PROPOSAL FOR THE INSTITUTION OF SCIENCE 10
Probing the Physical World

I. Identifying and Descriptive Information

A. Course Catalogue Description

1. **Course number:** SCIENCE 10
2. **Course Title:** Probing the Physical World
3. **Course Description:** Understanding the origin of the universe, synthesis of the elements, formation of the earth and the various critical issues affecting our world view and our planet through the methods and interconnected concepts of the physical sciences.
4. **Prerequisite:** None
5. **Semester Offered:**
6. **Course Credit:** 3 units
7. **Number of Hours:** 3 hours/week
8. **Course Goal:** For the student to gain better comprehension of his physical world, its origins and the changes that it undergoes, and to recognize the methods of inquiry that provided such understanding and directions of future explorations.

B. Rationale

Man has constantly endeavored to understand and make sense of the physical universe and the processes, natural or manmade, that occur in it, echoing Stephen Hawking's statement in his book *A Brief History of Time: From Big Bang to Black Holes*, "Today we still yearn to know why we are here and where we came from. Humanity's deepest desire for knowledge is justification enough for our continuing quest. And our goal is nothing less than a complete description of the universe we live in."

Man has been gifted with the ability to observe, see patterns, make generalizations and explore predictions. It is with this scientific lens that the universe and our home planet, the earth, have become less formidable and truly fascinating to study. Through various physical concepts in physics, chemistry, and earth science, the course intends to situate the student in the context of the changing universe, and to emphasize the impact and interconnectedness of human activity on the various physical phenomena that confront human beings and their surroundings.

C. Course Outline

1. **Course Outcomes:** Upon completion of the course, students must be able to:
   1. Evaluate perceptions/preconceptions/notions about natural phenomena through the methods of science;
   2. Integrate knowledge from the physical sciences and to be able to recognize the interdependence of various disciplines; and
   3. Utilize scientific inquiry, critical, creative, and integrative thinking in making informed decisions that will impact on their actions in relation to their environments.

Course Outcomes and Relationship to GE objectives
I *(introduced),* ***D*** *(demonstrated) or* ***R*** *(reinforced)*

Course Outcomes	GE Objectives*				
	A	B	C	D	E
1. Evaluate perceptions/preconceptions/notions about natural phenomena through the methods of science;	D	I	I	I	I
2. Integrate knowledge from the physical sciences and to be able to recognize the interdependence of various disciplines	D	D	D	D	D
3. Utilize scientific inquiry, critical, creative, and integrative thinking in making informed decisions that will impact on their actions in relation to their environments.	R	D	R	D	R

*A Broaden intellectual and cultural horizons
B Hone critical and creative thinking
C Develop a passion for learning and scholarship
D Cultivate a high sense of intellectual and moral integrity
E Foster a commitment to nationalism and social justice

2. Course Content

Lecture Topics	No. of Hours
I. How We Study the Physical World A. The Physical World: An Overview 1. Attributes and Properties 2. Hierarchy and Scales 3. Interactions B. Intuition, Preconceptions, and Ancient Notions C. Methods of Science D. Diagnostic Features of Science	**6**
II. The Cosmos A. Big Bang Theory 1. Pre-Big Bang Views of the Universe 2. Newtonian Mechanics and Conservation Laws 3. Light: Spectra, Doppler Effect, Blackbody Radiation 4. Relativity 5. Evidences for the Big Bang B. Formation of Stars and Planets	**9**
III. From Atoms to Molecules, Elements to Compounds A. Nucleosynthesis: Formation of the Elements B. Atomic Structure C. Bonding, Structure, and Properties of Materials D. Molecular Self-Assembly	**7.5**
IV. Forming the Earth A. Lithosphere B. Atmosphere C. Hydrosphere D. Biosphere E. Plate Tectonics	**7.5**
V. Critical/Contemporary Issues in the Physical World **Suggested Topics (Other emerging topics may be discussed):** A. Issues Related to the Cosmos 1. Cosmic Mysteries (e.g., Dark Matter, Dark Energy) 2. Extra-solar Planets 3. Space Exploration and Colonization 4. Are we alone? (Search for Extra-Terrestrial Intelligence) 5. Near-Earth Objects 6. Anti-matter 7. Other topics B. Issues Related to the Earth 1. Geohazards (and Plate Tectonics) 2. Climate Change and Environmental Degradation 3. Chaos and Complex Systems (e.g., Ocean Circulation, Cyclones) 4. Climate Change through Earth's History 5. Extreme Weather Events	**13.5**

6. Other Topics C. Issues Related to Humans and the Environment 1. Food Resources and Security 2. Medicines and Poisons 3. Water Resources Extraction and Management 4. Mineral and Energy Resources (and Plate Tectonics) 5. Pollution and Contamination 6. "Built-sphere": How Humans are Changing the Physical World (e.g., Anthropocene) 7. Other Topics D. Crosscutting Issues in Science 1. Fads, Fallacies, Fantasies and Fakes in the Name of Science 2. Status of Education and Research on the Physical Sciences in the Philippines	
VI. Triumphs and Limits of Science	**1.5**

3. Course Coverage

Week	Course Outcome	Topics	Teaching and Learning Activities	Assessment Tools
1-2	• Appreciate the magnitude in size and variety of components that make up the physical universe that man has sought to study and understand, from the vast cosmic space to the intricate world of atoms; • Recognize that science is primarily an active and creative process that has led to a better understanding of the physical world; • Formulate questions and/or inferences from information obtained from scientific inquiries; and • Recognize that some decisions and actions have or are influenced by social factors & may have long term effects.	**I. How We Study the Physical World** A. The Physical World: An Overview 1. Attributes and Properties 2. Hierarchy and Scales 3. Interactions B. Intuition, Preconceptions, and Ancient Notions C. Methods of Science D. Diagnostic Features of Science	• Group discussions on ancient and early ways of understanding the universe • Case studies showing use of the methods of science • Exercises on making conclusions; decision-making; asking questions	• Quizzes • Graded • Group presentations
3-5	• Compare and contrast pre-Big Bang views of stars, planets and the universe from various cultures • Explain the evidences for the Big Bang Theory • Discuss competing hypotheses on the formation of stars and planets	**II. The Cosmos** A. Big Bang Theory 1. Pre-Big Bang Views of the Universe 2. Newtonian Mechanics and Conservation Laws 3. Light: Spectra, Doppler Effect, Blackbody Radiation 4. Relativity 5. Evidences for the Big Bang B. Formation of Stars and Planets	• Research/presentations on Filipino views on the origin of the Universe • Video on the Big Bang	Exam/quizzes

6-8	• Describe the formation of the elements, from the Big Bang nucleosynthesis, to stellar nucleosynthesis; • Relate electronic structure to reactivity of the elements; and • Infer from observed properties the nature of interactions that hold particles together to form large aggregates or structures.	**III. From Atoms to Molecules, Elements to Compounds** A. Nucleosynthesis: the Formation of the Elements B. Atomic Structure C. Bonding, Structure, and Properties D. Molecular Self-Assembly	• Nuclear reactions • Stellar Fusion Game (online) • Use of models to portray structures and interactions • Examples of self-assembly	• Graded seat work and drills • Lecture exam
8-10	• Explain the formation of the different spheres of the earth • Explain the major interactions of the plates and the resultant surface features on earth	**IV. Forming the Earth** A. Lithosphere B. Atmosphere C. Hydrosphere D. Biosphere E. Plate Tectonics	• Fieldtrip to the following museums/agencies: ○ NIGS-UPGAA Geology Museum, NIGS Bldg, UP Diliman ○ PHIVOLCS Museum and Monitoring Station, CP Garcia Ave, Diliman, QC ○ PHIVOLCS Monitoring Stations in regions across the Philippines ○ Mind Museum, Fort Bonifacio • Fieldtrip to a Philippine volcano • Fieldtrip to an extremophile-bearing high pH natural spring (mimics early life conditions) • Thematic group discussions • Creative group reporting on selected topics • Video presentation	• Group reports • Exam
11-14	• Interpret relevant scientific data • Evaluate the validity of claims and statements on various critical / contemporary issues in science using the scientific method	**V. Critical / Contemporary Issues in the Physical World**	• Position papers/formulation of advocacies • Case studies • Presentations on topic (O) by volunteer students on issues affecting their communities, and recommended resolutions • Group discussion on the Philippine situation vs. the world status on various issues	Submitted student work: position papers; group presentations.
15	• Explorations • Suggest new areas of research	**VI. Triumphs and Limits of Science**		

4. **Course Requirements**
   4 long exams, several quizzes, group papers

REFERENCES AND RESOURCES

I. How We Study the Physical World

Wilson, Edward O. 1998. Consilience: The Unity of Knowledge. New York: Knopf.

Eames, Charles and Eames, Ray. 1977. Powers of Ten film.

L. Darden. Reasoning in Biological Discoveries (Cambridge University Press, New York, 2006).

M.S. Morgan, M. Morrison (eds.) Models as Mediators: Perspectives on Natural and Social Science (Cambridge University Press, Cambridge, 1999).

F. J. Rutherford, A. Ahlgren. Science for All Americans. (Oxford University Press, USA, 1991).

II. The Cosmos

J. Silk, 1989. The Big Bang.

S Woosley and T. Weaver. 1989. The Great Supernova of 1987. Scientific American, 261(2):34.

S. Singh. Big Bang: The Origin of the Universe (Fourth Estate, Great Britain, 2004).

D.J. Griffiths. Advertisement. Introduction to Electrodynamics, 2nd ed. Prentice Hall, New Jersey, 1989.

K.W. Ford. Chapter 1 (The Nature of Physics) and 4 (Conservation Laws). Classical and Modern Physics: Introductory text for students of science and engineering. Vol.1 (Xerox College Publishing, Massachusetts, 1972–74).

R.P. Feynman, R.B. Leighton, M. Sands. Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher (Basic Books. 2011).

L.N Cooper. An introduction to the meaning and structure of physics. (Harper & Row, New York, 1969).

D.E. Neuenschwander Emmy Noether's Wonderful Theorem (Johns Hopkins University Press, 2010).

L. Lederman and C.T. Hill. Symmetry and the Beautiful Universe (Prometheus Books, New York, 2005).

V.J. Stenger. Chapter 1. Timeless Reality: Symmetry, Simplicity, and Multiple Universes. Buffalo NY: (Prometheus Books, New York, 2000).

Zee. Fearful Symmetry: The search for beauty in modern physics, 2nd ed. (Princeton University Press, Princeton, 2007).

K.B. Krauskopf and A. Beiser. The Physical Universe, 15th ed. (McGraw-Hill Higher Education, New York, 2013).

Stellarium, open source planetarium for the computer. www.stellarium.org

Ambrosio, Dante L. 2010. Balatik: Etnoastronomiya: Kalangitan sa Kabihasnang Pilipino. Quezon City: University of the Philippines Press, 279 pp.

Lightman, Alan. 2005. The Discoveries: Great Breakthroughs in 20th Century Science. New York: Vintage Books, 553 pp.

III. From Atoms to Molecules, Elements to Compounds

Stoker, H. Stephen. 2012. General Chemistry (Phil. ed). Cengage Learning and other General Chemistry books

Barouch, Dan H. 1997. Voyages in Conceptual Chemistry. Sudbury, Massachusetts: Jones & Bartlett Publishers.

http://www.chymist.com >> for an illustrated history of alchemy and chemistry from ancient times to 1800, for the article, All the Gold in the Universe Could Come From the Collisions of Neutron Stars by Joseph Stromberg,July 17, 2013, about the origins of heavy metals in the universe.

http://youtube.com/watch?v=smwlzwgmmwc >> for the song, The Element by Tom Lehrer recorded in 1959 and originally published on the recording An Evening Wasted with Tom Lehrer

Videos from BBC. "The Atom: Clash of Titans"; "The Cosmos"

Casse, Michel. 2003. Stellar Alchemy: The Celestial Origin of Atoms. Cambridge University Press.

Various journal articles on molecular self-assembly

Molecular models

IV. Forming the Earth

Levin, Harold L. 2013. The Earth through Time, 10th ed.

Lunine, Jonathan I. 2013. Earth: Evolution of a Habitable World, 2nd ed.

Skinner, Brian J. et al. 2004. Dynamic Earth: An Introduction to Physical Geology, 5th ed.

Tarbuck, Edward J. & Lutgens, Frederick K. 2011. Earth Science, 13th ed.

Suggested Reading:
Bryson, Bill. 2010. A Short History of Nearly Everything

Suggested Websites:
www.phivolcs.dost.gov.ph
www.ucmp.berkeley.edu
earthobservatory.nasa.gov
science.nasa.gov
www.nationalgeographic.com
www.gsa.org

V. Critical/Contemporary Issues in the Physical World

DOST website on the state of science education and research in the Philippines
Outputs of research by UP on the state of physical sciences research and education
Pertinent IBON facts & figures on the issue and other NGO materials
Community profile on the pollution/contamination, if available
Search for articles at the websites of the UN World Food Programme and Food & Agriculture Organization of the UN
Local news articles and commentaries on food security in the Philippines