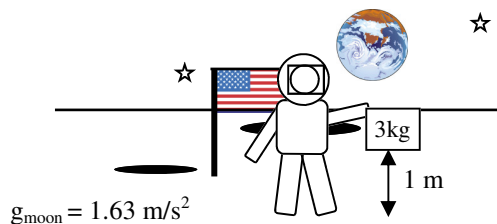
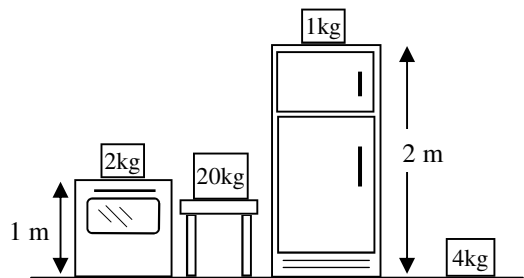


1. E, V, F, PE, or q?

- | | | |
|-----------------------|-----------------------|-------------------------------|
| 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 x 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 $E = V/r$
 ☆ $E = (\text{volts})/(\text{meters})$
 Proof:

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

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

ta dah!

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.

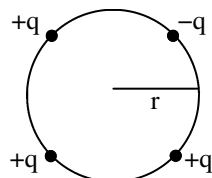
- Which mass feels the smallest gravitational field?
- Which mass feels the greatest gravitational force? Why?
- Which mass has more PE the 2 kg or the 3 kg? Why?
- Which mass has the greater PE: 2 kg or 20 kg? Why?
- Which mass's position would give the greatest PE to any of the masses? Why?
- So, which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

- 3kg ($g_{\text{moon}} < g_{\text{earth}}$)
- 20kg (most mass)
- 2kg (same h; more g)
- 20kg (much more m)
- 1kg (most h, top of frig)
- 1kg's position
- $mgh = 1(10)(2) = 20 \text{ J}$
- 40 J
- 60 J
- More
- 20 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!

- A 4C charge is placed at a position that has a potential of 12V.
 - How much PE does the charge have?
 - If released, how much KE would it have after a long time?
- 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?
- 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?
- Four charges are placed equidistance from a point.

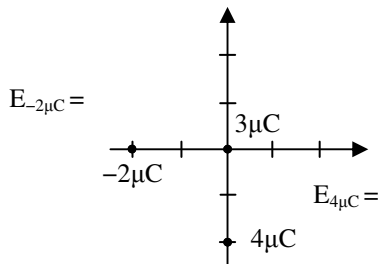
- 3A: $(12\text{J/C})(4\text{C}) = 48\text{J}$
 (Again, PE = qV)
 3B: 48 J (also = W to get it there from ∞)
- 4: N/C time C = N, so
 = 1.5 N OR F = qE
- 5: $E = V/m = 6\text{V}/(3\text{E}-3\text{m})$
 $E = 2,000 \text{ N/C}$ Direction will be toward neg plate.



- Write an expression for the potential due to the -q.
- Write an expression for V due to one of the + charges.
- Write an expression for the V_{net} at the center.
- If a fourth +q is placed at the center, its PE is:

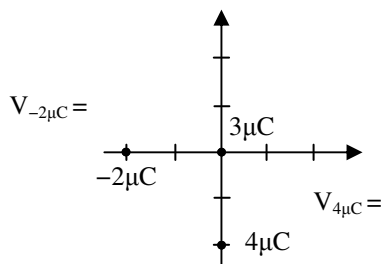
- $V = -kq/r$
- $+kq/r$
- $2kq/r$
- PE = V(q)
 $= (2kq/r)q$
 $= 2kq^2/r$

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



- Calculate the electric field due to each charge at the origin.
- Calculate the net electric field at the origin, both magnitude and direction.
- Calculate the net force on the $3\mu\text{C}$ charge.

The picture is redrawn to make it easier to work.



- Calculate the potential at the origin due to each charge.
- Calculate the net potential at the origin.
- Calculate the net potential energy of the $3\mu\text{C}$ charge.
- If released, how much kinetic energy would the $3\mu\text{C}$ charge have after a long time?

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

- $$E_{-2\mu\text{C}} = k \frac{2E - 6}{(2E - 2)^2}$$

$$= 4.5E7 \text{ N/C (left)}$$

$$E_{4\mu\text{C}} = 9E7 \text{ N/C (up)}$$
 twice the $q =$ twice the E
- $$E_{\text{net}} = \sqrt{(E_{-2\mu\text{C}})^2 + (E_{4\mu\text{C}})^2}$$

$$= 1E8 \text{ N/C}$$

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

$$= -26.6 + 180 = 153^\circ$$
- $(\text{N/C})(\text{C}) = \text{N}, \text{ so}$

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

$$= 3E2 \text{ N or } 300 \text{ N}$$
- $$V_{-2\mu\text{C}} = k \frac{-2E - 6}{2E - 2}$$
 OR $V = Er = -9E5 \text{ J/C}$

$$V_{-2\mu\text{C}} = k \frac{4E - 6}{2E - 2}$$
 OR $V = Er = 1.8E6 \text{ J/C}$
- just add

$$V_{\text{net}} = +9E5 \text{ J/C}$$
- $$PE = qV$$

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

$$PE = 2.7 \text{ J}$$
- $$PE = KE = W$$

$$= 2.7 \text{ J}$$