Safe Return Doubtful: History and Current Status of Modern Science in Antarctica

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Opening Remarks - Exploration

"We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time."

T.S. Eliot, *Little Gidding*, from *Four Quartets*, 1936-42.

Summary

Unit 0 Summary

1. Why explore?
   - *Little Gidding*, secs. IV and V
   - You *can* explore, but why?
   - The other part...

2. Course syllabus

3. The books and journal

4. Warm up exercises: mileage

5. Force, energy, work, and friction

6. Unit conversions
   - Currency
   - Energy

7. The extent of the Solar System, part I

Why Explore?

Why explore?

1. The world is a beautiful place
2. To learn things you do not know that you do not know
3. To learn about about yourself

That other part...

1. How to handle yourself in strange situations
2. How to use your brain to survive
3. *What really matters*

Warm-up exercises

1. How many gallons of gasoline will your vehicle hold? (Or that of your family, friends).
2. What is the gas mileage on the highway?
3. How far can you go?

Unit Conversions

We must learn how to deal with *units*.

1. In 1900-1915, 1.0 USD equals 3.8 krone.
2. One Calorie, which equals 1 kilocalorie, is 4184 *Joules*.

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1. **In 1900-1915, 1.0 USD equals 3.8 krone.**
2. One Calorie, which equals 1 kilocalorie, is 4184 *Joules*.

Question - The *Primus stove* was invented in 1892 by Franz Wilhelm Lindqvist, from Sweden. Suppose it cost 12.00 krone. What did it cost in USD?

Question - A northern sled dog was required for sledging in the early 1900s. Suppose one could be purchased for 50.00 USD. What is that cost in krone?

Unit Conversions

We must learn how to deal with *units.*

1. In 1900-1915, 1.0 USD equals 3.8 krone.

2. One Calorie, which equals 1 kilocalorie, is 4184 *Joules.*

Question - An inactive person requires about 2000 Calories per day. How many Joules does she require per day?

Question - A typical source of protein contains 4.0 Calories per gram. How many Joules are in 200 grams of protein?

Force, Work, and Energy

Force, Work, and Energy

Force:
$$F = ma \tag{1}$$

- F: Force, in Newtons (British unit: pounds or lbs.)
- m: mass, in kilograms (British unit: stone)
- a: acceleration, in meters per second squared (British unit: feet per second squared)

Professor: work several examples.

Work, or energy:

$$W = Fd \tag{2}$$

- F: Force, in Newtons (British unit: pounds or lbs.)
- d: Distance, in meters (British unit: feet)

Professor: work several examples.

Force of friction:

$$f = \mu mg \tag{3}$$

- f: Force of friction, in Newtons (British unit: pounds or lbs.)
- μ: Greek letter mu, unit-less constant ($\approx 0.01 - 0.1$)
- g: acceleration downward due to gravity, or 9.81 meters per second squared.

Professor: work several examples.

Warm-up exercises

1. How many kcal do you eat per day? (Pick a number between 2000 and 4000).
2. How much energy is this in Joules?
3. A unit of *power* is a Joule per second (J/s), also known as a Watt:
$$Power = \frac{Energy}{time} \tag{4}$$
4. Suppose running at 4 m/s requires 1000 Watts. For how long can you run with the amount of energy you picked in step 1?

1. Recall that
$$velocity = \frac{distance}{time} \tag{5}$$
Taking your answer from the previous question for the time you can run at 4 m/s on the energy you consume, predict how *far* you can run at 4 m/s before running out of energy.

2. What if at this distance there was a *depot* of food, containing an additional 2000 kcal of energy. Suppose you consume it. How much farther can you go?

Astronomy and Early Antarctic Exploration

Astronomy and Early Antarctic Exploration

James Cook and Charles Green, 1769

1. Kepler's Laws: $T^2 \propto r^3$
2. Kepler: Preduicted when Venus would *transit* the Sun, from our perspective
3. What is an AU?
4. Sir Edmond Halley (1656 - 1742). Halley's comet passed by in 1758 (16 years after he died).
   - Devised a method for determining distance to the Sun.
   - Astronomers sent out all over the world (Baja California, Tahiti, etc.) to make the recordings.

It is worth noting that an early Polynesian explorer is claimed by the Maori to have seen Antarctica first:

https://en.wikipedia.org/wiki/Ui-te-Rangiora

What are Kepler's Laws?

1. **The Law of Orbits**: All planets move in elliptical orbits, with the sun at one focus.
2. **The Law of Areas**: A line that connects a planet to the sun sweeps out equal areas in equal times.
3. **The Law of Periods**: The square of the period of any planet is proportional to the cube of the semimajor axis of its orbit.
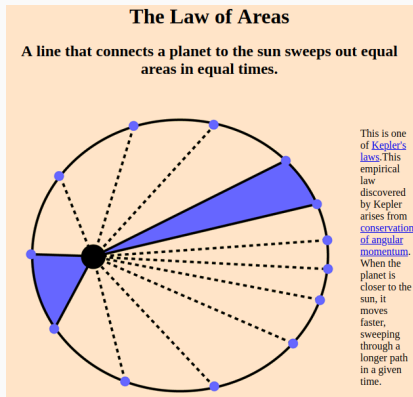
The Law of Orbits: All planets move in elliptical orbits, with the sun at one focus.
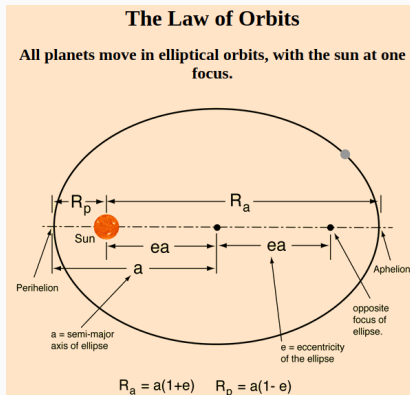
Figure 1: A diagram describing Kepler's First Law. A circle is a special case of an ellipse.

The Law of Areas: A line that connects a planet to the sun sweeps out equal areas in equal times.

The Law of Areas

A line that connects a planet to the sun sweeps out equal areas in equal times.

This is one of Kepler's laws. This empirical law discovered by Kepler arises from conservation of angular momentum. When the planet is closer to the sun, it moves faster, sweeping through a longer path in a given time.

Figure 2: A diagram describing Kepler's Second Law. Areas are swept out in equal times.

The Law of Periods: The square of the period of any planet is proportional to the cube of the semimajor axis of its orbit.
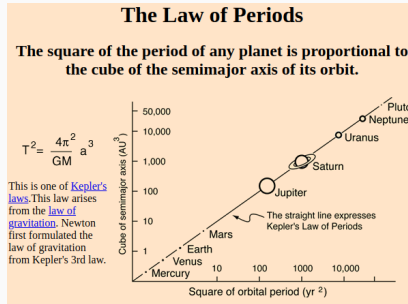
Figure 3: A diagram describing Kepler's Third Law. Period squared is proportional to radius cubed.
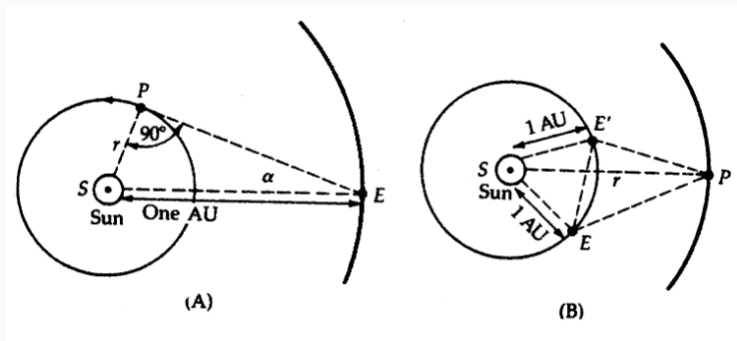
How can we use Kepler's Third Law to understand the location of the planets with respect to the Sun?

$$T^2 \propto r^3 \qquad (6)$$

Can we use geometry to determine r for a planet independently?

Figure 4: A diagram describing how Kepler determined radii. (Left) the method for a planet closer to the Sun that the Earth. (Right) the method for a planet farther from the Sun than the Earth.

Professor example: trigonometry for Venus.

Result of measuring the elongation angle for Venus: 46 degrees.

Radius of Venus *relative to that of the Earth:* 0.72 AU.

What then is the period of Venus? Use Kepler's Third Law, relative to Earth (observe on board).

$$\left(\frac{R_E}{R_V}\right)^2 = \left(\frac{T_E}{T_V}\right)^3 \tag{7}$$

T_E is the quantity 1.0 year, and R_E we do not know, but we simply call it 1 AU, or R_{AU}.

At your tables, fill in the following data using Kepler's Third Law:

Planet	Radius (AU)	Period
Mercury	0.387	–
Venus	0.723	–
Earth	1.0	1.0
Mars	1.524	–
Jupiter	5.203	–
Saturn	9.537	–
Uranus	19.191	–
Neptune	30.069	–

Table 1: Table of orbits of the planets of our solar system.

Astronomy and Early Antarctic Exploration

In 1769, people did not know the amount of kilometers corresponding to 1 AU. Sir Edmond Halley devised a method for determining the result, but it required transporting astronomers to opposite sides of the planet. A short video describes the technique:

https://youtu.be/GwP8wCzbFLc

Figure 5: Sir Edmond Halley (1656-1742) was the Royal Astronomer of Great Britain, and a colleague of Isaac Newton.

Astronomy and Early Antarctic Exploration

Definition of an angle *in radians:*

$$s = r\theta \tag{8}$$

Using this and other observations, we can show that

$$R_{AU} = \frac{D_E}{2\pi \Delta t \left(T_V^{-1} - T_E^{-1} \right)} \tag{9}$$

- D_E is Earth diameter 12,000 km
- Δt is about 12 minutes
- T values are orbital periods

Let's try to derive the AU!

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8. Early Antarctic Exploration