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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 motivation was due to pre-existing indigenous societies, advanced social, and cultural development, and natural resources.

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 modern science in Latin America was driven by internal social and intellectual factors rather than by capitalism.

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?

The development and adoption in Europe of the *Patio Process* for silver extraction (Pioneered in 16th century in Mexico) showcases the transmission of scientific knowledge from the Periphery to the Center.

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

\* Fountain of Youth - Restoration of youth to who bathes in its waters  
\* City of Gold - Seven caves

5. Multiple Choice - Nahua scientific activity, first period

- (a) Which of the following were 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 *tlacuilo* (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.

4 • A: A flying fish

2 • B: A condor

3 • C: A mercury mine

1 • D: The belief about a certain river among the Lucayo and Carib indigenous

5 • E: The Mexican opossum

## 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?

They started to study sound waves, sight evolution, and light waves.

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

Through the hummingbirds hibernation an illusion was created,

During winter the birds appeared to die and then be reborn in the spring.

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 only 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.

They used the argument of falsifiability.

They also stated that Creationism was not 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) Sun revolves around the earth. Anomaly: The data does not work with the framework.

b) It allowed for scientific context to different diseases and cures.

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

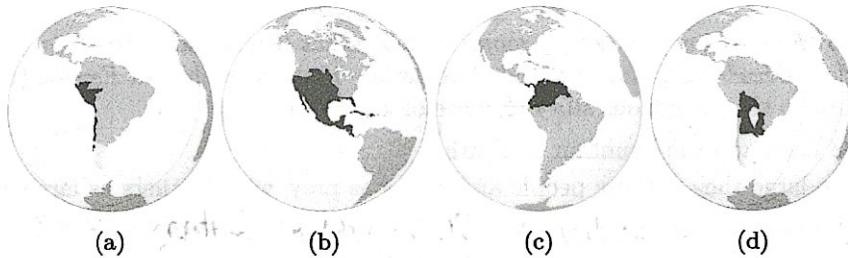


Figure 1: Maps depicting *virreinatos* in Latin America, 17th and 18th centuries.

Map in Fig. 1 (a-d)	Virreinato	Captial
b	Nueva España	Ciudad de México
c	Nueva Granada	Santa Fe de 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) Distribution of Texts and Scientific Attitude: Breath of Knowledge and emphasis on modern science.

b) Ownership of Scientific instruments. Such as microscopes and hydrometers strengthens the picture of the experimental approach.

2 Unit 1

c) The United States were already behind, Latin America had trade.

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?

No, due to only having a theory with no mechanism. It was not solved it only grew more theories.

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?

The correlation doesn't mean causation. No explanation provided.

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 shared a systematic and complete description of the Pato Process.  
He suggested creating a school to teach science to miners children.

4. *El Real Seminario de Minería* was created by Joaquín Velázquez de León, Fausto de Elhíyar, and others. However, several factors might have driven it to bankruptcy. Describe the Mexican efforts to preserve it.

mine owners/guilds gave donations, translation of text. Professors ↑ miners  
reached broader audiences. ↓ new miners

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 our theories in light of new evidence.

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

He conducted open minded experiments where he accepted where some of his theories were wrong. Thus he created a stronger theory.

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) Scientific attitude was not applied because they falsified results.

b) In latin America a good doctor (native) would give herbal remedies while a bad doctor (spaniard) would provide potions (false remedies) to the sick.

### 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) The city of Santa Fe de Bogotá was in the viceroyalty of Nueva Granada.  
b) Created a division of two groups to dominate the education of enlightenment thinking.  
c) There goals were to find boarders and attempt to reform and secularize education.
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) The city of Caracas was in the Viceroyalty of Nueva Granada.  
b) The Dominican order wanted to secularize scientific education in universities.
3. What scientific publication was created by José Celestino Mutis?  
José Celestino Mutis created the "Expedición Botánica".
4. Evaluate the logical truth of this claim: "anti-vaccination campaigns do not have the scientific attitude, therefore these are not scientific endeavors."  
The claim is valid due to its assertion that anti-vaccination campaigns lack a scientific attitude (empirical evidence) 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.  
An example of something that should count as science is brujería (witchcraft). This is because some hispanic witchcraft remedies have helped the sick especially in my community.
6. In Chapter 3 of *Science in Latin America*, we encounter the following quote:  
*La Universidad Gregoriana 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 Francisco 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) The interaction between foreign and Ecuadorian professors led to theories that focused on the methods of science.  
b) They were outnumbered but not outsmarted.  
c) They were differentiated by what was considered the center of the universe.
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 main points were that it focused on defending the Copernican ideas by stating that the earth moves with the other planets but the sun and stars don't move. He also argued that the system doesn't oppose the holy scriptures.  
b) This was controversial due to still being under a conservative institution.
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

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

- Applications, Mayan and Incan Number Systems

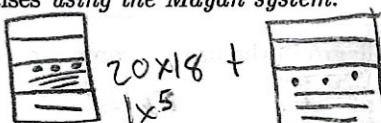
a) They made measurements regarding geography, astronomy, and mapping of  
b) Their work improved local knowledge of Nueva España by providing data, enhancing navigation routes, and better understanding of natural resources.

9. What was notable about the explorations of José Sanchez Labrador?  
His explorations were notable for his extensive mapping and surveying of Baja California Peninsula. He was also the first to document the region's geography, topography, and natural resources.  
c) As a result, they successfully coordinated their efforts for the Venus transit observations.

## 4 Applications, Mayan and Incan Number Systems

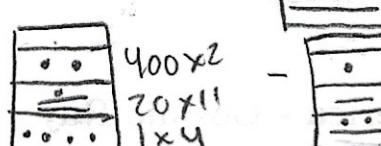
1. Work out the following exercises *using the Mayan system*.

$$(a) 365 + 365 = \underline{\quad}730\underline{\quad}$$



$$900 + 320 + 10 = \boxed{1230}$$

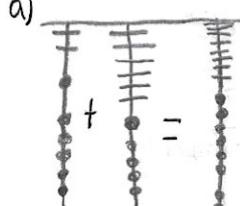
$$(b) 1024 - 512 = \underline{\underline{512}}$$



$\times 1$   
 $\times 5$   
 $\times 12$

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

(a)  $512 + 256 =$  768



b)

apply sixteen four-meter beams. Using the

$$(b) 365 - 67 = 298$$

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.

4m x 1b

0000 + 6 0006 + 6

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 than 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.

$$\boxed{?} \cdot 2 = 4 \text{ m}^2 \Rightarrow 150 \text{ m}^2 \times 4 \times 2 = 60 \text{ Potatoes}$$

$$\boxed{1} \cdot 3 = 6 \text{ m}^2 \Rightarrow 156 \text{ m}^2 \times 6 \text{ m}^2 = 90 \text{ Quinoa}$$

$$= \boxed{5} = 150$$

$= 60$        $= 90$

## 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.

- Detection of Cosmic Ray Sources
- Search for Dark matter
- Observation of the Crab Nebula
- Gamma-Ray Emission from the moon
- Study of Blazars

## 6 Modern Science in Latin America - Cosmic Ray Physics

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

The purpose of the Pierre Auger Observatory is to study Ultra-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