STEM Society Meeting, March 8, 2016

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1 About the STEM Society and the STEM Society Website

STEM is an abbreviation for Science, Technology, Engineering and Mathematics. The acronym STEM is commonly associated with K-12 education, but our use of the term is only slightly bound to this meaning. There are over one hundred people on the mailing list, although a much smaller group attends any one meeting. We meet on the second Tuesday of each month at the Trailside Center at 99th and Holmes in Kansas City, Missouri. The meetings are open to all. The start time is 6PM. We make presentations, have discussions, and have demonstration experiments. These relate to Science, the History of Science, Mathematics, Engineering, Philosophy and Technology at all levels. The topics have ranged from a technical discussion of the Mathematics of General Relativity to scientific experiments for young students.

These meeting notes contain links to many other documents, which may be viewed or downloaded by clicking the link. A partial list of documents can be reached by clicking the heading **Documents**. The meeting notes may also be viewed in an archive file (archive.pdf), which is in the list of documents. Many of the documents are PDF files. They may be viewed or downloaded to the computer by clicking, provided Adobe Reader, or another program capable of reading PDF files, is present. There are many more documents available at the site than are listed under **Documents** because the documents.htm file is not at all up to date. The last time I checked, about March 2014, there were about 350 document files on the site. We are in the process of creating better techniques for finding documents and authors. The first meeting of the STEM Society was in November of 2006. For several years we used the content management program called Joomla. It had a fancy looking interface, but was hard to use. It overran the space somehow at our internet provider Bluehost. So we now have a very simple HTML site. It is not so slick looking as Joomla, but is very easy to maintain and modify.

The web site is:

`http://www.stem2.org/`

Direct to the documents list:

`http://www.stem2.org/je/documents.htm`

Direct to the archive file:

`http://www.stem2.org/je/archive.pdf`

2 The March 8, 2016 Meeting Announcement

The March meeting of the STEM Society will take place on the second Tuesday of the month, March 8, 2016, at the Trailside Center at 99th and Holmes in Kansas City, Missouri. The starting time is 6PM. Also look at our website for past meeting notes
The web site is:

`http://www.stem2.org/`

In particular see last months notes containing Tom Grant's slides for his wonderful presentation titled **Isotope Tales**.

Questions, Topics and possible Discussions:

(a) The Johnson County Library has a terrific expanded Maker Space at the main library. I met Jeff Newhook there Thursday and viewed some of the excellent work he has done in several areas of electronics, laser cutting, 3d printing, 3d scanning, and in teaching children about electronics by building a lovely version of the crystal set using a Germanium diode and a capacitor made with sliding tubes. I invited him to come to our meeting Tuesday and bring a couple of his outstanding creations. Jeff is from Newfoundland, and is an Electronics Engineer.

(b) I would like to have a discussion on the topic of endocrinology and hormones. This is motivated by the book that I recently read about the history of the development of the birth control pill. This is:
[1] Eig, Jonathan, **The Birth of the Pill**, 2014.
This is more of a developmental history than an in depth technical treatment. Because my knowledge of Biology and Medicine is limited, perhaps we have Stem Society people who can contribute substantially to the discussion.

(c) Like the weather, everybody talks about global warming, but nobody does anything about it. In particular, there is little presentation of the technical details, but rather announcements about the end of the world, flooding

and destruction of cities, and the likes of a possible future fatal outbreak of pimples among the teenage class. We should try to create a Stem Society document presenting some of the facts from Physics and Mathematics about this subject. I propose to talk a bit about Black Body Radiation, and the equilibrium temperature of planets due to solar radiation.

(d) Another possible topic is that of Differential Equations, Orthogonal Functions and Orthogonal Polynomials, the use of the Wronskian, and application to solving the Schrödinger equation for the Hydrogen atom.

(e) As always, attendees are free to bring, and should bring additional topics, things, ideas, and presentations. We need more presentations from our very diverse and experienced fellowship.

3 Discussion on the Maker Space of the Johnson County Library

At the central library on 87th Street there is a new maker space in a much larger room than the previous maker space, which had been around for a couple of years.

Some of the equipment includes: four 3d printers, a laser cutter, several computers, a 3d scanner, an electronics bench with soldering equipment, a desoldering tool, meters and tools, various hand tools.

There is a digital audio room with software and equipment, and a video room and camera, with a green screen.

The equipment is free to use, and some materials are free.

4 Discussion of Endocrenology and Hormones, The Pill

The material that I presented was mostly from the university Biology book **Biology** by Neil Cambell and Jane Reece, 7th edition, Chapter 45 Hormones and the Endocrine System. Similar material can be found in other such Biology books.

This was motivated by reading **The Birth of the Pill**, by Jonathan Eig (as in Eigenvalue), W. H. Norton, 2014, which is summarized in the following subsection.

4.1 The Development of the Birth Control Pill

- **The Birth of the Pill**, by Jonathan Eig (as in Eigenvalue), W. H. Norton, 2014.
- The pill was created largely by the efforts of Gregory Pincus, Margaret Sanger, Katherine McCormick, and John Rock. All were rather old, Pincus was the youngest in his fifties.
- Birth control was illegal in 30 states at the time.
- Pill dosage: 10, 5, and 2.5 milligrams
- Gregory Pincus (April 9, 1903 August 22, 1967) biologist, endocrinologist, pioneer of in vitro fertilization, fired from Harvard, denied tenure because of his "Frankenstein" research. Started his own research laboratory, with extremely small funding. Experiments with rabbits.
- **Hormones** androgens

  progesterone, progestin

  estrogen

  steroids

  oral contraceptive
- Carl Djerassi (1923-2015) organic chemist, responsible for the artificial synthesis of progesterone, making the pill practical and lowering cost. Also he was a Novelist "The Bourbaki Gambit"
- Drug trials were done in Puerto Rico, contraception was not illegal there as it was in the US.
- John Rock (March 24, 1890 December 4 1984), Catholic physician, expert on hormones, obstetrician gynecologist, who specialized in female infertility. Pincus to Rock: "Treat infertility with progesterone, perhaps this will cause fertility after it is no longer given." Sanger was

upset about having a Catholic involved, but Rock proved to be very supportive of the effort. Sanger just barely lived to see the introduction of the pill.

- Margarat Sanger (September 14, 1879 September 6, 1966) was personally very interested in sex, she was a famous crusader for women's rights and birth control.

- Anthony Comstock. The Comstock Act outlawed pornography and contraception, "Comstock Laws."

- Worcester Massachusetts, (pronounced wooster). Pincus started the Worcester Foundation for Experimental Biology.

- The drug company Searle was founded in Omaha, Nebraska, in 1888, by Gideon Daniel Searle. Searl obtained the first approval of the drug by the FDA in 1957. The first Approval was for applying the pill to "Menstrual Disorders," and for only two years. But in 1960 the FDA approved the pill for use in contraception, at a lower dosage.

- Griswald Supreme Court discission ended anti-contraception laws

- G. A. Searle, pharmacy company manufactured the first pill, called Enovid.

- Katherine McCormick (August 27, 1875 December 28, 1967), was a biologist, suffragist, philanthropist. Wealth was from the McCormick family by marriage, which came from the famous invention of the McCormick Reaper, and the International Harvester Company. Katherine McCormick was an early women MIT science graduate, married a wealthy McCormick heir, who unknown to her at the time of the marriage, had very serious schizophrenia.

- Planned Parenthood was founded by Sanger and others.

- The Catholic effort limiting birth control and abortion is an example of illegal religious interference in the world. Freedom of religion does not give religions the right to enforce their religions beliefs, but only to have such beliefs. The Sunday Blue Laws, forcing stores to close on Sunday because of religion, is another example of illegal religious interference in the real world.

- Estrogen is mixed in the pill, and is also released during pregnancy. Drug company Searle accidentally contaminated the pill with estrogen, but this was found to prevent side effects and so was kept.
- None of the pioneers made any significant money on the pill.
- McCormick supplied several million dollars for the research and development, in pursuit of her life long interest in birth control.

See

`http://www.stem2.org/je/pill.pdf`

for a pdf of this document on the pill, and for any update of this document.

5 Black Body Radiation and the Equilibrium Temperature of Planets

The following material occurs as the stand alone document

`http://www.stem2.org/je/eqptemp.pdf`

6 The Stefan-Boltzmann Equation

Radiated power from a surface of area A, emissivity e, absolute temperature T, and Stefan-Boltzmann constant σ is

$$P = e\sigma AT^4.$$

This equation was originally found empirically by Stefan in 1879, and the derived later by Boltzmann using statistical mechanics.

The value of the Stefan-Boltzmann constant is given in SI units by

$$\sigma = 5.670367 \times 10^{-8} Wm^{-2}K^{-4}$$

In cgs units the Stefan-Boltzmann constant is:

$$\sigma = 5.6704 \times 10^{-5} (erg)(cm)^2 s^{-1} K^{-4}$$

7 Kirchhoff's Equality Theorem on Emissivity and Absorption

In 1895, Kirchhoff proved the equality of emissivity e and absorption a coefficients

$$e = a,$$

for radiation, using a purely thermodynamic argument, without any detailed theory of the radiation process.

8 The Intensity of Incident Solar Radiation

Let $I(d)$ be the solar radiation intensity at a distance d from the sun, in Joules per sec per meter squared. Let the total radiated power from the sun be P_s. We take the sun to be a black body so that by the Stefan-Boltzmann law, we have

$$P_s = \sigma A_s T_s^4,$$

where σ is the Stefan-Boltzmann constant, T_s is the surface temperature of the sun, and A_s is the surface area of the sun given by

$$A_s = 4\pi R_s^2,$$

where R_s is the radius of the sun. So

$$P_s = \sigma 4\pi R_s^2 T_s^4.$$

This power of the sun is spread out over a sphere of radius d at the location, which is a distance d from the sun. So that the power intensity is

$$I(d) = \frac{P_s}{4\pi d^2} = \frac{\sigma 4\pi R_s^2 T_s^4}{4\pi d^2}$$

$$= \frac{\sigma R_s^2 T_s^4}{d^2},$$

Watts per meter squared. Notice that the power intensity $I(d)$ is inversely proportional to the square of the distance d from the sun.

9 The Planet Equilibrium Temperature

The planet and the sun are taken to be perfect black body emitters, but the planet is taken to be less than a perfect black body absorber. That is a can be between 0 and 1. The albedo or whiteness is defined as $1 - a$. So a black body has albedo 0.

Let a planet be located at distance d from the sun, its radius be R_p, its surface absorbtion coefficient be a, and its cross sectional area be

$$A_c = \pi R_p^2.$$

The input radiant power from the sun is

$$P_i = I(d)aA_c = I(d)a\pi R_p^2$$

$$= \frac{\sigma R_s^2 T_s^4}{d^2} a\pi R_p^2.$$

If the temperature of the planet is T_p. Then by the Stefan-Boltzmann law the power radiated from the planet is

$$P_o = \sigma A_p T_p^4 = \sigma 4\pi R_p^2 T_p^4,$$

where the emissivity is taken to be 1, and A_p is the surface area of the planet. We find the equilibrium temperature by equating the input power to the output power

$$P_i = \frac{\sigma R_s^2 T_s^4}{d^2} a\pi R_p^2 = \sigma 4\pi R_p^2 T_p^4 = P_o.$$

Cancelling terms we have

$$\frac{R_s^2 T_s^4}{d^2} a = 4T_p^4.$$

Then

$$T_p^4 = \frac{T_s^4 R_s^2 a}{4d^2},$$

so that the equilibrium temperature is

$$T_p = T_s a^{1/4} \sqrt{\frac{R_s}{2d}}.$$

10 Planetary Data

Planet	Equilibrium Temperature	Surface Temperature	Distance
Mercury	449 K	440 K	57,910,000 km
Venus	328	730	108,200,000
Earth	279	287	149,600,000
Mars	226	218	227,940,000
Jupiter	122	120	778,330,000
Saturn	90	88	1,424,600,000
Uranus	64	59	2,873,550,000
Neptune	51	48	4,501,000,000
Pluto	44	37	5,945,900,000

Sun surface temperature $T_s = 5778$ K.
Sun Radius 696,000 kilometers $R_s = 6.96 \times 10^8$ m.

11 The Theory of Black Body Radiation

I may add material on this later.

12 Bibliography

[1] Eisberg Robert Martin, **Fundamentals of Modern Physics**, John Wiley and Sons, 1961.

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[4] Jacobson Mark Z., **Fundamentals of Atmospheric Modeling**, Cambridge University Press, 1999, Linda Hall QC861.2 .j32 .

[5] Barry Roger G., Chorley Richard J., **Atmosphere, Weather, and Climate**, Eighth Edition, 2003, Routledge, Linda Hall QC861.2 .B36.