Kamarina Hewett

Midterm - INTD262

Dr. Jordan Hanson - Whittier College Dept. of Physics and Astronomy

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1 Unit 0

1. Offer some reasons why the Spaniards created the *virreinatos* of Nueva España and Perú in their respective locations, with Tenochtitlan and Lima as capital cities.

already a civilization, common language (all spoke a little Aztec), natural resources - water, existing technology + agriculture

2. Was there a link between the introduction of capitalism and the growth of scientific activity in Latin America, or did the growth of modern science precede capitalism? If capitalism is a pre-requisite, then you cant count indigenous science as science. Science in latin America preceded capitalism, but there is a link between the two as scientific inquiry is always evolving

3. Given the definition of *peripheral* scientific activity in the Introduction, can you give an example of the creating and transmission of scientific results from the periphery to the center of science?

traditional indigenous medicine; use of cinchona bark to treat malaria leading to the use of quinine in western medicine

4. Give some examples of *pseudo-scientific* beliefs regarding mythical places the colonials sought in the New World.

- fountain of youth + city of gold
- Animapi (men w/ one eye in center of forehead)
- men w/ feet turned backwards

5. **Multiple Choice - Nahua scientific activity, first period**

   (a) Which of the following where media through which inhabitants of the Mexica empire recorded scientific observations about the natural world?

   - ~~A: *Axolotl* (codices) and *huitzitzilin* (paintings, stelae)~~
   - B: *Amoxtl* (codices) and *tlacuiloli* (paintings, stelae)
   - ~~C: *Tomatl* (plume, writing tool) and *altepetl* (city-state)~~
   - ~~D: *Quetzal* (plume, writing tool) and *huitzitzilin* (city-state)~~ hummingbirds

   (b) Using information from *Historia natural y moral de las Indias* (de Acosta), *Historia general y natural de las Indias* (Oviedo), *Décadas del Nuevo Mundo* (Anglería), *Historia de Nueva España* (Hernández), match the European story to the indigenous story or piece of knowledge.

   D • (1): Ponce de León and the Fountain of Youth
   B • (2): Griffins so large they capture people and calves as prey, with feathers as large as an arm.
   C • (3): "A fountain running with hot water and as the water runs it turns to stone."
   A • (4): "fish that as they leave the water turn into butterflies."
   E • (5): "...a monstrous animal, with the face of a fox, a tail of a cercopithecus, ears of a bat, human hands, and feet of a monkey." Carries young on the belly.

   - A: A flying fish (4)
   - B: A condor (2)
   - C: A mercury mine (3)
   - D: The belief about a certain river among the Lucayo and Carib indigenous (1)
   - E: The Mexican opposum (5)

6. **Nahua scientific activity, second period** pg. 40

   (a) Father Bernardino de Sahagún translates from Nahuatl a description of a "tiger" that the indigenous say can do the following: (a) see small things even though there is fog or darkness (b) creates sounds "through the air" to intimidate hunters. What does this writing tell us about the Nahua understanding of physics?

Empirical understanding of nature and animals based on observation and experience integration of natural world w/spiritual or cultural beliefs; Holistic view of physical world

   (b) Why did the Spaniards and Aztec believe that hummingbirds were connected to immortality?

They are "reborn" or "resurrected" every spring after being "dead" each winter.

7. Suppose the following statement is given: "If someone was born between 1945 and 1991, then they have Strontium-90 in their bones." Which of the following statements is *deductively valid*?

   - Adam was born in 1963. Therefore, Adam has Strontium-90 in his bones.
   - Eve has Strontium-90 in her bones. Therefore, Eve was born between 1945 and 1991.

8. Consider the following passage from Chapter 1 of *The Scientific Attitude*:

   > In 1981, the state of Arkansas passed Act 590, which required that public school teachers give "balanced treatment" to "creation science" and "evolution science" in the biology classroom. It is clear from the act that religious reasons were not to be offered as support for the truth of creation science, for this would violate federal law. Instead, the curriculum was expected to concentrate onlyu on the "scientific evidence" for creation science. But was there any? And, how precisely was creation science different from creationism?

   Explain the arguments used in court to thwart Act 590 the following year.

Micheal Ruse used poppers Theory of falsifiability to say that since creationism cannot be falsified, it is not science. (a better argument is that creationism is "bad" science)

9. Thomas Kuhn wrote a famous book entitled *The Structure of Scientific Revolutions* (1962). Rather than describing science as a global accumulation of progress, he argues that, sociologically, scientists move between periods of "puzzle-solving" within an accepted framework and revolution triggered by unavoidable experimental anomalies. (a) Give one example of a scientific revolution, and note the anomaly. (b) Do you think that the colonization of Nueva España triggered a scientific revolution?

a) transition from geocentric to heliocentric model. observed motion of planets could not be easily explained by geocentric model - heliocentric model gave simpler & more coherent explanation for movement of planets

b) while colonization led to an exchange of knowledge, its primary goal was economic & territory growth. They valued religious ideas over indigenous scientific attitudes, erasing written knowledge (like codices) - but much of these scientific ideas were passed down through oral tradition

10. Fill in Tab. 1 below, using Fig. 1.

(a) (b) (c) (d)

Figure 1: Maps depicting *virreinatos* in Latin America, 17th and 18th centuries.

Map in Fig. 1 (a-d)	*Virreinato*	Captial
b	*Nueva España*	Mexico city
c	*Nueva Granada*	Bogotá
d	*Río de la Plata*	Buenos Aires
a	*Perú*	Lima

Table 1: Fill in the missing information.

11. Consider the library of José Ignacio Bartolache. (a) What does the distribution of texts in this library tell us about the scientific attitude of Latin Americans in the 18th Century? (b) What other scientific items did Bartolache own, and what clues does this add to our picture of the scientific attitude in that time and place? (c) Considering these collections were built before 1760, draw a comparison to the state of science in the American colonies (later the United States). a) They were polymaths; studied various topics from language to science from different places and people
b) He owned scales, microscopes, telescopes, thermometer, interested in verifying/figuring things out
c) U.S. was behind in creating scientific institutions. science in the colonies didnt really progress until after the revolution while latin America did science + institutions long before they were independent.

2 Unit 1

1. In Chapter 2 of *The Scientific Attitude*, we encounter the following quote:

> Samir Okasha recounts the example of John Couch Adams and Urbain Le Verrier ... they were working (independently) within the Newtonian paradigm and noticed a slight perturbation in the orbit of the planet Uranus.

Newton's Law of Gravity predicts perfectly elliptical orbits for the planets, with no perturbations. Was the law of gravity therefore *falsified*? What solved the problem in the end? This would have been, however if not for the discovery of Neptune they used Newtonian gravity to predict where Neptune would be

2. **Bode's Law** was an attempted mathematical explanation of the planetary orbits. Bode's sequence was the pattern $0, 3, 6, 12, 24, \ldots$, plus 4 to each, then divide the sequence by 10. The result is 0.4, 0.7, 1.0, 1.6, 2.8, 5.2, 10.0, 19.6, 38.8, 77.2,... . At the time (1772), the radii of the planets from the Sun were 0.387, 0.723, 1.0, 1.524, 5.203, 9.539. Nine years later, Uranus was discovered at 19.18. Twenty years later, the asteroid belt between Mars and Jupiter was discovered at 2.77. Did Bode's Law become a scientific fact because it fit the data? It was taken seriously because it helped to discover two new planets, but ultimately it was seen as a peculiar coincidence or "a remarkable artifact of naive correlation"

3. In 1761, Judge Francisco Javier Gamboa created a set of legal and scientific studies that were meant to reform the mining industry, to make it more efficient. Recall some scientific results that he shared within his *Comentarios a las ordenanzas de minas*. What chemicometallurgical technique, important for ore extraction, did he share with The Crown? What institutions did he suggest creating? He created a "complete and systematic description of the patio process" and suggested creating a school for miners children and training experts and professional scientists in mining and metallurgy.

4. *El Real Seminario de Minería* was created by Joaquín Velázquez de León, Fausto de Elhúyar, and others. However, several factors might have driven it to bankrupcy. Describe the Mexican efforts to preserve it. funded by mine workers + local scientific community, locals translated books and prepared texts designed for teaching, Scientists for teaching support made up for lack of professors.

5. What are the two tenets of the scientific attitude, or ethos, according to the author of *The Scientific Attitude*? empirical caring about evidence and being willing to use evidence to revise ones theories

6. Recall the story of Ignaz Semmelweis and antiseptic handwashing in maternity wards. Discuss how the scientific attitude was applied in this situation. Semmelweis did not assume to know what caused childbed fever, he came up w/hypothesis + examined similarities + differences between wards, learned from observation + controlled experiments → when he found answer he changed his ideas based on the new data

7. Recall the story of the false discovery of cold fusion. (a) Discuss how the scientific attitude was not applied in this situation. (b) Now select a piece of science from Latin American history that we have encountered thus far, and apply the criteria of the scientific attitude to it. a) original experimenters too blinded by hype of theory to be more deliberate w/inquiry, self-scrutinize work, repeat experiment did not care about evidence or use evidence to revise their theory
b) cinchona bark was used to treat fevers and malaria; Europeans observed effectiveness and hypothesized that there was an active ingredient; Scientists conducted experiments isolating compounds from bark; discovered quinine was the active ingredient effective in treating malaria

3 Unit 2

1. (a) In what viceroyalty (Fig. 1) was the city of Santa Fe de Bogotá? (b) Discuss the scientific implications of the "half century-long polemic on Copernican theories, which started in 1773 between José Celestino Mutis and the Dominican Congregation of Santa Fe de Bogotá. (c) In 1783, the Expedición Botánica began in Santa Fe. What were some of its goals and achievements?

a) Nueva Granada
b) Mutis advocacy for heliocentrism challenged cosmology + theological nature of geocentrism
Newtonian physics did not allow room for "the lord" or religion's
c) mapping/documenting regions and boarders, study of medicinal plants (flora + fauna)

2. (a) In what viceroyalty (Fig. 1) was the city of Caracas? (b) In 1767, the Jesuit order was expelled from the Spanish colonies. The Dominican order recovered authority over some colleges and universities. What was the implication for science?

a) Nueva Granada
b) Dominican order was more aligned with religion, scientific theories like heliocentrism + evolution contradicted religious teachings

3. What scientific publication was created by José Celestino Mutis?

Flora de Nueva Granada ?

4. Evaluate the logical truth of this claim: "anti-vaccination campaigns do not have the scientific attitude, therefore these are not scientific endeavors." lack of scientific attitude is sufficient to prove non-science. If something is a scientific endeavor, it must display a scientific attitude. Anti-vax campaigns do not display a scientific attitude, and therefore are not scientific endeavors

5. Discuss one example we have encountered from our scientific history that should count as science, even though it has not traditionally been considered scientific.

Medieval theory of the four humors and the adoption of native medicine and treatment into that theory

6. In Chapter 3 of *Science in Latin America*, we encounter the following quote:

> *La Universidad Gegoriana* in Quito alone had "seventy-one foreign professors teaching at the university ... Native professors were twenty-one, of whom five were from Loja, four from Quito, three from Guayas, three from Cuenca, three from Riobamba, two from Ibarra, and one from Ambato." ... As a consequence, it is not strange that in a center of cultural ferment such as Quito, intellectual Jesuits were most closely linked to the Franco-Spanish geodetic mission directed by La Condamine and Jorge Juan.

71 foreign
21 native

(a) What scientific transition began to take place as a result of the interaction between foreign and Ecuadorian professors? (b) What can we infer about the ratio of the native professors at the university? (c) Consider Father Fransisco Javier Aguilar, who taught physics and mathematics at Universidad Gregoriana. He taught no less than five world systems, and focused on three: Ptolemaic, Copernican, and Tychonic. What distinguished these?

a) Geodetic mission stimulated interest in observation + scientific experimentation, expeditions w/goal of establishing navigation routes took along with scientific instruments + astronomers
acceptance of Newtonian physics + heliocentric model
b) ideas shared internationally, foreign science valued over native science (c) on back (next pg)

7. In 1767, Mutis published *Reflexiones sobre el sistema tycónico*. (a) What were the main points of this publication? (b) Was it considered controversial? a) the Earth moves like other planets do, but the sun and the stars remain static, except for a unique movement of the sun on its axis and the copernican system is by no means opposed to the holy scripture
b) yes, but some stemmed from the issue of secular control in the universities and the creation of a public university (confrontation btwn two groups that wanted to control education)

8. When Joaquín Velázquez de León and José de Gálvez arrived in Baja California, they remained there for three years. (a) What types of measurements did they make? (b) How did this improve local knowledge of Nueva España? (c) Velázquez de León communicated with Chappe d'Auteroche that he would help with the Venus transit measurements, and d'Auteroche suggested that Velázquez de León remain in Real de Santa Ana, while

#6c | Focused on three world systems: Ptolemaic, Copernican, + Tychonic. These systems were formed by scientific spirit, according to local context, and the impact of certain events in central countries.

The ptolemaic system proposed that Earth was immovable and at the center of the universe. The moon, sun, planets, and stars all revolve around earth in circular orbits.

The copernican system said it was not the Earth, but the sun is at the center of the universe. The Earth and other planets revolve around the sun (still in circular orbits)

The Tychonic system combines these ideas, proposing that the Earth is at the center of the universe. While the sun + moon revolve around the Earth, however, other planets orbit around the sun.

d'Auteroche would work in San José del Cabo. What happened as a result?

a) astronomical + geographical measurements
b) accurate modern map (boarders + boundaries of places), know venus transit
c) epidemic, they all died ∴

9. What was notable about the explorations of José Sanchez Labrador?

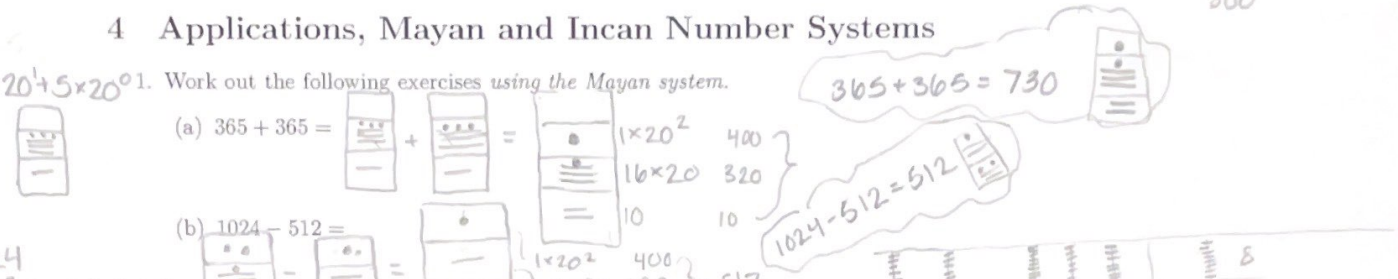
Botanical + zoological exploration, documented colombian flora + fauna unknown to European scientists, geographical explorations of colombia

1000
400
300

4 Applications, Mayan and Incan Number Systems

$18\times20^1+5\times20^0$

1. Work out the following exercises *using the Mayan system.*



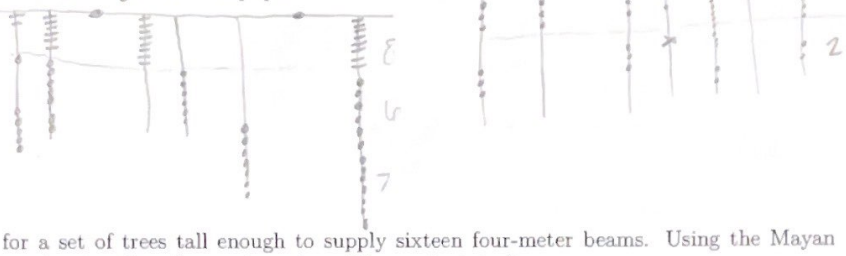
(a) $365 + 365 =$

(b) $1024 - 512 =$

1024
$2\times20^2+11\times20^1+4\times20^0$

512
$1\times20^2+5\times20+12$

2. Work out the following exercises *using the Incan quipu:*



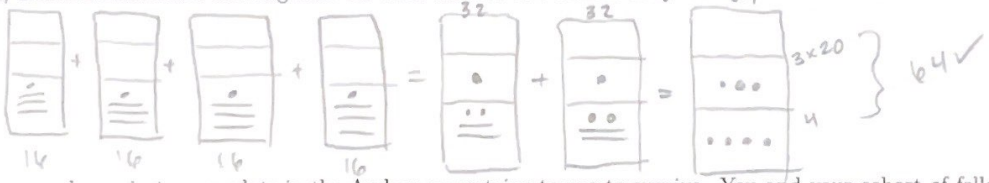
(a) $512 + 256 = 768$

(b) $365 - 67 = 298$

3. Suppose we are looking for a set of trees tall enough to supply sixteen four-meter beams. Using the Mayan system, create a calculation showing that the total number of beams is sixty-four.

$16\times4=16+16+16+16$

64



$2\times150m^2=300m^2$

4. Suppose you have six terrace plots in the Andean mountains to use to survive. You and your cohort of fellow Incans decide to grow potatoes and quinoa. Quinoa actually do better at higher altitudes that potatoes. So the plan is to use the two lowest terraces for potatoes, and the upper four for quinoa. Each terrace is 30 meters by 5 meters. A potato plant requires a 0.2 meter by 0.2 meter patch, and a quinoa plant requires a 0.3 meter by 0.3 meter patch. How many potato plants and how many quinoa plants can you plant? Store the results in a diagram of quipu knot system.

$\square_{0.2}^{0.2} = \frac{1}{25}m^2$

$\frac{300m^2}{0.04m^2}=7500$

$300m^2\times25m^2=7500$

$4\times150m^2=600m^2$

$\square_{0.3}^{0.3} = \frac{9}{100}m^2$

$\frac{600}{9/100} = \frac{600}{9}\times100=6,666$

100k on next page (back of paper)

7500 potatoes, 6,666 quinoa

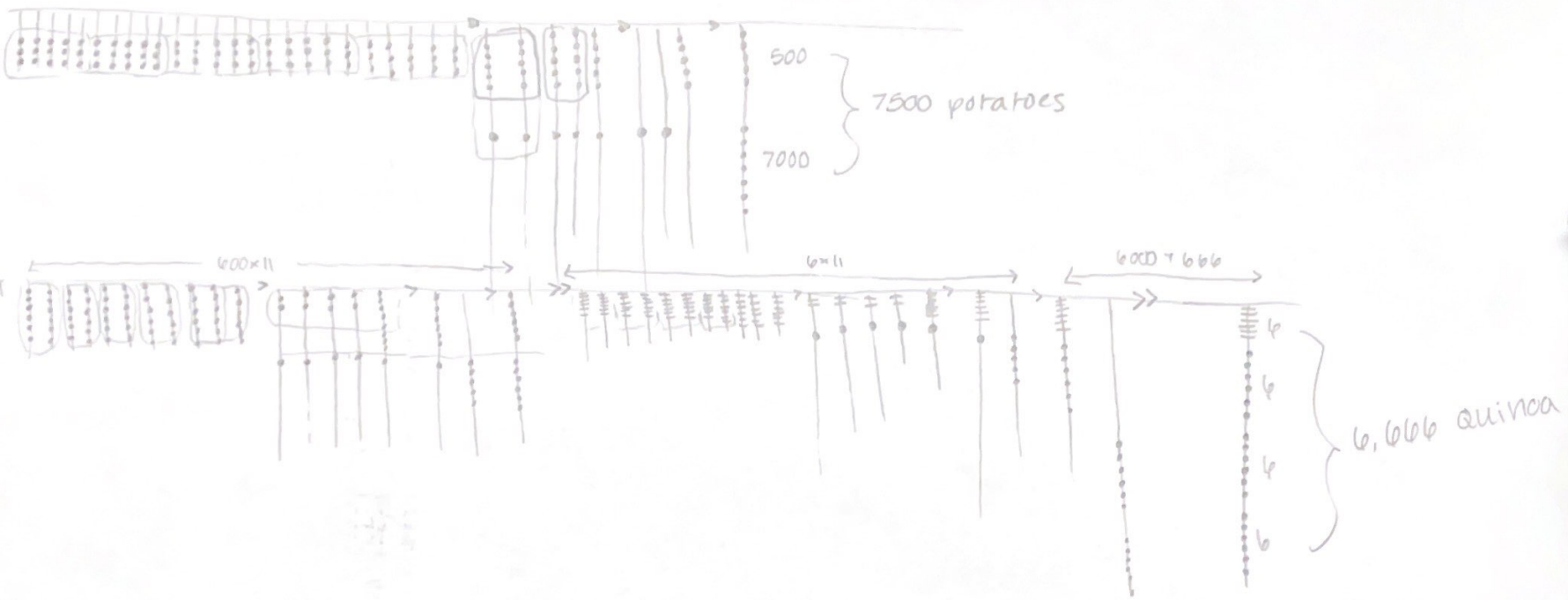
5 Modern Science in Latin America - Gamma Ray Astrophysics

1. What is a gamma-ray?

- A: A charged particle with mass
- B: A neutral particle with mass
- (C): A quantum of light
- D: A radio wave

#4

500×25



2. What was the purpose of the Milagro experiment?

- A: To observe the direction of incoming gamma-rays
- B: To observe the energy of incoming gamma-rays
- C: To observe the direction and energy of incoming gamma-rays
- D: To observe the charge of incoming gamma-rays

3. What upgrades to the Milagro concept were made that produced the HAWC design?

- A: Using oil instead of water as the detection medium
- B: Increasing the amount of water tanks to improve the sensitivity
- C: Moving the tanks to a higher altitude
- D: Both B and C

4. List some of the discoveries of HAWC and/or Milagro in the field of gamma-ray astrophysics.

- observation of Highest Energy Gamma Rays
- detected new High Energy Gamma-Ray sources (pulsar wind nebulae + supernova remnants)
- Extended Gamma-ray emission in the Milky Way

6 Modern Science in Latin America - Cosmic Ray Physics

1. What is the purpose of the Pierre Auger Observatory?

Studies cosmic rays w/extremely high energies

2. What is the typical energy of a cosmic-ray observed at Auger?

- A: 10^{12} eV
- B: 10^{14} eV
- C: 10^{16} eV
- D: 10^{18} eV

more common, but observatory is designed to study rays specifically in the 10^{18}+ range

1200
+400