Physics NINJA

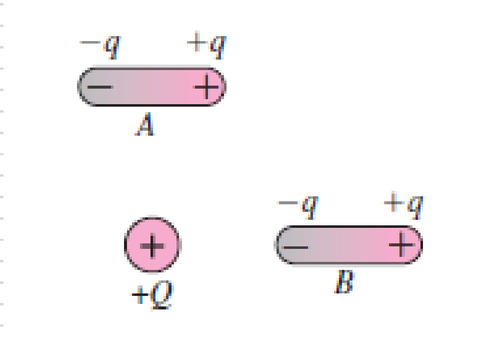
Physics 1302B/1402B

Midterm Review 1

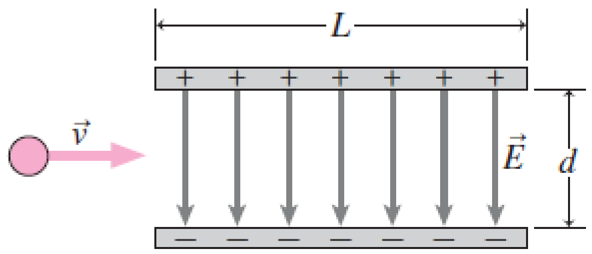
Electric Fields, Forces, Potential, Potential Energy, Capacitors.

Chapter Review

P1) Dipoles *A* and *B* are both located in the field of a point charge *Q*, as shown below. Does either experience a net torque? A net force? If each dipole is released from rest, describe qualitatively its subsequent motion.



P2) You’re working on the design of an ink-jet printer. Ink drops of mass m, speed v, and charge q will enter a region of uniform electric field E between two charged plates. The drops enter midway between the plates, and the electric field deflects them toward the correct place on the page. Find an expression for the maximum electric field for which drops can still get through without hitting either plate.



I solved this problem on Youtube!

Visit www.physicsninja.org (click youtube button at the top of page)

P3) Three identical charges $+q$ and a fourth charge $-q$ form a square of side a.
(a) Find the magnitude of the electric force on a charge Q placed at the square's center.
(b) Describe the direction of this force?

P4) Two equal positive charges are attached to opposite ends of a spring with spring constant 150N/m and equilibrium length 50 cm. What is the value of the charge if the spring stretches by 14cm?

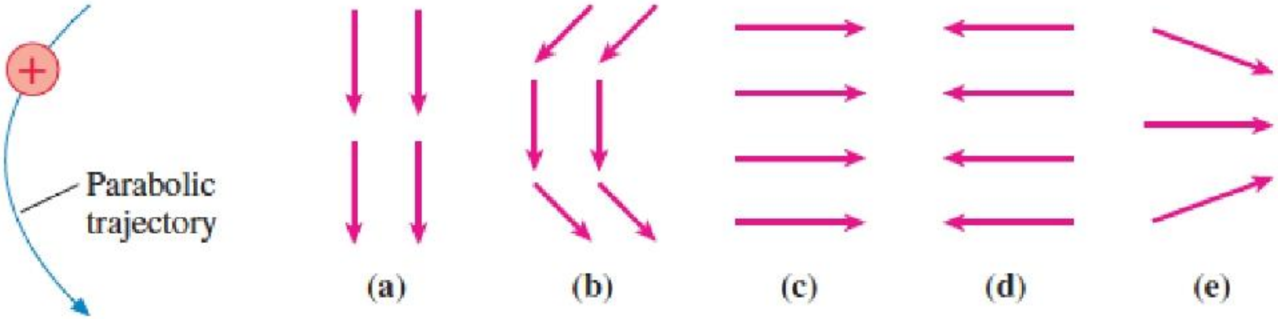
P5) Two identical small metal spheres initially carry charges q_1 and q_2
When they're $1.0m$ apart, they experience a $2.5\mathrm{N}$ attractive force. Then they're brought together so charge moves from one to the other until they have the same net charge. They're again placed 1.0 m apart, and now they repel with a $2.5\mathrm{N}$ force. What were the original charges q_1 and q_2.

P6) Two small spheres with mass $m = 15.0g$ are hung by silk threads of length $L = 1.2m$ from a common point. When the spheres are given equal quantities of negative charge q each thread hangs at an angle $\theta = 25^o$. Find the magnitude of the charge q on each sphere. B) if both threads are shortened to length $L/2$, while the charge remains unchanged, what new angle will each thread make?

P7) Two identical conducting spheres A and B carry equal charge. They are separated by a distance much larger than their diameters. A third identical conducting sphere C is uncharged. Sphere C is first touched to A, then to B, and finally removed. As a result, the electrostatic force between A and B, which was originally F, becomes:

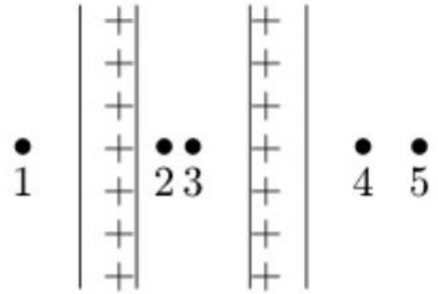
P8)

Which electric field is responsible for the proton's trajectory?



P9)

MC5 Two large parallel plates carry positive charge of equal magnitude that is distributed uniformly over their inner surfaces. Rank the points 1 through 5 according to the magnitude of the electric field at the points, least to greatest.



(A) 1, 2, 3, 4, 5

(B) 5, 4, 3, 2, 1

(C) 1, 4, and 5 tie, then 2 and 3 tie

(D) 2 and 3 tie, then 1 and 4 tie, then 5

(E) 2 and 3 tie, then 1, 4, and 5 tie

P10) An electric field does 4 J of work on a charged particle, moving it from a potential of 1 V to a potential of 3 V. The particle has a charge of:

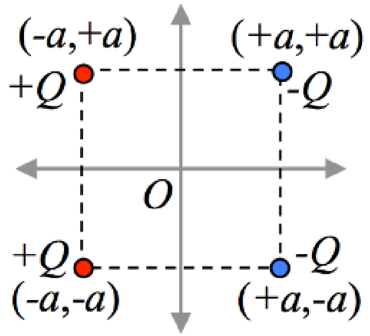
a. -8 C
b. +8 C
c. -2 C
d. +0.5 C
e. -0.5 C

P11)

An electron is released in an area of space occupied by an electric field. Which of the following statements is true?

a. The electron will move from high potential to low potential.
b. The electron will experience a force in the same direction as the electric field.
c. The electron will move parallel to the equipotential lines.
d. The field will do work on the particle.
e. The electron will accelerate at a rate directly proportional to its mass.

P12)



Four point charges, two of $+Q$ and two of $-Q$, are arranged at the corners of a square of sides $2a$ as shown above. Relative to an electric potential of zero at a distance $r = \infty$, what is the electric potential at the origin O?

a. $\frac{kq}{a}$

b. $\frac{4kq}{a}$

c. $\frac{4kq\sqrt{2}}{a}$

d. $\frac{kq\sqrt{2}}{a}$

e. zero

P13) The electric dipole moment of sodium chloride is 9.0 Debye units, where 1 Debye unit equals 3.336×10^{-30} C m.

(a) The Na^+ and the Cl^- ions each have a charge magnitude of 1.60×10^{-19} C. What is the average distance between the Na^+ and the Cl^- ions in sodium chloride?

(b) What is the maximum torque exerted on a sodium chloride molecule by an electric field with a strength of 1.50×10^4 N/C?

(c) If a sodium chloride molecule is aligned with the field in part (a), how much energy is required to rotate it by 180° so that it is anti-aligned with the field?

(d) If a sodium chloride dipole is placed in a region that previously had no electric field, what is the magnitude of the electric field of the dipole at a point on the dipole axis and 0.2 nm from the center of the dipole?

P14)

An electron beam is accelerated horizontally over a distance of 2.5 cm using an electric field of 2.0×10^{4} N/C. After leaving this electric field region, the electrons pass between two metal, 1.5 cm long deflecting plates with a vertical field between the plates of 5.0×10^{3} N/C. The mass of an electron is 9.1×10^{-31} kg. The charge on an electron is 1.6×10^{-19} C.

(a) What is the speed of an electron after it leaves the field region in which it is initially accelerated?

(b) What is the speed of an electron after it leaves the region of the metal deflecting plates?

(c) At what angle to the horizontal does an electron's velocity vector point after the electron leaves the region of the metal deflecting plates?

P15) A charged spherical oil drop has a mass of 8.1 x 10^-14 kg. It remains motionless in a vertical electric field of magnitude 1.65×10^6 N/C. What is the charge on the oil drop in units of the electron charge $e = 1.60 \times 10^{-19}$ C?

(a) $0.5e$
(b) $1.0e$
(c) $2.0e$
(d) $3.0e$
(e) $4.0e$

P16) . Which of the following statements are true?

I. Electric field lines from different directions can start and end at the same point in space.

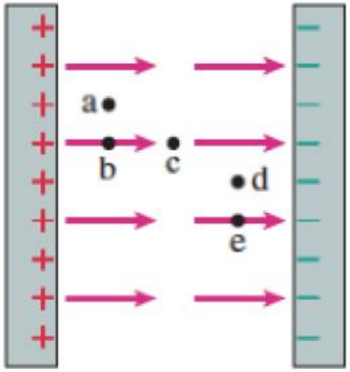
II. Static electric field lines cannot close on themselves. They must have a beginning and an end, even if these points are at infinity.

III. The density of electric field lines increases in the vicinity of an electric charge.

(a) Statement I only.
(b) Statement II only.
(c) Statement III only.
(d) Statements I and II.
(e) Statements II and III.

P17)

Question



- Rank the work that could be done on a proton placed at the various points in the diagram.
  - (a) $W_a > W_b > W_c > W_d > W_e$
  - (b) $W_a = W_b > W_c > W_d = W_e$
  - (c) $W_a = W_b = W_c = W_d = W_e$
  - (d) $W_e = W_d > W_c > W_b = W_a$
  - (e) $W_e > W_d > W_c > W_b > W_a$

P18)

Question

- Consider the four field patterns shown. Assuming there are no charges in the regions shown, which of the patterns represent(s) a possible electrostatic field?

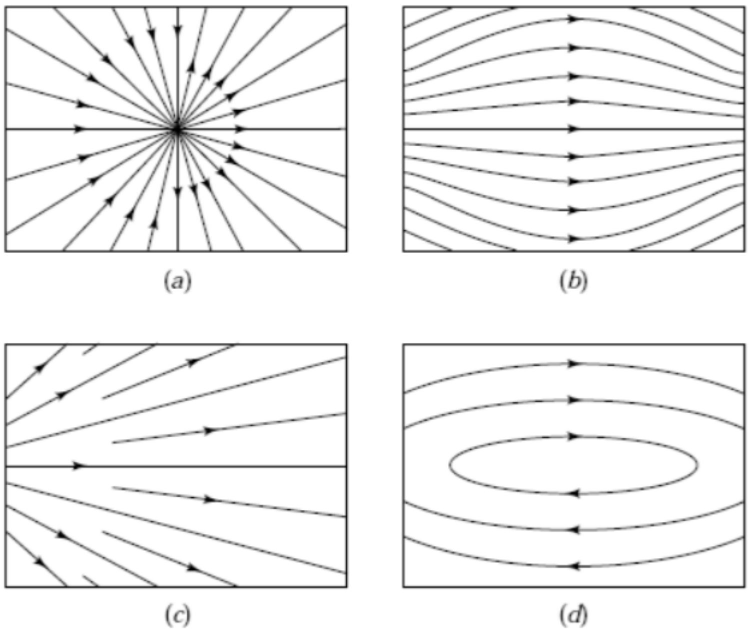
(a) (*a*)

(b) (*b*)

(c) (*b*) and (*d*)

(d) (*a*) and (*c*)

(e) (*b*) and (*c*)



P19a)

Question

- An electron initially moving horizontally near Earth's surface enters a uniform electric field and is deflected upward. What can you say about the direction of the electric field (assuming no other interaction such as gravity)?

(a) The electric field points upward.

(b) The electric field points downward.

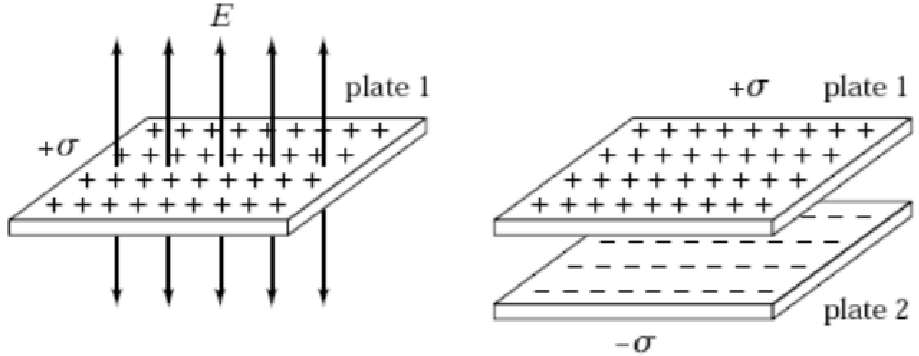
(c) The electric field has an upward component.

(d) The electric field has a downward component.

(e) There is not enough information to tell.

P19b)

The electric charge per unit area is $+\sigma$ for plate 1 and $-\sigma$ for plate 2. The magnitude of the electric field associated with plate 1 is $\sigma/2\varepsilon_o$, and the electric field lines for this plate are as shown. When the two are placed parallel to one another, the magnitude of the electric field is



- (a) σ/ε_o between, 0 outside.
- (b) σ/ε_o between, $k\sigma/\varepsilon_o$ outside.
- (c) Zero both between and outside.
- (d) $k\sigma/\varepsilon_o$ both between and outside.
- (e) none of the above.

P20) A proton with a speed of 2.00×10^5 m/s moves through a region of space with a potential difference of +100 V due to other charges. What is the speed of the proton after it leaves this region of space?

(a) 3.61×10^5 m/s
(b) 2.78×10^5 m/s
(c) 2.00×10^5 m/s
(d) 1.44×10^5 m/s
(e) 0.79×10^5 m/s

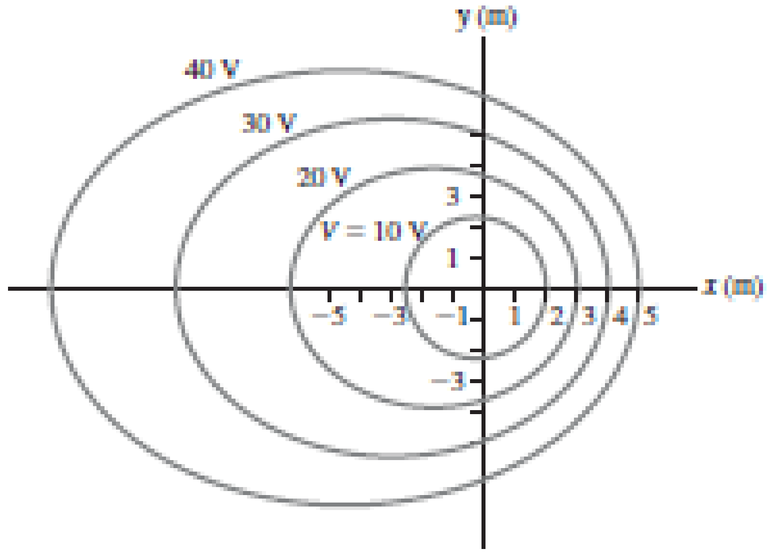
P21)

Electrical Potential – Concepts

a)Must the potential be zero at any point where the electric field is zero?
b)Must the electric field be zero at any point where the potential is zero?
c) The potential is constant throughout an entire volume. What must be true of the electric field within that volume?
d) Two equal but opposite charges form a dipole. Describe the equipotential surface on which V=0?

P22)

Figure 22.21 shows some equipotentials in the x-y plane. (a) In what region is the electric field strongest? What are (b) the direction and (c) the magnitude of the field in this region?



P23)

Two metal spheres each 1.0 cm in radius are far apart. One sphere carries 38 nC, the other nC. (a) What's the potential on each? (b) If the spheres are connected by a thin wire, what will be the potential on each once equilibrium is reached? (c) How much charge moves between the spheres in order to achieve equilibrium?

P24) A 5.0-g object carries 3.8uC. It acquires speed *v* when accelerated from rest through a potential difference *V*. If a 2.0-g object acquires twice the speed under the same circumstances, what's its charge?