PreAP Electrostatics 12

1. E, V, F, PE, or q?

A. _______ in coulombs.		G. _______ =qE		M. _______ Electric potential	
B. _______ in N/C		H. _______ in Joules		N. _______ About position only	
C. _______ = KE		I. _______ Are vectors.		O. _______ Needs two charges	
D. _______ Potential		J. _______ = W done		P. _______ Potential difference	
E. _______ in Newtons		K. _______ Scalars		Q. _______ = E(r)	
F. _______ in J/C		L. _______ = qV		R. _______ = also in V/m	

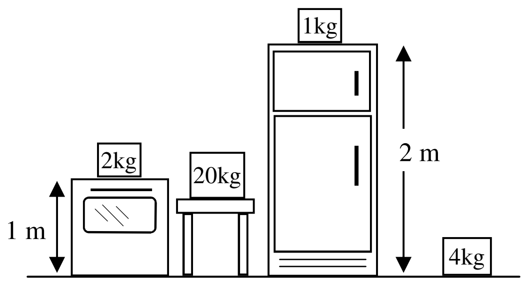
1A: q 1B: E; 1C: PE;
1D: V; 1E: F 1F: V
1G: F (N/C times C = N)
1H: PE; 1I: F and E; 1J: PE
1K: V, PE, q 1L: PE (J/C ×C)
1M: V; 1N: E and V (anything that's per C); 1O: F, PE; 1P: V
1Q: $V = Er = \left(k\frac{q}{r^2}\right)r = k\frac{q}{r}$

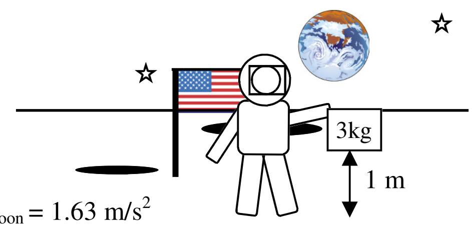
1R: If V = Er then E = V/r
☆ E = (volts)/(meters)
Proof:

$E = \frac{V}{m} = \frac{J/C}{m/1}$ multiply by recipr

$So\ E = \frac{J}{C}\left(\frac{1}{m}\right) = \frac{Nm}{C}\left(\frac{1}{m}\right) = N/C$

ta dah!





g_{moon} = 1.63 m/s^2

2. Five different masses are placed in different positions. One is on the moon. We are going to use this as an analogy for electrostatics. Many of the same principles and concepts apply.

A. Which mass feels the smallest gravitational field?
B. Which mass feels the greatest gravitational force? Why?
C. Which mass has more PE the 2 kg or the 3 kg? Why?
D. Which mass has the greater PE: 2 kg or 20 kg? Why?
E. Which mass's position would give the greatest PE to any of the masses? Why?
F. So, which mass's position has the greatest gravitational voltage (J/kg)?
G. What is the PE of the 1 kg mass on the refrigerator?
H. What would be the PE of the 2 kg mass if on the refrigerator?
I. What would be PE for the 3 kg mass if it was on the refrigerator?
J. So, the refrigerator gives ______ joules of PE for every kg put there.
K. The stove (on the left) only gives on ______ joules of PE for every kg put there.

A. 3kg ($g_{moon} < g_{earth}$)
B. 20 kg (most mass)
C. 2kg (same h; more g)
D. 20kg (much more m)
E. 1kg (most h, top of frig)
F. 1kg's <u>position</u>
G. mgh = 1(10)(2) = 20 J
H. 40 J
I. 60 J
J. More
K. 10 J

So, the refrigerator gives the most gravitational voltage: it's about position. This is like electrostatic voltage, which is in J/C: how much energy each coulomb would have AT THAT POSITION!

3. A 4C charge is placed at a position that has a potential of 12V.
A. How much PE does the charge have?

B. If released, how much KE would it have after a long time?

3A: (12J/C)(4C) = 48J (Again, PE = qV)
3B: 48 J (also = W to get it there from ∞)

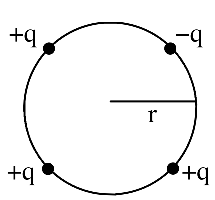
4. A point in space has an electric field strength of 0.75 N/C. A 2C charge is placed at that point. How much force does it feel?

4: N/C time C = N, so = 1.5 N OR F = qE

5. E is in N/C or in V/m. If the plates of a capacitor are separated by 3mm and the plates are charged to 6V, how strong is the electric field between the plates?

5: E = V/m = 6V/(3E–3m)
E = 2,000 N/C Direction will be toward neg plate.

6. Four charges are placed equidistance from a point.



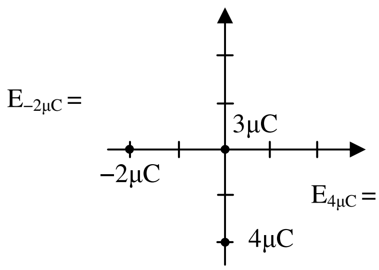
A. Write an expression for the potential due to the –q.
B. Write an expression for V due to one of the + charges.
C. Write an expression for the V_{net} at the center.

D. If a fourth +q is placed at the center, its PE is:

A. V= –kq/r
B. +kq/r
C. 2kq/r
D. PE = V(q)
= (2kq/r)q
= 2kq^2/r

7. Two fixed charges are placed on the x-y axis, as shown on the diagram. A third charge of 3μC is moved from infinity to the origin. Each line is 1 cm.

E at origin is due to the charges NOT at the origin.



A. Calculate the electric field due to each charge at the origin.

A. $E_{-2\mu C} = k\dfrac{2E-6}{(2E-2)^2} = 4.5E7\ N/C\ (left)$

$E_{4\mu C} = 9E7\ N/C\ (up)$

twice the q = twice the E

B. Calculate the net electric field at the origin, both magnitude and direction.

B. $E_{net} = \sqrt{\left(E_{-2\mu C}\right)^2 + \left(E_{4\mu C}\right)^2}$

$= 1E8\ N/C$

$\theta = \tan^{-1}(y/x)$

$= \tan^{-1}(9/-4.5)$

$= -63^\circ + 180^\circ = 117^\circ$

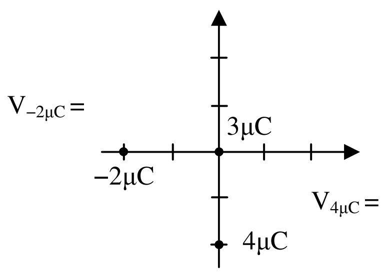
C. Calculate the net force on the 3μC charge.

C. $(N/C)(C) = N,\ so$

$F = qE = 1E8(3E-6)$

$= 3E2N\ or\ 300N$

The picture is redrawn to make it easier to work.



D. Calculate the potential at the origin due to each charge.

D. $V_{-2\mu C} = k\dfrac{-2E-6}{2E-2}$

$OR\ \ V = Er = -9E5\ J/C$

$V_{-2\mu C} = k\dfrac{4E-6}{2E-2}$

$OR\ \ V = Er = 1.8E6\ J/C$

E. Calculate the net potential at the origin.

E. $scalars,\ so\ just\ add$

$V_{net} = +9E5\ J/C$

F. Calculate the net potential energy of the 3μC charge.

F. $PE = qV$

$= (3E-6)(9E5)$

$= 27E-1$

$PE = 2.7\ J$

G. If released, how much kinetic energy would the 3μC charge have after a long time?

G. $PE = KE = W$

$= 2.7\ J$