Problems

17–1 to 17–4 Electric Potential

1. (I) How much work does the electric field do in moving a $-7.7\,\mu C$ charge from ground to a point whose potential is $+55$ V higher?
2. (I) How much work does the electric field do in moving a proton from a point with a potential of $+125$ V to a point where it is -55 V? Express your answer both in joules and electron volts.
3. (I) How much kinetic energy will an electron gain (in joules and eV) if it accelerates through a potential difference of 23,000 V in a TV picture tube?
4. (I) An electron acquires 7.45×10^{-16} J of kinetic energy when it is accelerated by an electric field from plate A to plate B. What is the potential difference between the plates, and which plate is at the higher potential?
5. (I) How strong is the electric field between two parallel plates 5.8 mm apart if the potential difference between them is 220 V?
6. (I) An electric field of 640 V/m is desired between two parallel plates 11.0 mm apart. How large a voltage should be applied?
7. (I) The electric field between two parallel plates connected to a 45-V battery is 1500 V/m. How far apart are the plates?
8. (I) What potential difference is needed to give a helium nucleus ($Q = 2e$) 65.0 keV of kinetic energy?
9. (II) Two parallel plates, connected to a 200-V power supply, are separated by an air gap. How small can the gap be if the air is not to become conducting by exceeding its breakdown value of $E = 3 \times 10^6$ V/m?
10. (II) The work done by an external force to move a $-8.50\,\mu C$ charge from point a to point b is 15.0×10^{-4} J. If the charge was started from rest and had 4.82×10^{-4} J of kinetic energy when it reached point b, what must be the potential difference between a and b?
11. (II) What is the speed of an electron with kinetic energy (*a*) 750-eV, and (*b*) 3.2-keV?
12. (II) What is the speed of a proton whose kinetic energy is 3.2 keV?
13. (II) An alpha particle (which is a helium nucleus, $Q = +2e$, $m = 6.64 \times 10^{-27}$ kg) is emitted in a radioactive decay with KE = 5.53 MeV. What is its speed?

17–5 Potential Due to Point Charges

14. (I) What is the electric potential 15.0 cm from a $4.00\,\mu C$ point charge?
15. (I) A point charge Q creates an electric potential of $+125$ V at a distance of 15 cm. What is Q?
16. (II) A $+35\,\mu C$ point charge is placed 32 cm from an identical $+35\,\mu C$ charge. How much work would be required to move a $+0.50\,\mu C$ test charge from a point midway between them to a point 12 cm closer to either of the charges?
17. (II) Draw a conductor in the shape of a football. This conductor carries a net negative charge, $-Q$. Draw in a dozen electric field lines and two equipotential lines.
18. (II) (*a*) What is the electric potential a distance of 2.5×10^{-15} m away from a proton? (*b*) What is the electric potential energy of a system that consists of two protons 2.5×10^{-15} m apart—as might occur inside a typical nucleus?
19. (II) Three point charges are arranged at the corners of a square of side L as shown in Fig. 17–25. What is the potential at the fourth corner (point A), taking $V = 0$ at a great distance?

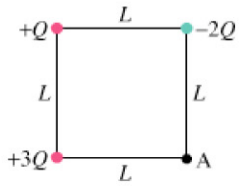

FIGURE 17–25
Problem 19.

20. (II) An electron starts from rest 32.5 cm from a fixed point charge with $Q = -0.125\,\mu C$. How fast will the electron be moving when it is very far away?
21. (II) Two identical $+9.5\,\mu C$ point charges are initially 3.5 cm from each other. If they are released at the same instant from rest, how fast will each be moving when they are very far away from each other? Assume they have identical masses of 1.0 mg.
22. (II) Two point charges, $3.0\,\mu C$ and $-2.0\,\mu C$, are placed 5.0 cm apart on the x axis. At what points along the x axis is (*a*) the electric field zero and (*b*) the potential zero? Let $V = 0$ at $r = \infty$.
23. (II) How much work must be done to bring three electrons from a great distance apart to 1.0×10^{-10} m from one another (at the corners of an equilateral triangle)?
24. (II) Consider point a which is 72 cm north of a $-3.8\,\mu C$ point charge, and point b which is 88 cm west of the charge (Fig. 17–26). Determine (*a*) $V_{ba} = V_b - V_a$ and (*b*) $\vec{\mathbf{E}}_b - \vec{\mathbf{E}}_a$ (magnitude and direction).

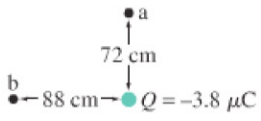

FIGURE 17–26
Problem 24.

25. (III) How much voltage must be used to accelerate a proton (radius 1.2×10^{-15} m) so that it has sufficient energy to just penetrate a silicon nucleus? A silicon nucleus has a charge of $+14e$, and its radius is about 3.6×10^{-15} m. Assume the potential is that for point charges.
26. (III) Two equal but opposite charges are separated by a distance d, as shown in Fig. 17–27. Determine a formula for $V_{BA} = V_B - V_A$ for points B and A on the line between the charges.

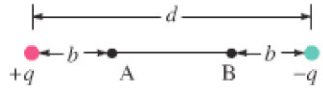

FIGURE 17–27
Problem 26.