CYRUS JUDGE

Midterm - INTD262

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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.

   The Spaniards created the viceroyalties here because they were places where advanced societies in native cultures already existed.

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?

   The growth of science was due to capitalism, as the main motivation for the pursuit of science in the Americas was initially to further the mining programs started there.

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?

   Examples of science moving from the periphery to the center of science during the period discussed in the book come from native treatments, like quinine. Although initially discarded by the Spaniards, Native plants quickly became important and became the cause of entire expeditions.

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

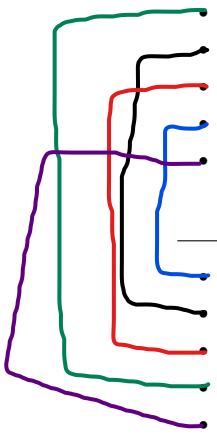
   One of the mythical places the colonials sought to find was the fountain of youth, which was believed to be located somewhere in present day Florida by the colonials.

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 *tlacuiloll* (paintings, stelae)
   - C: *Tomatl* (plume, writing tool) and *altepetl* (city-state)
   - D: *Quetzal* (plume, writing tool) and *huitzitzilin* (city-state)

   (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.



   - (1): Ponce de León and the Fountain of Youth
   - (2): Griffins so large they capture people and calves as prey, with feathers as large as an arm.
   - (3): "A fountain running with hot water and as the water runs it turns to stone."
   - (4): "fish that as they leave the water turn into butterflies."
   - (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
   - B: A condor
   - C: A mercury mine
   - D: The belief about a certain river among the Lucayo and Carib indigenous
   - E: The Mexican opposum

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

   (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?

   This describes that the Nahuatl had an understanding of how vision and sound operate, like the fact that sound moves through the air.

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

   This is because they witnessed hummingbirds nesting in trees undergoing torpor during the winter, and they believed they instead died during this time.

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*?

   d 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?

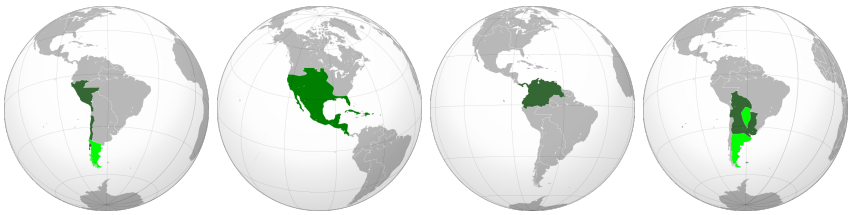
   Explain the arguments used in court to thwart Act 590 the following year.

   In court, they used Popper's definition of science. They argued that creation science is not science because it is not falsifiable.

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?

   The planet Neptune was discovered by scientific anomaly, as Uranus was not following its expected orbit. I believe the discovery of Nueva Espana triggered a revolution, as it led to new scientific methods (like methods of mining) and discoveries (like native plants and animals of the Americas).

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*	Bogota
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. The distribution of texts in Bartolache's library show that enlightenment ideals allowed researchers to explore a broad variety of topics. B. Bartolache also had a microscope, hydrometer, magnifying glass, and thermometer. C. Compared to the South American colonies, the colonies that became the United States were still in the early phases of scientific development.

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?

The Law of Gravity was not falsified, it simply was adjusted with new knowledge. In the end, the planet Neptune was discovered.

2. **Bode's Law** was an attempted mathematical explanation of the planetary orbits. Bode's sequence was the pattern $0, 3, 6, 12, 24, ...$, 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?

Bode's Law did not become a scientific fact because of the discoveries of Neptune and Pluto.

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 suggested the patio process to the crown, and sought to create a school for teaching science to miner's children.

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.

Both the government and private investors attempted to contribute funds to preserve the school, and the school was adapted to fit the Mexican education system.

5. What are the two tenets of the scientific attitude, or ethos, according to the author of *The Scientific Attitude*?

1. We care about empirical evidence. 2. We are willing to change theories in light of new science.

6. Recall the story of Ignaz Semmelweis and antiseptic handwashing in maternity wards. Discuss how the scientific attitude was applied in this situation.

Semmelweis used empirical evidence through the puncture wound of his colleagues to realize the existence of germs. He then altered his theory to move from dead tissue to living tissue, furfilling the second requirement.

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.

The creators of cold fusion did not use empirical evidence, as they created the correct situation to prove their hypothesis true. They also did not change in light of new science, as they ignored the critics who pointed issues in their technology. The scientific attitude was applied to the study of quinine, as they used the evidence of the Native's using the bark and changed their current view of science to fit the treatment.

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 Grenada. B. The debate called for a change to the heliocentric model of the universe. C. The goal of the Expedicion Botanica was to expand the scientific knowledge of both the geography of Nueva Granada and the plants and animals that lived there. The expedition was successful in these goals and created classifications of many plants and animals.

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?

   The viceroyalty of New Granada. The Dominicans were more focused on religion, and this slowed the growth of science.

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."

   This statement is truthful, as anti-vaccination campaigns ignore new science.

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.

   Cartography is not considered scientific, however it is important to the understanding of the world.

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.

   (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. Enlightenment ideals began, as the influx of local knowledge moved researchers away from existing scientific beliefs. B. Although they were not the majority, the researchers still respected the knowledge of the Natives, as the amount of professors is still significant. C. Ptolemaic: The Earth is the center of the universe. Copernican: The sun is the center of the universe. Tychonic: The Earth is the center of the universe and the sun and moon orbit it, and the rest of the planets orbit the sun.

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. Mutis defended the Copernican system by arguing that the Earth moves the same as the other planets, and that the Copernican system does not oppose religious scriptures. The statement was controversial, as it led to a debate in Caracas.

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

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

A. They made astronomical measurements and studied the transit of Venus. B. They also took topographical data, which helped understanding of the landscape for later travel. C. Chappe d'Auteroche died as a result, due to an outbreak in Cabo.

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

He connected Paraguay and Potosi and was able to break the isolation of the missionary province of Chiquitos. He left a record and map of these discoveries.

4 Applications, Mayan and Incan Number Systems

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

   (a) $365 + 365 =$

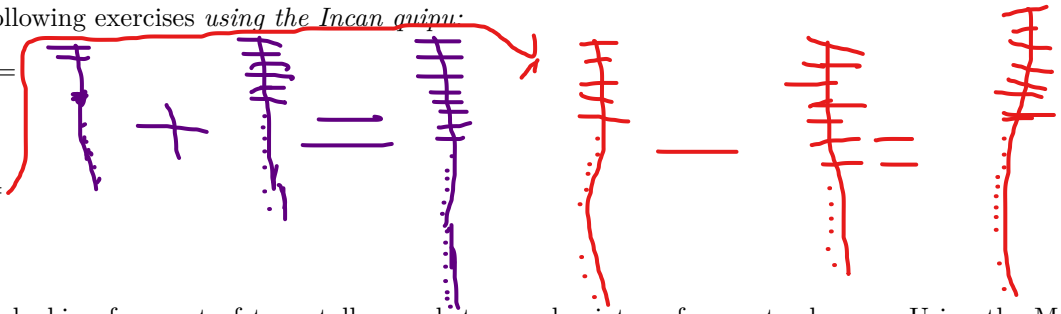
   (b) $1024 - 512 =$

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

   (a) $512 + 256 =$

   (b) $365 - 67 =$

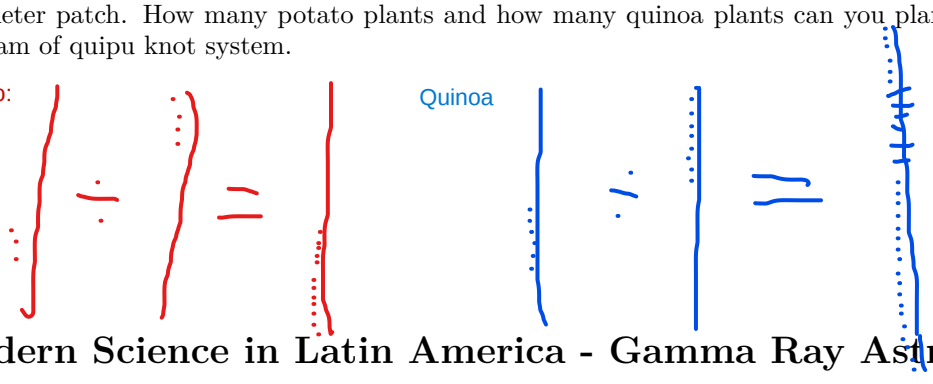
3. Suppose we are looking for a set of trees tall enough to supply sixteen four-meter beams. Using the Mayan system, create a calculation showing that the total number of beams is sixty-four.

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.

   Potato:

   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

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.

    The Milagro has found new TeV sources and emission from supernova remnants. The HAWC has searched for signals that may hint towards dark matter.

6 Modern Science in Latin America - Cosmic Ray Physics

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

    The Pierre Auger Observatory is designed to detect ultra-high energy cosmic rays.

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