of 1.67×10^{-27} kg for the mass of the hydrogen ion.

Question Video

A 40.2

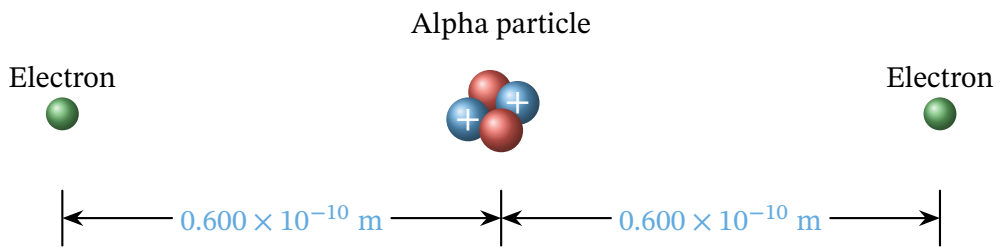
B 42.8

C 48.2

D 49.0

E 44.1

Q3: To form a helium atom, an alpha particle that contains two protons and two neutrons is fixed at one location, and two electrons are brought in from far away, one at a time. The first electron is placed at 0.600×10^{-10} m from the alpha particle and held there while the second electron is brought to 0.600×10^{-10} m from the alpha particle on the other side from the first electron, as shown.
The charge of an electron is -1.60×10^{-19} C and the charge of a proton is $+1.60\times10^{-19}$ C.



How much work is moving the first electron?

A -8.87×10^{-18} J

B -6.21×10^{-18} J

C -8.05×10^{-18} J

D -5.18×10^{-18} J

E -7.68×10^{-18} J

- How much work is moving the second electron?

A -8.87×10^{-18} J

B -6.21×10^{-18} J

C -8.05×10^{-18} J

D -5.18×10^{-18} J

E -5.76×10^{-18} J

- What is the electrostatic energy of the alpha particle and two electrons at their final positions?

A -1.41×10^{-18} J

B -1.20×10^{-17} J

C -1.27×10^{-17} J

D -1.12×10^{-17} J

E -1.34×10^{-17} J

Q4: An object has a mass of 6.0 μg. The object has a charge +3.0 μC. The object is moving in the space neighbouring a fixed +5.0 μC charge.

What is the potential energy of the object at a distance of 4.0 cm from the fixed charge?

A 3.4 J

B 5.5 J

C 4.0 J

D 6.3 J

E 4.7 J

If the object starts accelerating from rest at a point 4.0 cm from the fixed charge, what speed will the object have when it is 8.0 cm away from the fixed charge?

A 33.5 km/s

B 36.7 km/s

C 28.3 km/s

D 32.4 km/s

E 26.8 km/s

Q5: Two large charged plates of charge density $\pm 30\ \mu\text{C/m}^2$ face each other at a separation of 5.0 mm. An electron is released from rest at the negative plate. At what speed will the electron be moving when it reaches the positive plate?

Electron charge is -1.60×10^{-19} C.

A 8.6×10^7 m/s

B 7.2×10^7 m/s

C 5.7×10^7 m/s

D 7.7×10^7 m/s

E 6.0×10^7 m/s

Q6: An electron is to be accelerated in a uniform electric field having a strength of 2.00×10^6 V/m.

Question Video

What energy in keV is given to the electron if it is accelerated through 0.400 m?

A 4.00 keV

B 800 keV

C 125 keV

D 1.00 keV

E 2.50 keV

Over what distance would it have to be accelerated to increase its energy by 50.0 GeV?

A 50.0 km

B 25.0 km

C 5.00 km

D 8.00 km

E 16.0 km

Q7: To form a hydrogen atom, a proton is fixed at a point and an electron is brought from an effectively infinite distance from the proton to a distance of 0.529×10^{-10} m from it. Find the magnitude of work done moving the electron.

A 4.43×10^{-18} J

B 4.96×10^{-18} J

C 4.80×10^{-18} J

D 4.64×10^{-18} J

E 4.36×10^{-18} J

Q8: An object with a charge $q = -2.0\ \mu\text{C}$ is initially at rest at a distance of 2.0 m from a fixed charge $Q = +6.0\ \mu\text{C}$. What is the kinetic energy of the object when it is at a distance of 1.0 m from Q?

Question Video

A 0.044 J

B 0.054 J

C 0.090 J

D 0.066 J

E 0.082 J

Q9: A beam of protons is produced by a Van de Graaff generator. The beam produces a 5.00 mA current and the protons in the beam have energies of 1.00 keV.

Question Video

What is the speed of the protons?

A 4.80×10^5 m/s

B 4.20×10^5 m/s

C 4.53×10^5 m/s

D 5.04×10^5 m/s

E 4.38×10^5 m/s

How many protons are produced each second?

A 1.84×10^{16}

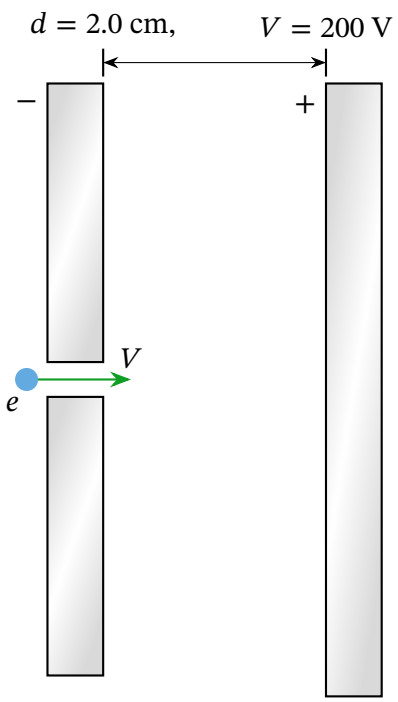
B 8.24×10^{15}

C 1.06×10^{16}

D 2.56×10^{16}

E 3.13×10^{16}

Q10: An electron enters a region between two large parallel plates separated by a distance of 2.0 cm. Within the region is a uniform electric field caused by a potential difference of 200 V across the parallel plates. The lower potential plate has a small hole in it, through which an electron passes into the region containing the electric field. The electron initially has negligible velocity as it enters the region between the parallel plates.



- Find the speed of electron at 0.10 cm from the negative plate.

A 2.8×10^6 m/s

B 2.3×10^6 m/s

C 1.0×10^6 m/s

D 1.4×10^6 m/s

E 1.9×10^6 m/s

- Find the speed of electron at 0.50 cm from the negative plate.

A 6.8×10^6 m/s

B 5.3×10^6 m/s

C 1.9×10^6 m/s

D 3.4×10^6 m/s

E 4.2×10^6 m/s

- Find the speed of electron at 1.0 cm from the negative plate.

A 6.6×10^6 m/s

B 5.3×10^6 m/s

C 3.4×10^6 m/s

D 4.9×10^6 m/s

E 5.9×10^6 m/s

- Find the speed of electron at 1.5 cm from the negative plate.

A 11×10^6 m/s

B 9.3×10^6 m/s

C 4.8×10^6 m/s

D 6.9×10^6 m/s

E 7.3×10^6 m/s

- Find the speed of electron immediately before it hits the positive plate.

A 11×10^6 m/s

B 9.3×10^6 m/s

C 6.0×10^6 m/s

D 7.7×10^6 m/s

E 8.4×10^6 m/s

Q11: A point particle has a charge of 3.0 μC.

What distance from the particle corresponds to an electric potential of 120 V?

A 260 m

B 320 m

C 230 m

D 450 m

E 200 m

What distance from the particle corresponds to an electric potential of 3.0×10^2 V?

A 78 m

B 56 m

C 90 m

D 33 m

E 84 m

Q12: In a nuclear fission process, a nucleus splits into two equal fragments, each containing 52 protons. The nucleus can be considered to have split when the two fragments are separated by 4.21×10^{-14} m.

What is the electric potential that one fragment has due to its position relative to the other fragment when at the separation distance?

A 2.10 MV

B 4.21 MV

C 3.53 MV

D 1.78 MV

E 1.24 MV

What is the electric potential energy of one fragment due to its position relative to the other fragment when at the separation distance?

A 23.0 MeV

B 84.2 MeV

C 78.4 MeV

D 92.5 MeV

E 74.1 MeV

Q13: If a beam of protons were to gain its kinetic energy in only one pass through a potential difference to move with the speed of $0.400c$, how high would this potential difference have to be?

A 376 MeV

B 11.3 MeV

C 2 350 MeV

D 1 050 MeV

E 85.6 MeV

Q14: Two point charges, $Q_1 = 8.0 \times 10^{-7}$ C and $Q_2 = -6.0 \times 10^{-8}$ C, are held 45.0 cm apart. A point P is located 5.0 cm from the negative charge and along the line between the two charges.

- What is the magnitude of the electric field at P?

A 2.6×10^5 N/C

B 4.2×10^5 N/C

C 21×10^5 N/C

D 6.3×10^5 N/C

E 23×10^5 N/C

What is the magnitude of the electric force on an electron placed at P?

A 4.2×10^{-14} N

B 3.2×10^{-14} N

C 41×10^{-14} N

D 23×10^{-14} N

E 3.9×10^{-13} N