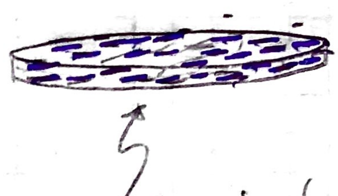
5.39 Car engine needs 3.75e21 electrons.

$$3.75e21\ e^- \times \frac{1.602e{-19}\ C}{1\ e^-} = 601\ \text{Coulombs} = \boxed{601\ C}$$

5.41 2.5 g copper penny has a charge of $-2.0e-9\,C$

a) How many extra e^- are on the penny?

$$-2.0e{-9}\,C \times \frac{1\,e^-}{-1.602e{-19}\,C} = \boxed{1.25e10\ e^-}$$



extra electrons

b) By what percent is the mass of the penny increased by these electrons?

$$\text{Mass of electrons} = 1.25e10\ e^- \times \frac{9.11e{-31}\,kg}{1\,e^-}$$

$$= 1.14e{-20}\ kg$$

$$\text{Percent increase} = \frac{M_{new} - M_{original}}{M_{original}} \times 100$$

converting to grams

$$= \frac{(2.5g + 1.14e{-17}g) - 2.5g}{2.5g} \times 100$$

$$= 0 \times 100 = 0\%\ \text{(negligible)}$$

5.45

$m = 50.0\,g$, $q = 2.00\,\mu C = 2.00e{-6}\,C$

What fraction of e^- have been removed to give it this charge?

Given: Cu has atomic number 29 & atomic mass 63.5

* How many electrons are there ordinarily in 50 g of copper?

$$50\,g\ Cu \times \frac{1\ mol\ Cu}{63.5\,g} \times \frac{6.02e23\ atoms}{1\ mol} \times \frac{29\,e^-}{1\ atom} =$$

1.37e25 electrons (neutral charge)

* How many electrons removed?

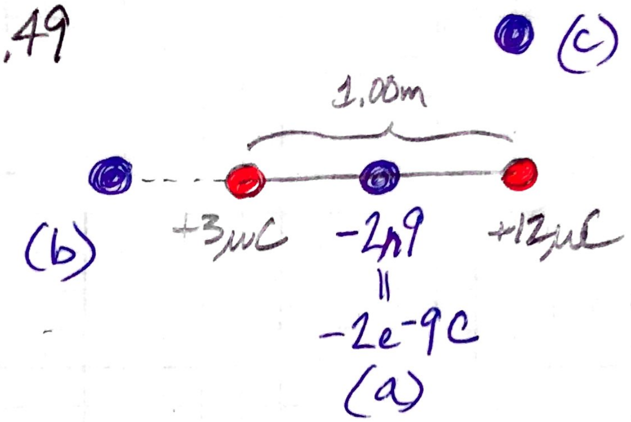
$$2.00e{-6}\,C \times \frac{1\,e^-}{1.602e{-19}\,C} = 1.25e13\ e^-$$

* Fraction removed $= \dfrac{\text{electrons removed}}{\text{electrons normally}}$

$$= \frac{1.25e13\,e^-}{1.37e25\,e^-} \times 100$$

$$= \boxed{9.08e{-11}\ \%}$$

5.49



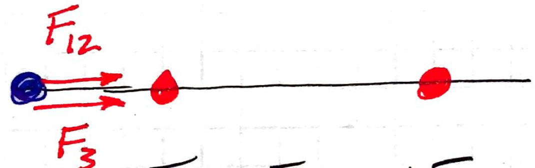
a)

$$F_{net} = F_{from\ 3} + F_{from\ 12}$$

$$-\frac{kq_1q_2}{r^2} + {}^{+}\frac{kq_1q_2}{r^2} = \frac{-(9e9)(3e\text{-}6)(2e\text{-}9)}{(0.5)^2} + \frac{(9e9)(12e\text{-}6)(2e\text{-}9)}{(0.5)^2}$$

$$= \boxed{6.48e\text{-}4\ N \text{ to the right}}$$

b)

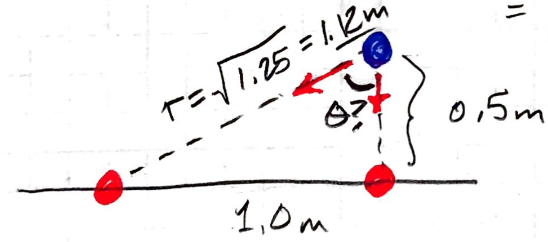


$$F_{net} = F_{from\ 3} + F_{from\ 12}$$

$$+\frac{kq_1q_2}{r^2} + \frac{kq_1q_2}{r^2} = \frac{(9e9)(3e\text{-}6)(2e\text{-}9)}{(0.5)^2} + \frac{(9e9)(12e\text{-}6)(2e\text{-}9)}{(1.5)^2}$$

$$= \boxed{3.12e\text{-}4\ N \text{ to the right}}$$

c)



$$F_{from\ 3} = \frac{kq_1q_2}{r^2} = \frac{(9e9)(3e\text{-}6)(2e\text{-}9)}{(1.12m)^2} = \underline{4.30e\text{-}5N}$$ But what are components?

$\theta = \tan^{-1}(1.0/0.5) = 63.4°$, so

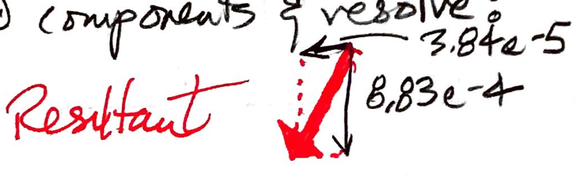
$$F_{3x} = F_3 \sin 63.4 = 4.3e\text{-}5 \sin 63.4$$
$$\underline{3.84e\text{-}5\ -\hat{\imath}}$$

$$F_{3y} = F_3 \cos 63.4 = \underline{1.93e\text{-}5\ -\hat{\jmath}\ N}$$

$$F_{from\ 12} = \frac{kq_1q_2}{r^2} = \frac{(9e9)(12e\text{-}6)(2e\text{-}9)}{(0.5)^2}$$

$$= \underline{8.64e\text{-}4\ -\hat{\jmath}\ N}$$

Add components & resolve:



$$R = \boxed{8.84e\text{-}5N\ @\ 267°}$$

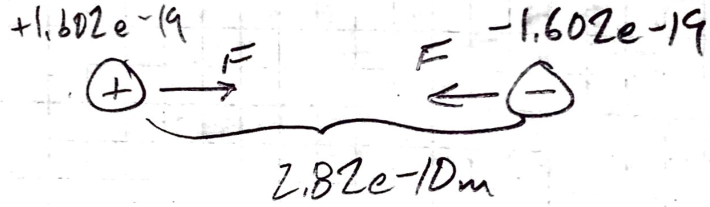
5.50 In salt crystal (NaCl), the distance between ions is 2.82e-10 m. Find force of attraction.

Na & Cl are singly-charged ions, so

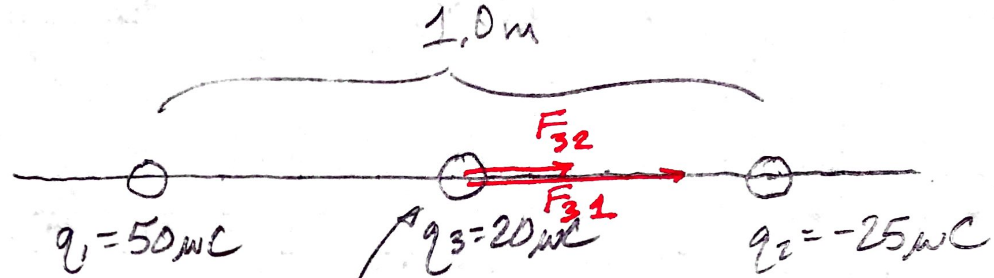
$$F = k\frac{q_1 q_2}{r^2}$$

$$= \left(9e9 \frac{Nm^2}{C^2}\right) \frac{(+1.602e{-19}\,C)(-1.602e{-19}\,C)}{(2.82e{-10}\,m)^2}$$

$$= \boxed{2.90e{-9}\,N}$$



5,53



Find F on q_3.

Positive q_1 repels q_3 &
Negative q_2 attracts q_3.

I've used diagram to analyze direction of forces, so I'm not using charge sign (+ or −) in analysis.

$$F_{net} = F_1 + F_2$$

$$= \frac{k q_1 q_3}{r^2} + \frac{k q_2 q_3}{r^2}$$

$$= 9e9 \left(\frac{(50e\text{-}6)(20e\text{-}6)}{(0.5)^2} + \frac{(25e\text{-}6)(20e\text{-}6)}{(0.5)^2} \right)$$

$$= \boxed{54\,N}$$