Epoch-Making Events in Science CP320

Study Guide: *The Dancing Universe*; Marcello Gleiser

To use this Study Guide effectively, apply the principles of active reading:

1. Follow the guide as you read *The Dancing Universe* and also after each lecture;
2. Actually write a response to each item in the guide, based on your reading and the class lectures.
3. Study with classmates so you can explain the material to each other. Mere casual reading of *The Dancing Universe* is not an effective way to learn.

As a result of reading and studying *The Dancing Universe*, the student should be able to:

1- State the definition of myth given by Gleiser (p 7).

2- State the two reasons why Gleiser begins the book with a discussion of creation myths (pp 3, 4).

3- Compare and contrast the nature of science with the nature of myth (pp 9-22).

4- State the caution Gleiser gives to scientists and to religious people in their approach to science and religion (p 21).

5- a. List the four major groups of early Greek philosophers with their approximate time periods, specifically including Thales, Parmenides, Pythagoras, Leucippus, Democritus, and

b. the specific contributions of each to the development of Western thought (p 41).

6- a. List the major Greek/Hellenistic philosophers from Plato to Ptolemy with their approximate time periods, specifically including Plato, Aristotle, Aristarchus, Ptolemy, and

b. the specific contributions of each to the development of Western thought (p 58).

7- State the principal contribution of the atomists, especially with respect to the concepts of change and permanence (pp 37-42).

8- a. Name the book on astronomy written by Ptolemy, and

b. describe the system of planets developed by Ptolemy, giving specific attention to the organization of the planets and the geometrical devices used to explain their motion (pp 55-57).

9- State the source for all answers for astronomy and cosmology in the medieval (Western) mind and the description of the heavens and earth, according to Gleiser (p 63).

10- Describe the role of both Augustine and Thomas Aquinas in the formulation of the Roman Church's position of cosmology by the thirteenth century. (pp 63-68).

11- a. State the major contributions of Copernicus, including a description of his heliocentric model,

b. contrast the heliocentric model with the geocentric model (Ptolemaic model) accepted by the Roman Church, and

c. state the reasons given by Copernicus in support of his model (pp 68-75).

12- State the major contributions of Kepler, including his three laws of planetary motion (pp 75-96).

13- Describe the major contributions (and their significance) of Galileo, including his telescopic observations, his Letter to Castelli, his book *Dialogue* (pp 99-119).

14- Explain the significance of Galileo's statement, "the Bible does not err, but its human interpreters may." (p 106).

15- List the objections to the heliocentric model of Copernicus (pp 104-119),

a. given by the Roman Church, and

b. stated as common sense objections.

16- State what Gleiser says the Roman Church failed to recognize with respect to Galileo (p 119).

17- List the accomplishment of Newton's approach as represented in his book *Principia* (pp 132-135)

18- State Newton's three laws of motion (p 135).

19- Describe what Newton means in his Book III as the 'System of the World' (p 135).

20- State what Gleiser means by the phrase 'the credo of science' (p 139).

21- State what Gleiser calls the 'beauty of science' as well as its 'downfall' (p 141).

22- Describe Newton's ideas about God as 'cosmic designer' (pp 141-144).

23- State the warning given in using the 'God of the gaps' approach to fill in gaps in current scientific understanding of the world (p 144).

24- List the three aspects of the revision of the Western conception of the cosmos that resulted from the combined work of Kepler, Galileo, Descartes, and Newton (p 149).

25- Describe what is meant by the 'mechanistic approach to nature as a strict determinism,' especially as expressed in the phrase 'a giant clockwork mechanism' (pp 149-151).

26- Describe the consequences of the 'rational foundation for the emerging new science' concerning the physical world (pp 149-151).

27- Contrast the view of the Theists with that of the Deists with respect to God's relationship to the cosmos (pp 153-155).

28- Describe how scientists were able to determine (by measurement) the chemical composition of distant stars and galaxies without being able to visit those distant objects (pp 156-160).

29- List the developments in modern physics that 'contradict our common sense' (p 192).

30- State the principal contribution to modern physics by Max Planck (pp 192-193).

31- List the early contributions of Einstein to the theory of light and time (pp 191-211).

32- List the contributions to modern physics concerning the structure of matter by Röntgen, von Laue, Bragg, Becquerel, Curie, and Thomson (pp 220-225).

33- State what Einstein said was his 'most revolutionary idea', related to his theory of the photoelectric effect for which he won the Nobel Prize in Physics in 1921 (pp 228-229).

34- Describe the development of quantum mechanics as given by Gleiser (p 239).

35- State whose work is described as 'outside-in' and whose as 'inside-out' (p 239).

36- a. Describe what Einstein dubbed 'the happiest thought of my life' and

b. the physical theory to which it led. (p 243-244).

37- a. List the questions that arise if the Universe is expanding, and

b. State their significance for the differences between science and religion (p 245).

38- State the two principal consequences of Einstein's General Theory of Relativity (p 253).

39- Describe two experimental confirmations of the prediction of 'curvature of space-time and motions in a curved geometry' (pp 258-259).

40- State the 'cosmological principle' of Einstein (p 262).

41- a. Describe the Doppler Effect,

b. give one common example, and

c. describe the significance of its use in the development of cosmology (pp 266-278).

42- State what Gleiser says about belief and our relationship to science (p 269).

43- Describe what Gleiser says is one way that human beings are special (p 274).

44- a. State Hubble's Law and

b. describe its importance to cosmology (pp 276-278).

45- State the number of galaxies estimated to be in our Universe (p 278).

46- Describe the 'immediate consequence of Hubble's expansion law' (p 282).

47- a. State the steady-state model of cosmology and

b. list its principal developers (pp 288-289).

48- State the three developments that led to the downfall of the steady-state model of the cosmos (p 290).

49- Describe the developments in the sub-atomic structure of matter that played a major role in the theory of the development of the cosmos (pp 291-296).

50- Describe the ideas of Gamow, Bondi, and Herman that are the core of the big-bang hypothesis (pp 296-299).

51- State the principal features of the big-bang model (pp 294-300).

A. Create a timeline that includes the following persons with approximate dates: Thales, Pythagoras, Democritus, Plato, Aristotle, Ptolemy, Augustine, Aquinas, Gutenberg, Copernicus, Kepler, Galileo, Newton, Paley, Maxwell, Planck, Einstein, Bohr, de Broglie, Schrödinger, Heisenberg, Hubble, Doppler, Lemaître, Wilson and Penzias, Gamow.

B. Associate with each of these persons their principal contribution(s) to our search for understanding of the world.