Warm-up set 4

Question

1. HRW6 25.TB.37. [119743] The equipotential surfaces associated with an isolated point charge are:

(a) concentric cylinders with the charge on the axis
(b) vertical planes
(c) horizontal planes
(d) radially outward from the charge
(e) concentric spheres centered at the charge

Answer:

(e) Concentric spheres centered at the charge

Equipotential surfaces are by definition surfaces on which the electric potential is uniform. Given that

$$V = \frac{kq}{r}$$

then for a point charge, all the points of the surface, or the point of equal V, must be equadistant from the charge. This condition is filled by a sphere of any size radius, with its center at the charge.

Question

2. HRW6 25.TB.17. [119723] Two large parallel conducting plates are separated by a distance d, placed in a vacuum, and connected to a source of potential difference V. An oxygen ion, with charge 2e, starts from rest on the surface of one plate and accelerates to the other. If e denotes the magnitude of the electron charge, the final kinetic energy of this ion is:

(a) 2eV
(b) eVd
(c) Vd / e
(d) eV / d
(e) eV / 2

Answer:

V is the potential energy of a charged particles per coulomb or

$$PE = KE = qV = 2eV$$

Thus the potential energy, subsequently converted to kinetic energy, is the product of the charge, 2e, and the potential, V.

Question

3. HRW6 25.TB.10. [119716] During a lightning discharge, 30 C of charge move through a
potential difference of 1.0 x 10^8 V in 2.0 x 10^{-2} s. The energy released by this lightning bolt is:

(a) 1.5 x 10^{11} J
(b) 1500 J
(c) 3.0 x 10^9 J
(d) 3.3 x 10^6 J
(e) 6.0 x 10^7 J

Answer:

Again,

$$PE = qV$$

And thus

$$qV = 30C \cdot 1.0 \cdot 10^8 V = 3.0 \cdot 10^9 J$$

The time period in which this occurs is irrelevant since this is an energy value, not a power value.