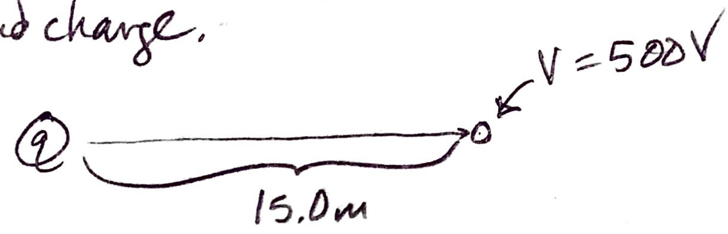
7.47

V = 5.00e2 Volts at distance 15.0m from charge. Find charge.



$V = \frac{kQ}{r}$, so $Q = \frac{Vr}{k} = \frac{(500)(15)}{9e9} = \boxed{+8.33e{-7}\,C}$

What does a 500 V potential at the point mean? It means that, for a hypothetical 1.0 C charge located infinitely far away from q, we'd have to do 500 J of work ($\frac{500\,J}{1\,C} = 500\,V$) to move it to within 15 m of the charge q.

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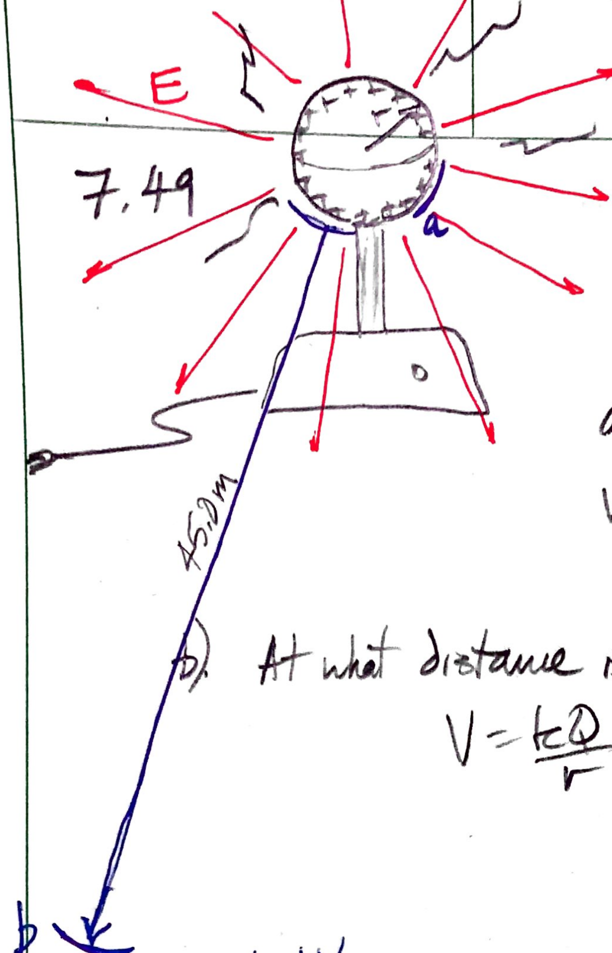
7.49



$d = 2.00\text{m}$, so $r = 1.00\text{m}$ (surface)
$q = +5.00e-3\,C$ on sphere

a) Find V near surface

$$V = \frac{kQ}{r} = \frac{(9e9)(5e-3C)}{1.0m} = \boxed{4.5e7\,V}$$

b) At what distance is $V = 1.0e6\,V$?

$$V = \frac{kQ}{r} \longrightarrow r = \frac{kQ}{V} = \frac{(9e9)(5e-3C)}{1e6V}$$

$$= \boxed{45.0m}$$

$b = 1e6V$

c) An Oxygen atom w/ 3 e^- missing is released at surface (a). Find energy in MeV (mega-electronVolts) at (b).

Okay, first of all monoatomic O is highly reactive & doesn't occur much in nature. But, if it did... what is ΔU from a to b?

$$\Delta U = q\Delta V = (3 \times 1.602e-19C)(1e6V - 4.5e7V)$$

net charge

$$= -2.11e-11\,J \text{ (E lost)},$$

so $\boxed{2.11e-11\,J}$ for the particle (K gained at expense of U)

They want the answer in MeV, though, so either

i. convert:

$$2.11e-11J \times \frac{eV}{1.602e-19J} = 132e6V = \boxed{132\ MeV}$$

or

ii Do it in eV from the beginning:

$$E = (3e^-)(1e6V - 4.5e7V) = \boxed{132\ MeV}$$

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7.55 In region equipotentials (V) vary according to z=k, $V = 100V$ at $z = 0m$, $200V$ at $0,50m$, & $300V$ for $z = 1,00m$.

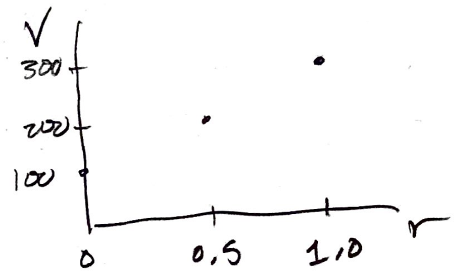
Find Electric field in this region.

$$E = -\frac{dV}{dz}, \quad \& \quad \underline{V = 200z + 100}$$

How?

$$m = \frac{\Delta y}{\Delta x} = \frac{300V - 200V}{0,50m} = 200\,\frac{V}{m}$$

y intercept = 100



$$E = -\frac{d}{dz}(200z + 100) = -200\,\frac{V}{m} = \boxed{-200\ N/C\ \hat{k}}$$

$$\boxed{= 200\ N/C \text{ in the } -z \text{ direction.}}$$

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7.56 In a region where $V = -xy^2z + 4xy$, what is the Electric field?

Three dimension included, so

$$E = \underbrace{-\nabla V}_{\text{"del operator"}} = \frac{-\partial V_x}{\partial x} + \frac{-\partial V_y}{\partial y} + \frac{-\partial V_z}{\partial z}$$

"partial derivatives"

$$E_x = -\frac{\partial V_x}{\partial x} = \frac{-\partial}{\partial x}\left(-x\underbrace{y^2z}_{\text{constant}} + 4x\underbrace{y}_{\text{constant}}\right) = \underline{+y^2z - 4y}\ \hat{i}$$

$$E_y = \frac{-\partial V_y}{-\partial y} = \frac{-\partial}{\partial y}\left(-xy^2z + \underbrace{4xy}_{\text{constant}}\right) = \underline{+2xyz - 4x}\ \hat{j}$$

$$E_z = \frac{-\partial}{\partial z}\left(\underbrace{-xy^2z}_{\text{constant}} + \underbrace{4xy}_{\text{constant}}\right) = xy^2 + 0\ \hat{k}$$

$$\boxed{\vec{E} = (+y^2z - 4y)\hat{i} + (2xyz - 4x)\hat{j} + (xy^2)\hat{k}}$$