Problem 1:

A system consists of two charged particles of equal mass. Initially the particles are far apart, have zero potential energy, and one particle has nonzero speed. If radiation is neglected, which of the following is true of the total energy of the system?

(A) It is zero and remains zero.
(B) It is negative and constant.
(C) It is positive and constant.
(D) It is constant, but the sign cannot be determined unless the initial velocities of both particles are known.
(E) It cannot be a constant of the motion because the particles exert force on each other.

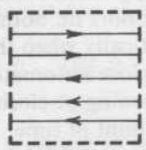
Problem 3:

The exponent in Coulomb's inverse square law has been found to differ from two by less than one part in a billion by measuring which of the following?

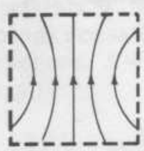
(A) The charge on an oil drop in the Millikan experiment
(B) The deflection of an electron beam in an electric field
(C) The neutrality of charge of an atom
(D) The electric force between two charged objects
(E) The electric field inside a charged conducting shell

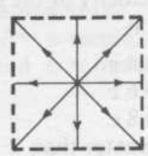
Problem2:

One of Maxwell's equations is $\nabla \cdot \mathbf{B} = 0$. Which of the following sketches shows magnetic field lines that clearly violate this equation within the region bounded by the dashed lines?

(A)


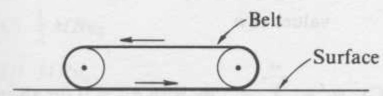
(B)


(C)


(D)


(E)

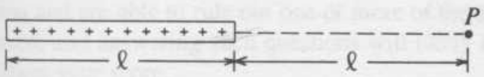

Problem 4:



An electric sander has a continuous belt that rubs against a wood surface as shown schematically above. The sander is 100 percent efficient and draws a current of 9 amperes from a 120-volt line. The belt speed is 10 meters per second. If the sander is pushing against the wood with a normal force of 100 newtons, the coefficient of friction is most nearly

(A) 0.02 (B) 0.2 (C) 0.4
(D) 1.1 (E) 10

Problem 5:



The long thin cylindrical glass rod shown above has length ℓ and is insulated from its surroundings. The rod has an excess charge Q uniformly distributed along its length. Assume the electric potential to be zero at infinite distances from the rod. If k is the constant in Coulomb's law, the electric potential at a point P along the axis of the rod and a distance ℓ from one end is $\frac{kQ}{\ell}$ multiplied by

(A) $\frac{4}{9}$

(B) $\frac{1}{2}$

(C) $\frac{2}{3}$

(D) ln 2

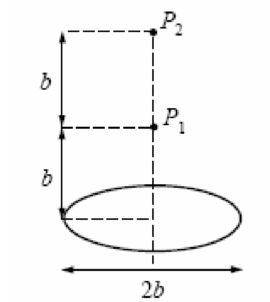
(E) 1

Problem 6:

A cube has a constant electric potential V on its surface. If there are no charges inside the cube, the potential at the center of the cube is

(A) zero (B) $V/8$ (C) $V/6$ (D) $V/2$ (E) V

Problem 7:



Consider a uniformly charged wire that has the form of a circular loop with radius *b*. Consider two points on the axis of the loop. P_1 is at a distance *b* from the loop's center, and P_2 is at a distance 2*b* from the loop's center. The potential *V* is zero, very far from the loop. At P_1 and P_2 the potentials are V_1 and V_2, respectively. What is V_2 in terms of V_1?

(A) $V_1/3$

(B) $2V_1/5$

(C) $V_1/2$

(D) $(2/5)^{1/2}V_1$

(E) $4\pi V_1$

Problem 8:

A current i in a circular loop of radius b produces a magnetic field. At a fixed point far from the loop, the strength of the magnetic field is proportional to which of the following combinations of i and b?

(A) ib (B) ib^2 (C) i^2b (D) $\frac{i}{b}$ (E)

Problem 9:

Consider a uniformly charged wire that has the form of a circular loop with radius *b*. Consider two points on the axis of the loop. P_1 is at a distance *b* from the loop's center, and P_2 is at a distance 2*b* from the loop's center. The potential *V* is zero, very far from the loop. At P_1 and P_2 the potentials are V_1 and V_2, respectively. How much work would be required to move a charge *q* from P_1 to P_2?

(A) qV_2/V_1

(B) qV_2

(C) $q\log_e(V_2/V_1)$

(D) qV_1V_2

(E) $q(V_2 - V_1)$