

## Midterm - INTD262

### Unit o

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

Tenochtitlan and Lima were chosen because of their locations. Tenochtitlan was situated in a fairly central location in Mesoamerica and Lima's location was by the coast of Peru which made communication with Spain and other colonies a lot easier. Both regions were also very rich in their resources which proved beneficial for the Spaniards.

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 introduction of capitalism did influence the growth of modern science as exploiting the resources for economic gain meant having knowledge of those resources. They needed to know about agriculture, mining, and even navigation. More capitalist practices had led to the establishment of many scientific institutions such as universities. Although there were definitely a couple of scientific practices that existed before the rise of capitalism, capitalism and the growth of modern science go hand in hand.

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?

An example of peripheral scientific activity can be seen in the contributions of the Latin American scientists. A scientist that was predominantly considered a European scientist, Alexander von Humboldt had traveled to Latin America to study the regions plants and geography. His work was very important because it heavily contributed to better understanding the regions ecology and geography. He then went on to publish his findings in Europe where he was able to transmit his scientific knowledge from the periphery of the Spanish Empire to the scientific community in Europe.

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

Some examples of pseudo-scientific beliefs would be the Fountain of Youth, El Dorado and The seven cities of Cibola.

5a.) 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)

5b.) 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 opossum

1D, 2B, 3C, 4A, 5E

6a.) 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 writing shows that the Nahua had at least some understanding of physics even if they didn’t know exactly what it was. Its really interesting to see the curiosity of the Nahua people and how they used their knowledge to create assumptions about the creatures. The Nahua were able to recognize the own limitations of a humans vision and were able to compare it to the tiger who was able to see things that a normal human could not. The tiger creating sounds “through the air” shows that the Nahua people had some understanding of sound waves and how it affects the behavior in the natural world.

6b.) Why did the Spaniards and Aztec believe that hummingbirds were connected to immortality?

The Spanish and Aztec believed that hummingbirds were connected to immortality because of the hummingbirds ability to basically hibernate. Usually during winter time, the birds would migrate and the people thought that the bird had died. But once spring season came rolling around, the birds would come back leading the people to believe that the bird had come back from the dead. The hummingbird was a bird that the Spanish and Aztec saw constantly which made them believe that the bird was immortal.

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.

One of the main arguments that were used in court to go against the Act 590 was that creation science did not fit the criteria of a scientific theory. They said that a legitimate theory is one that has empirical evidence, proper testability and the ability to make a hypothesis based off of the claim. Another argument that was used was that creation science is a science, it was just a very poor science as it was constantly proved wrong.

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?

An example of a scientific revolution would be when people found out that the Earth is not at the center of the universe and that it's really the Sun that we orbit around. The reason this revolution came to be was because the observations regarding the planetary movements that were previously made were not remaining true so new testing was required. I believe that the colonization of Nueva España did trigger a scientific revolution as a lot of the Spanish colonization had introduced European scientific methods. As the colonizers saw different ecosystems and diverse indigenous knowledge systems, they were able to look back and reflect at the theories they had previously made and were able to see how it plays out in this ecosystem. I would say rather than it triggering a scientific revolution, it was more of a scientific evolution that the colonization had played a part in.

10.) Fill in the table:

B -Nueva Espana- Mexico City

C -Nueva Granada- Bogota

A -Rio De La Plata- Buenos Aires

D -Peru- Lima

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).

Bartolache's library just goes to show the growing scientific attitude in the 18th century Latin America as his library contained many diverse texts of mathematics, astronomy, natural history, medicine and much more. This shows an integration of the European techniques in the Latin American contexts. Bartolache had instruments such as the barometer and the telescope which demonstrated his constant participation in scientific experimentation. Comparing this to the American Colonies, we are able to identify that the American Colonies had far more institutional support which made it easier to access resources. Despite the Latin Americas interest in the scientific attitude and experimentation, the colonies were ahead due to the support.

## **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 wasn't necessarily falsified but rather it demonstrated a need for the scientific method. It required further looking into which is what both Adams and Verrier did. The problem was resolved when they were looking at a planet (Neptune) and looking at it's location consistently, and were able to prove their prediction correct because of it. So instead of fully falsifying the theory, it just reaffirmed it and showed the strength and accuracy of the scientific method.

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?

Just because Bode's Law fit the data, it does not make it a scientific fact. The law never really had a fundamental theoretical basis and it never explained gravitational forces. Although the law had all the numerical values and it all fit the data, since there was never a full hypothesis or prediction, it never had the power to be considered a scientific theory.

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?

One of the main techniques that he had discussed was the usage of mercury to extract ores. By using mercury to extract metals such as silver and gold, this had greatly enhanced the efficiency of the mining operations. Gamboa had also suggested that scientific institutions are created in order to educate and find new mining techniques. This would help with the overall productivity of the mining industry in Nueva Espana.

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 bankruptcy. Describe the Mexican efforts to preserve it.

The Mexican government had recognized the importance of the mining industry so in order to sustain it, the government had provided funding and were looking to match the institutions needs with the mining needs. The government had also improved the students curriculum to make the quality of education better.

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

Empiricism and Skepticism. Empiricism prioritizes the importance of observation and experimentation as the main basis of knowledge. It says that scientific understanding should be based off of empirical evidence that has been gathered through systematic observation. Skepticism advocates questioning the hypothesis and questioning claims. It promotes testing the theories and being open to new ideas and demanding amplex amount of evidence to back the claims.

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

The scientific attitude was applied because Ignaz had to theorize what the issue could be and then break down as to why the issue could be happening. He observed that babies were dying because of poor sanitary conditions and that a way that this could be fixed is by using antiseptic handwashing methods. He then tested this theory by emphasizing the importance of sanitation in the wards to all of his medical staff, which then led to a significant decrease in deaths and infection rates.

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.

In the case of the false discovery of cold fusion, the scientific attitude was not applied in this situation because of the scientists constantly changing their results in order to better suit their initial theory. Even though the trials didn't go according to their original scientific hypothesis, they would falsify information and make it seem as though everything was going according to plan. I would say the fountain of youth could be an example of poor scientific attitude. People had thought that the Fountain of Youth would provide and give people the strength of a young man. I think that instead of there actually being a fountain that made you "younger" I think that they probably were very dehydrated from the war so when they drank and bathed in the water, they instantly felt better and rejuvenated.

## **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?

The city of Santa Fe de Bogota was located in the viceroyalty of Nueva Granada. Mutis and the Dominican Congregation had a lot of tension between the two of them because Mutis was promoting emerging scientific thought while the Dominican Congregation was promoting traditional religious beliefs. This conflict had started many conversations about the shift in scientific inquiry and the power of religious institutions over the common people. One of the main goals of the Expedicion Botanica was to identify useful plants and grow in their agricultural practices. This expedition had contributed to the foundation of botany in Colombia.

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 city of Caracas was located in the viceroyalty of Nueva Granada. The Jesuits were very crucial in promoting education and scientific inquiry as they supported empirical research and modern scientific methods. Their removal had led to the Dominican order promoting theology and because of this less emphasis was placed on scientific advancements which most likely hindered the progress of scientific education and research.

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

He had created the Flora de Nueva Granada which was a scientific publication that showed the diverse plant life in Colombia.

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

It's not that anti-vaccinations don't take the scientific attitude into account, it's that they go about very poorly. They still use scientific concepts but their approaches are severely flawed.

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 categorization of different species is something that is traditionally not considered as science but it should be considered because we have to identify different species.

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 uni- versity ... 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?

The interaction between the two had started a transition from more traditional thoughts into modern scientific inquiries. The blending of the two ideas had introduced new Enlightenment ideas which prioritized empirical research and critical thinking. By looking at the ratio between the two types of professors we can see that the European intellectuals had influenced the shape of the curriculum and scientific discourse during this time. Ptolemaic is the model that puts the

Earth at the center of our universe. The Copernican system says that the Sun is at the center of our universe. Lastly, Tychonic says that the Sun and Moon orbit the Earth while 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?

The main points of this publication were to prove the Tychonic system correct. He emphasized the importance of empirical evidence and believed that the Geocentric model was inaccurate as it never took into account that the planetary observations were “inadequate”. This was definitely considered controversial as Mutis was going against the common norm. Both religious and academic authorities were going against his theories that the Tychonic system was indeed the correct one.

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?

The measurements that they had made were geodetic measurements to measure the geographical coordinates and they observed the astronomical observations, particularly Venus’s transit. Their measurements had improved the local knowledge of Nueva España as they provided accurate measurements and descriptions. As a result of them working together, they were able to split up the workload amongst themselves and they were able to calculate the distances from different locations for more accuracy.

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

Labrador had many geographical discoveries and he had heavily contributed to cartography. His explorations had helped develop more accurate maps which were important for navigation.

## **Unit 4**



1. a.)  $365 + 365$

$$365 + 365 = 730$$

$$730/20 = 20 \times 36 = 720 \text{ r } 10$$

$$= \begin{array}{c} \cdot \\ \hline \hline \hline \end{array} = \begin{array}{c} \hline \hline \end{array}$$

36      r   10

1. b.)  $1024 - 512$

$$1024 - 512 = 512$$

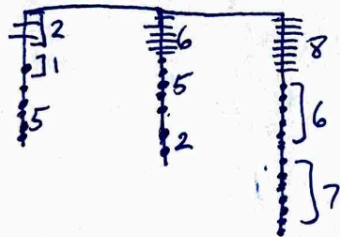
$$512/20 = 20 \times 25 = 500 \text{ r } 12$$

$$\begin{array}{c} \cdot \\ \cdot \\ \hline \hline \hline \hline \end{array} = \begin{array}{c} \cdot \\ \cdot \\ \hline \hline \end{array}$$

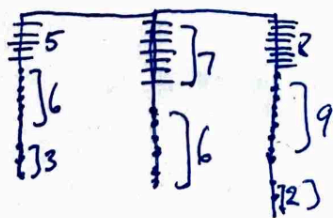
500      r   12

2. a.)  $512 + 256$

$$512 + 256 = 768$$



b.)  $365 - 67$



$$3.) \quad 3 \times 5 = 15$$

$$\begin{array}{c} \text{---} \\ \text{---} \\ \text{---} \end{array} + \dots + \begin{array}{c} \text{---} \\ \text{---} \\ \text{---} \end{array} = \boxed{64}$$

(15)                      (4)                      (60)

## Unit 5

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.

Observations relating to the Milkyway, Observations of High Energy Gamma Rays from nearby galaxies and more.

## Unit 6

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

The purpose of the Pierre Auger Observatory is to advance our knowledge of the high energy astrophysical phenomena and all the mysteries that surround Cosmic rays. It investigates everything about Cosmic rays from understanding the composition of it to understanding the processes that drive Cosmic ray production.

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