PH 202 Homework Assignment Chapter on E Potential & V Field – 27 Problems Total

1. During a particular thunderstorm, the electric potential difference between a cloud and the ground is $V_{cloud} - V_{ground} = 1.3 \times 10^8$ V, with the cloud being at the higher potential. What is the change in an electron's electric potential energy when the electron moves from the ground to the cloud?

Solution for Problem 1

2. A particle with a charge of -1.5 μC and a mass of 2.5×10^{-6} kg is released from rest at point A and accelerates toward point B, arriving there with a speed of 42 m/s. The only force acting on the particle is the electric force. **(a)** Which point is at the higher potential? Give your reasoning. **(b)** What is the potential difference $V_B - V_A$ between A and B?

Solution for Problem 2

3. Suppose that the electric potential outside a living cell is higher than that inside the cell by 0.070 V. How much work is done by the electric force when a sodium ion (charge = +*e*) moves from the outside to the inside?

Solution for Problem 3

4. An electric car accelerates for 7.0 s by drawing energy from its 290-V battery pack. During this time, 1200 C of charge passes through the battery pack. Find the minimum horsepower rating of the car.

Solution for Problem 4

5. In a television picture tube, electrons strike the screen after being accelerated from rest through a potential difference of 25 000 V. The speeds of the electrons are quite large, and for accurate calculations of the speeds, the effects of special relativity must be taken into account. Ignoring such effects, find the electron speed just before the electron strikes the screen.

Solution for Problem 5

6. The potential at location *A* is 452 V. A positively charged particle is released there from rest and arrives at location *B* with a speed v_B. The potential at location *C* is 791 V, and when released from rest from this spot, the particle arrives at *B* with twice the speed it previously had, or $2v_B$. Find the potential at *B*.

Solution for Problem 6

7. A moving particle encounters an external electric field that decreases its kinetic energy from 9520 eV to 7060 eV as the particle moves from position *A* to position *B*. The electric potential at *A* is -55.0 V, and the electric potential at *B* is +27.0 V. Determine the charge of the particle. Include the algebraic sign (+ or -) with your answer.

Solution for Problem 7

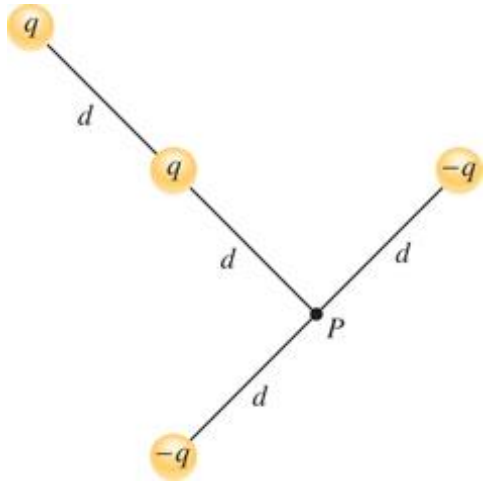
8. An electron and a proton are initially very far apart (effectively an infinite distance apart). They are then brought together to form a hydrogen atom, in which the electron orbits the proton at an average distance of 5.29×10^{-11} m. What is $EPE_{final} - EPE_{initial}$, which is the change in the electric potential energy?

Solution for Problem 8

9. Two charges A and B are fixed in place, at different distances from a certain spot. At this spot the potentials due to the two charges are equal. Charge A is 0.18 m from the spot, while charge B is 0.43 m from it. Find the ratio q_B/q_A of the charges.

Solution for Problem 9

10. The drawing shows four point charges. The value of q is 2.0 µC, and the distance d is 0.96 m. Find the total potential at the location P. Assume that the potential of a point charge is zero at infinity.



Solution for Problem 10

11. A charge of +125 µC is fixed at the center of a square that is 0.64 m on a side. How much work is done by the electric force as a charge of +7.0 µC is moved from one corner of the square to any other empty corner? Explain.

Solution for Problem 11

12. Charges of $-q$ and $+2q$ are fixed in place, with a distance of 2.00 m between them. A dashed line is drawn through the negative charge, perpendicular to the line between the charges. On the dashed line, at a distance L from the negative charge, there is at least one spot where the total potential is zero. Find L.

Solution for Problem 12

13. Two protons are moving directly toward one another. When they are very far apart, their initial speeds are 3.00×10^6 m/s. What is the distance of closest approach?

Solution for Problem 13

14. A charge of -3.00 µC is fixed in place. From a horizontal distance of 0.0450 m, a particle of mass 7.20×10^{-3} kg and charge -8.00 µC is fired with an initial speed of 65.0 m/s directly toward the fixed charge. How far does the particle travel before its speed is zero?

Solution for Problem 14

15. Two equipotential surfaces surround a $+1.50 \times 10^{-8}$ C point charge. How far is the 190-V surface from the 75.0-V surface?

Solution for Problem 15

16. The inner and outer surfaces of a cell membrane carry a negative and a positive charge, respectively. Because of these charges, a potential difference of about 0.070 V exists across the membrane. The thickness of the cell membrane is 8.0×10^{-9} m. What is the magnitude of the electric field in the membrane?

Solution for Problem 16

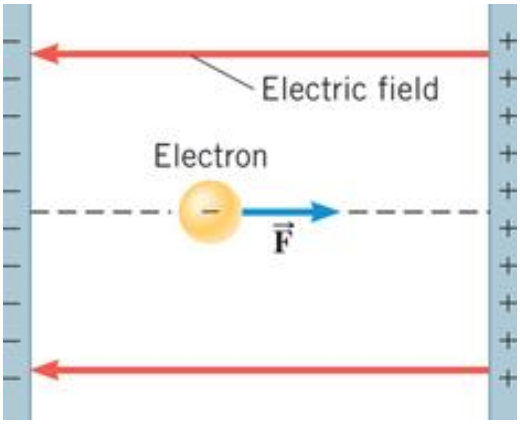
17. A spark plug in an automobile engine consists of two metal conductors that are separated by a distance of 0.75 mm. When an electric spark jumps between them, the magnitude of the electric field is 4.7×10^{7} V/m. What is the magnitude of the potential difference ΔV between the conductors?

Solution for Problem 17

18. An electric field has a constant value of 4.0×10^{3} V/m and is directed downward. The field is the same everywhere. The potential at a point *P* within this region is 155 V. Find the potential at the following points: **(a)** 6.0×10^{-3} m directly above *P*,
(b) 3.0×10^{-3} m directly below *P*, **(c)** 8.0×10^{-3} m directly to the right of *P*.

Solution for Problem 18

19. An electron is released from rest at the negative plate of a parallel plate capacitor and accelerates to the positive plate (see the drawing). The plates are separated by a distance of 1.2 cm, and the electric field within the capacitor has a magnitude of
2.1×10^{6} V/m. What is the kinetic energy of the electron just as it reaches the positive plate?



Solution for Problem 19

20. What is the capacitance of a capacitor that stores 4.3 μC of charge on its plates when a voltage of 1.5 V is applied between them?

Solution for Problem 20

21. The electric potential energy stored in the capacitor of a defibrillator is 73 J, and the capacitance is 120 μF. What is the potential difference that exists across the capacitor plates?

Solution for Problem 21

22. Two identical capacitors store different amounts of energy: capacitor A stores 3.1×10^{-3} J, and capacitor B stores 3.4×10^{-4} J. The voltage across the plates of capacitor B is 12 V. Find the voltage across the plates of capacitor A.

Solution for Problem 22

23. The membrane that surrounds a certain type of living cell has a surface area of 5.0×10^{-9} m^2 and a thickness of 1.0×10^{-8} m. Assume that the membrane behaves like a parallel plate capacitor and has a dielectric constant of 5.0. **(a)** The potential on the outer surface of the membrane is +60.0 mV greater than that on the inside surface. How much charge resides on the outer surface? **(b)** If the charge in part (a) is due to positive ions (charge +*e*), how many such ions are present on the outer surface?

Solution for Problem 23

24. What is the potential difference between the plates of a 3.3-F capacitor that stores sufficient energy to operate a 75-W light bulb for one minute?

Solution for Problem 24

25. An empty capacitor is connected to a 12.0-V battery and charged up. The capacitor is then disconnected from the battery, and a slab of dielectric material ($\kappa = 2.8$) is inserted between the plates. Find the amount by which the potential difference across the plates changes. Specify whether the change is an increase or a decrease.

Solution for Problem 25

26. A cordless electric shaver uses energy at a rate of 4.0 W from a rechargeable 1.5-V battery. Each of the charged particles that the battery delivers to the shaver carries a charge that has a magnitude of 1.6×10^{-19} C. A fully charged battery allows the shaver to be used for its maximum operation time, during which 3.0×10^{22} of the charged particles pass between the terminals of the battery as the shaver operates. What is the shaver's maximum operation time?

Solution for Problem 26

27. An empty capacitor has a capacitance of 3.2 μF and is connected to a 12-V battery. A dielectric material ($\kappa = 4.5$) is inserted between the plates of this capacitor. What is the magnitude of the surface charge on the dielectric that is adjacent to either plate of the capacitor?
(Hint: The surface charge is equal to the difference in the charge on the plates with and without the dielectric.)

Solution for Problem 27

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