#12)

Compound #	mass iodine (g)	mass fluorine (g)	Mass Fluorine / mass I
1	4.75	3.56	0.749(47) → 0.749
2	7.64	3.43	0.448(95) → 0.449
3	9.41	9.86	1.04(782) → 1.05

given.

(a) calculate mass F / mass I

(b) how do the ratios support atomic theory:

The three ratios of mass fluorine to mass iodine are related to each other by whole number ratios:

0.44895 to 0.74947 to 1.04782

reduces to 1 to 1.67 to 2.33
or, approximately 1 to $1\frac{2}{3}$ to $2\,^1/_3$
or 3 to 5 to 7

we are essentially using Dalton's Logic for how the law of multiple proportions supports the existence of atoms, with atoms of a specific element having a unique mass (isotopes were not a part of his theory).

If atoms exist, they would combine in whole numbers to make compounds, and the ratios of masses of one element to another would themselves be related by whole numbers, if a few compounds exist with the elements. The whole number ratio of 3 : 5 : 7 supports the idea that elements must combine in discrete amounts; with whole numbers of atoms.

(We can now calculate the empirical formulas:

IF_5, IF_3, and IF_7, and see why the 5 : 3 : 7 ratio exists.)

(15.) How did Rutherford interpret these results of the Au foil expt:

(a) most α particles were not appreciably deflected:
whatever the α particles were being deflected by (the nucleus) must be very small compared to the rest of the atom, in terms of cross sectional area.

(b) A few α particles were deflected at v. large angles:
The nucleus must be the same charge as the α particles (positive) to repel the α, and must be massive compared to the alpha particle, since the alpha deflected sharply and the nucleus / gold atom was not.

(c) How would results be different if Be foil was used?
- a smaller fraction of the alpha particles will be scattered back by the nucleus, since Be's nucleus is expected to be smaller than Au's nucleus. Also, since Be's nucleus is only ≈ 2x as massive as an alpha (9 amu to 4 amu, vs 197 to 4 with Au) the α won't scatter back with as much speed

(31.) ^{63}Cu (62.9296 amu, 69.17% abundance)
^{65}Cu (64.9278 amu, 30.83 abundance)

Calculate atomic mass:

$$(0.6917)(62.9296\text{ amu}) + 0.3083(64.9278\text{ amu})$$
$$= 43.528404\text{ amu} + 20.01724\text{ amu}$$
$$= 63.54564\text{ amu} \rightarrow \boxed{63.55\text{ amu}}$$

(34.) (a) purpose of a magnet in a mass spectrometer:
The purpose of the magnet / magnetic field is to deflect the beam of ions into a curved path; The mass of the ion can be calculated according to the path / radius of curvature, the speed of the ion beam, and the magnetic field.

$$F = qv \times B \quad \text{or} \quad F = qvB_{\perp}$$

^ component of magnetic field that is ⊥ to path of ions / ⊥ to velocity.

if you set the Force from the magnetic field equal to the centripetal force (the ion is deflected in a circular path)

you get $F = qvB_{\perp} = \frac{mv^2}{R}$

or $m = \frac{qvB_{\perp}R}{v^2} = \frac{qBR}{v}$

↑ determined by the strength of electric field, before ions are deflected by magnet.

so you can find the mass of the isotope. more massive isotopes will be deflected less sharply so will have a large R for a given magnetic fields strength and speed.

(b) Cl: atomic mass ≈ 35.5 amu.
So why no peak at 35.5 amu on the spectrum? (p. 49)

Cl has two isotopes: Cl-35, and Cl-37. So its mass spectrum has 2 peaks, @ 35 amu and @ 37 amu.

the 35.5 amu is the average atomic mass, calculated using a weighted avg; ≈ 75% are 35 amu, and ≈ 25% are 37 amu

(c) Phosphorus's mass spectrum only has one peak: at 31 amu
Phosphorus must have essentially one isotope: with mass of 31 amu

(d) Mass spectrometry shows that many elements have more than one isotope, which means that not all atoms of the same element are identical, since not all atoms of the same element have the same mass. This contradicts #2 of Dalton's theory (as summarized on p. 40): "All atoms of a given element are identical."

(81)

Droplet	Calculated charge ("Warmombs")	charge divided by 2.88×10^{-8} Wa
A	3.84×10^{-8}	$1.33 \approx 1\frac{1}{3}$
B	4.80×10^{-8}	$1.67 \approx 1\frac{2}{3}$
C	2.88×10^{-8}	1
D	8.64×10^{-8}	3

(a) Drop D would fall most slowly. It has the largest charge (all drops are negatively charged, with extra electron(s)), so will be repelled the most strongly by the negative plate at the bottom of the apparatus.

(b/c) see above: I divided the charge on each droplet by the charge on drop "C", which had the smallest charge. each drop must contain a whole number of electrons, so:

$$\left(1\tfrac{1}{3} \text{ to } 1\tfrac{2}{3} \text{ to } 1 \text{ to } 3\right) \times 3$$
$$= 4 \text{ to } 5 \text{ to } 3 \text{ to } 9$$

So, Drop A has 4 extra e^-
Drop B has 5 extra e^- ← answer to (c)
Drop C has 3 extra e^-
Drop D has 9 extra e^-

$$\frac{3.84 \times 10^{-8}}{4} = \frac{4.80 \times 10^{-8}}{5} = \frac{2.88 \times 10^{-8}}{3} = \frac{8.64 \times 10^{-8}}{9} = \boxed{9.60 \times 10^{-9} \text{ Wa per electron}} \quad (b)$$

(d) $$\frac{9.60 \times 10^{-9} \text{ Wa}}{1.602 \times 10^{-19} \text{ C}} = \boxed{5.99 \times 10^{10} \text{ Wa/C}}$$

or 1.67×10^{11} Coulombs per Warmomb.

(88) $F = \frac{k q_1 q_2}{d^2}$ $\quad k = 9.0 \times 10^9 \ Nm^2/C^2$

$q_{electron} = -1.6 \times 10^{-19}$ C

calculate. F (between e- and p+) if an e- is 0.53×10^{-10} m apart from a proton

$$F = \frac{(9.0 \times 10^9 \ Nm^2/C^2)(-1.6 \times 10^{-19} C)(1.6 \times 10^{-19} C)}{(5.3 \times 10^{-11} \ m)^2} = -8.2 \times 10^{-8} \ N$$

(e-charge, proton charge)

(b) change it to 2 protons in nucleus:

$$F = \frac{(9.0 \times 10^9 \ Nm^2/C^2)(-1.6 \times 10^{-19} C)(3.2 \times 10^{-19} C)}{(5.3 \times 10^{-11} m)^2} = -1.64 \times 10^{-7} \ N,$$

$$\boxed{-1.6 \times 10^{-7} \ N}$$

(c) 1 proton in nucleus, but now double the distance.

$$F = \frac{(9.0 \times 10^9 \ Nm^2/C^2)(-1.6 \times 10^{-19} C)(1.6 \times 10^{-19} C)}{(1.06 \times 10^{-10} m)^2} = \boxed{-2.1 \times 10^{-8} \ N}$$

(-2.0506×10^{-8})

(d) Increasing the nuclear charge (# of protons) would increase the attractive force between the e- and the nucleus, so ionization energy (energy needed for e- to leave the atom) would increase.

(e) The n=2 electron would need more energy than the n=6 electron, to leave the atom. The n=2 electron is closer to the nucleus, so will be more strongly attracted to nucleus. So will need more energy to leave the atom.