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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.

To break their empire into smaller, more managable sections. They chose existing cities for capitals to take advantage of the existing infastructure, and with Tenochtitlan, it was already capital.

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?

Some say that scientific progress in Latin America was only spurred by the want and need to increase production capibilities. But Juan José Saldaña argues that if that were true, there would be no science in Latina America.

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?

Quinine as a cure for malaria traveled from indigenous knowledge in the periphery to the mainstream as a widespread cure for malaria.

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

The fountain of Youth, fish that transform into butterflies, a fountain that runs with water that turns to stone

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.

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   - 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**

   (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 tells us that the Nahua understood that sound travels through the air and that there is a difference in optical ability between tigers and humans

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

Because, hummingbirds seem to die and be reborn each year as they go dormant with the changing seasons.

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?

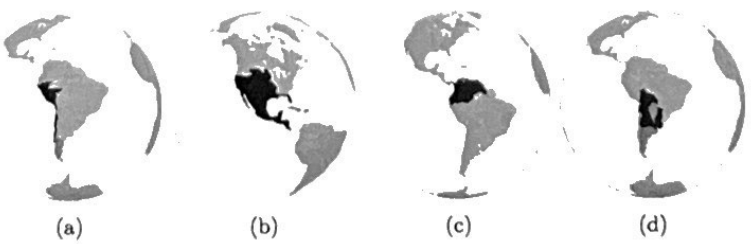
   Explain the arguments used in court to thwart Act 590 the following year.

After being introduced to the theory of falsifiability, the judge was convinced the creationism is 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) The Copernican revolution: the path of the planets could not be explained in a geocentric model.
b) The colonization of Nueva España was in part a scientific revolution because of large amounts of new data.

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* | Tenochtitlan CDMX |
| 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) That they were very curious about a wide range of subjects

b) Microscopes, hydrometer, thermometer - Bartolache interested in doing science rather than reading about it.

c) Latin Americans were doing science and building universities long before independence whereas as science in the U.S. did not become robust until after the American Revolution.

## 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, Adam and LaVerrier sought another explanation for the anomaly and discovered Neptune.

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?

No it did not become fact because the discovery of Neptune did not fit the pattern. It was simply coincidence that that pattern of numbers fit with the distances of the planets, there was no reasoning.

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?

Gamboa suggested the patio process for extracting silver from ore. He also suggested opening schools for miners children that taught sciences.

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.

Mine owners and the broader scientific community stepped in to stop it from closing, and in the process they cut out the Crown from the institution.

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

1) The willingness to accept sensory evidence

2) The willingness to change hypotheses as new data emerges

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

Semmelweis was able to figure it out because he had an open mind and developed and changed his hypothesis as he gathered 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) The scientific attitude was not applied because the two that "discovered" cold fusion were not open to outside critique and were also not self-critical in ensuring their evidence actually supported their claims.

b) Latin Americans wanting to learn and apply European Enlightenment demonstrates the collaboration aspect of the scientific attitude

## 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) New Grenada
(b) Copernican theory and Newtonian physics did not allow room for the Lord according to some, mostly the Dominicans.
(c) Establishing borders of the territories

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) New Grenada
(b) The Jesuits were responsible for alot of science including enlightenment ideas. After they were expelled, edvention fell to the Crown and the Dominicans neither of whom were keen to teach Enlightenment ideas so scientific progress was significantly slowed.

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

Mercurio Peruano

4. Evaluate the logical truth of this claim: "anti-vaccination campaigns do not have the scientific attitude, therefore these are not scientific endeavors."

This is logically true because in order for something to be considered scientific, it must have the scientific attitude

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.

The classification of hummingbirds by the Aztec should be considered scientific because they were able to identify the different sub-species

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) Transition from geocentric to heliocentric
(b) From the ratio we can assume that foreign ideas were very prevelant
(c) Ptolemaic is geocentric, Copernican is heliocentric, Tychonic, planets orbit the sun which orbits Earth.

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) He found that the sun spins + bible is not contradicted by heliocentric world system
(b) It was not controversal because there had been conversations about adopting Copernican worldview for decades beforehand

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 took astronomical and geographical measurments
(b) They helped correct the scale of maps
(c) This ensured that measurments were taken even if something happened with weather or in this case an epidemic killed most of the French.

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

He was a zoologist and led expeditions on the Chaco River that opened communications between Potosi and Paraguay.

## 4 Applications, Mayan and Incan Number Systems

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

(a) $365 + 365 = 730$

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

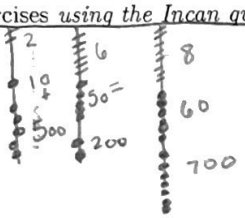
(b) $1024 - 512 = 512$

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

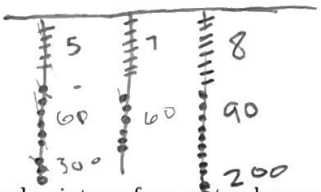
$- \quad 1\times20^1 + 5\times20^1 + 12\times20^0$

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

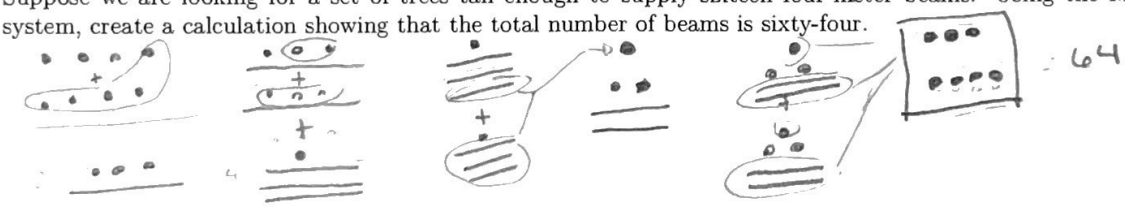
(a) $512 + 256 = 768$




(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.




$5\times30 = 150m^2$ 2

$150m^2 \times 2 = 300m^2$

$\frac{1}{5}\cdot\frac{1}{5} = \frac{1}{10}m^2$

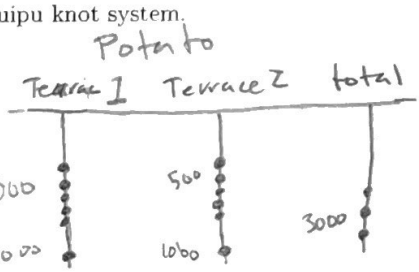
$\frac{300}{\frac{1}{10}} = 3000$ Potatoes

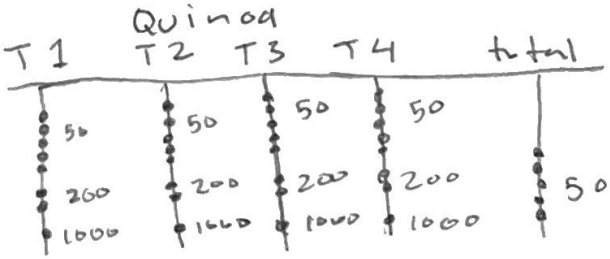
$150m^2 \times 4 = 600m^2$

$\frac{3}{10}\cdot\frac{3}{10} = \frac{16}{50}m^2$

$\frac{600}{\frac{16}{50}} = 5000$ Quinoa

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.




## 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.

Milagro and HAWC have had similar discoveries both contributing to the knowledge of gamma rays sources, and both have been used in the search for dark matter.

## 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 cosmic rays which are the highest energy particles. The research is especially focused on the rare highest energy cosmic ray that have energy over $10^{14}$ eV

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