Welcome to 3.091

3.091 Periodic Table Quiz

September 18, 2003

Name _____

Grade _____/10

1																	2
3	4											5	6	7	8	9	10
11	12											13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
87	88	89															

La	Lazy
Ce	college
Pr	professors
Nd	never
Pm	produce
Sm	sufficiently
Eu	educated
Gd	graduates
Tb	to
Dy	dramatically
Ho	help
Er	executives
Tm	trim
Yb	yearly
Lu	losses.

La	Loony
Ce	chemistry
Pr	professor
Nd	needs
Pm	partner:
Sm	seeking
Eu	educated
Gd	graduate
Tb	to
Dy	develop
Ho	hazardous
Er	experiments
Tm	testing
Yb	young
Lu	lab assistants.

La	Learned
Ce	cool
Pr	people
Nd	never
Pm	punt
Sm	Sadoway:
Eu	even
Gd	geniuses
Tb	think
Dy	Donald
Ho	has
Er	engineering
Tm	theory
Yb	you’ll
Lu	love.

57

CEase not I to slave, back breaking to tend;
PRideless and bootless stoking hearth and fire.
No Dream of mine own precious time to spend
Pour'ed More to sate your glutt'nous desire.
SMelting anew my ten-thousandth hour
EUtopia forever I eschew.
Growing Dimmer is my fleeing power
To Bid these curs'ed problem sets adieu.
DYing away whilst thy hosts are fought
HOpeless I come should in lecture I doze.
ERgo, like a sad slave, stay and rest nought.
Then Must I tool and toil while fatigue grows.
  Yet, Bloody though I must be, and quite ill
  Light the Universal abyss I will.

- Blake Stacey

57'

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57

Being your slave, what should I do but tend
Upon the hours and times of your desire?
I have no precious time at all to spend,
Nor services to do till you require.
Nor dare I chide the world-without-end hour
Whilst I, my sovereign, watch the clock for you,
Nor think the bitterness of absence sour
When you have bid your servant once adieu.
Nor dare I question with my jealous thought
Where you may be, or your affairs suppose,
But, like a sad slave, stay and think of naught
Save where you are how happy you make those.
So true a fool is love that in your will,
Though you do anything, he thinks no ill.

The Structure of the Atom

status report *ca*. end of the 19th century

* atom is electrically neutral

* -ve charge carried by electrons

* e- has very small mass

  ⇨ bulk of the atom is +ve,

  ⇨ most mass resides in +ve charge

Question:
what is the spatial distribution of charge inside an atom?

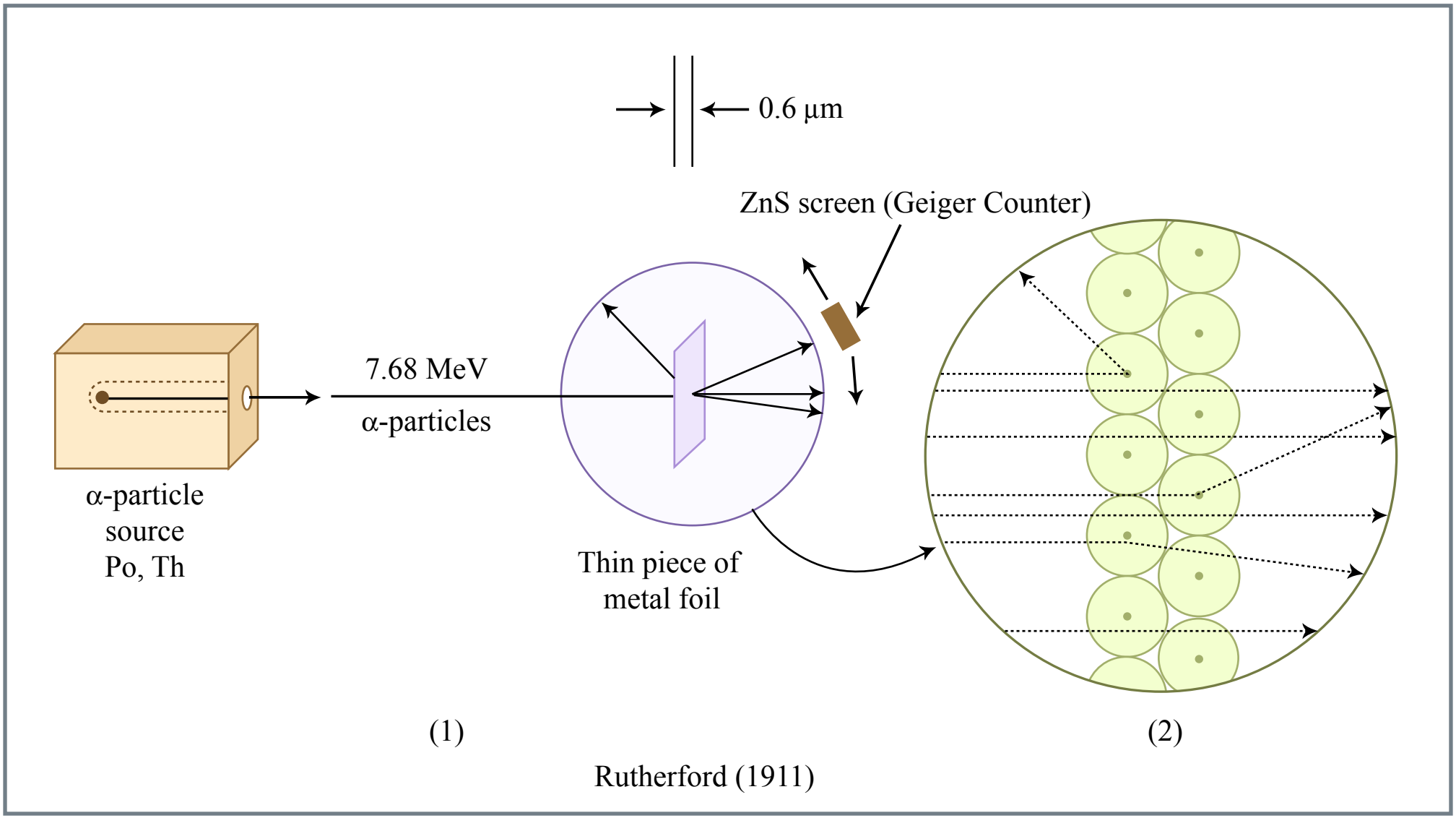
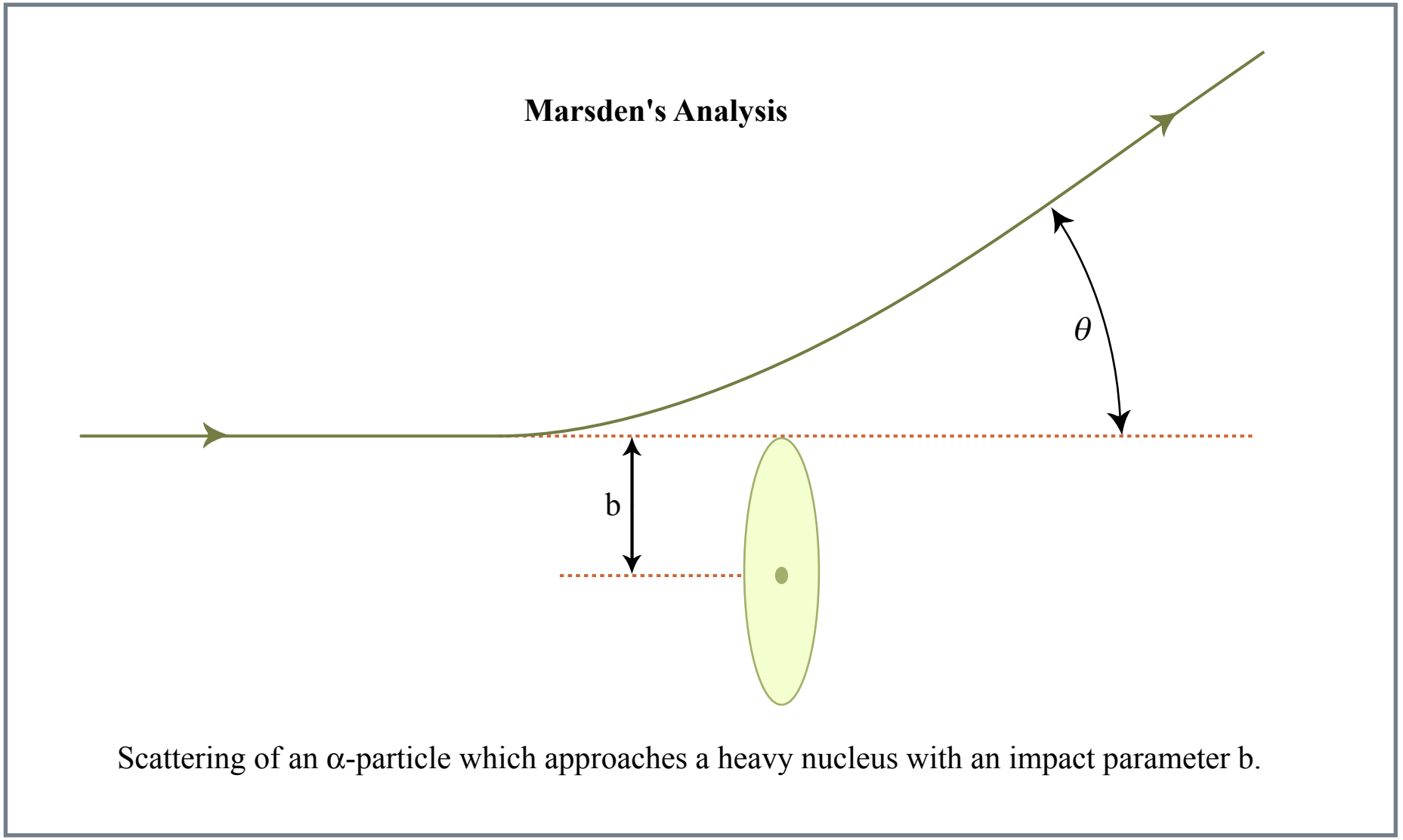


Figure by MIT OCW.



Scattering of an α-particle which approaches a heavy nucleus with an impact parameter b.

Figure by MIT OCW.

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By N. BOHR, *Dr. phil. Copenhagen* *.

Introduction.

IN order to explain the results of experiments on scattering of α rays by matter Prof. Rutherford† has given a theory of the structure of atoms. According to this theory, the atoms consist of a positively charged nucleus surrounded by a system of electrons kept together by attractive forces from the nucleus; the total negative charge of the electrons is equal to the positive charge of the nucleus. Further, the nucleus is assumed to be the seat of the essential part of the mass of the atom, and to have linear dimensions exceedingly small compared with the linear dimensions of the whole atom. The number of electrons in an atom is deduced to be approximately equal to half the atomic weight. Great interest is to be attributed to this atom-model; for, as Rutherford has shown, the assumption of the existence of nuclei, as those in question, seems to be necessary in order to account for the results of the experiments on large angle scattering of the α rays‡.

In an attempt to explain some of the properties of matter on the basis of this atom-model we meet, however, with difficulties of a serious nature arising from the apparent

* Communicated by Prof. E. Rutherford, F.R.S.

† E. Rutherford, Phil. Mag. xxi. p. 669 (1911).

‡ See also Geiger and Marsden, Phil. Mag. April 1913.

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instability of the system of electrons: difficulties purposely avoided in atom-models previously considered, for instance, in the one proposed by Sir J. J. Thomson *. According to the theory of the latter the atom consists of a sphere of uniform positive electrification, inside which the electrons move in circular orbits.

The principal difference between the atom-models proposed by Thomson and Rutherford consists in the circumstance that the forces acting on the electrons in the atom-model of Thomson allow of certain configurations and motions of the electrons for which the system is in a stable equilibrium; such configurations, however, apparently do not exist for the second atom-model. The nature of the difference in question will perhaps be most clearly seen by noticing that among the quantities characterizing the first atom a quantity appears—the radius of the positive sphere—of dimensions of a length and of the same order of magnitude as the linear extension of the atom, while such a length does not appear among the quantities characterizing the second atom, viz. the charges and masses of the electrons and the positive nucleus; nor can it be determined solely by help of the latter quantities.

The way of considering a problem of this kind has, however, undergone essential alterations in recent years owing to the development of the theory of the energy radiation, and the direct affirmation of the new assumptions introduced in this theory, found by experiments on very different phenomena such as specific heats, photoelectric effect, Röntgen-rays, &c.

Whatever the alteration in the

Bohr Postulates for the Hydrogen Atom

1. Rutherford atom is correct
2. Classical EM theory not applicable to orbiting e^-
3. Newtonian mechanics applicable to orbiting e^-
4. $E_{\text{electron}} = E_{\text{kinetic}} + E_{\text{potential}}$
5. e^- energy quantized through its angular momentum:

   $L = mvr = nh/2\pi, \quad n = 1, 2, 3, \ldots$
6. Planck-Einstein relation applies to e^- transitions:

   $\Delta E = E_f - E_i = h\nu = hc/\lambda$

   $c = \nu\lambda$

Frayn, Michael. *Copenhagen.* Anchor, 8 August 2000. ISBN: 0385720793.
Won the 2000 Tony Award for Best Play.

Isotopes of Hydrogen

$^{1}_{1}H$ **hydrogen**

1766 Henry Cavendish, London

$^{2}_{1}H$ **deuterium** $^{2}_{1}D$

1931 Harold Urey, Columbia U.

$^{3}_{1}H$ **tritium** $^{3}_{1}T$

1934 Ernest Rutherford, Cambridge U.

hydrogen: environmentally friendly fuel?

- Cavendish observed that combustion of hydrogen produced water vapor by the reaction

$$H_2 + \tfrac{1}{2} O_2 \Rightarrow H_2O$$

- but, in an internal combustion engine

$$H_2 + \text{air } (80\% N_2 / 20\% O_2) \Rightarrow H_2O + NO_x$$

- other issues:

  * safety (H_2 on board)
  * environmental impact of H_2 prod^n
  * cost