

SUBJECT Astronomy 5

INSTRUCTOR Professor Hansen

DATE 10/25/16

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GRADE

University of California
Los Angeles

EXAMINATION BOOK

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Signature



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Astro 5, Midterm Exam: Fall Quarter 2016

All multiple choice questions worth two points. Conceptual questions as indicated.

History:

- (1) The ancient greeks had a model of the solar system in which the center of the solar system was
 (a) Earth (b) Mars (c) The Sun (d) The Galaxy
- (2) Kepler's innovation that made it possible to accurately describe planetary orbits was to realise that
 (a) The Sun was at the center of the solar system
 (b) Planetary Orbits are described by ellipses, not circles
 (c) The Planets all orbit in a plane
- (3) Galileo observed the phases of Venus and inferred that Venus
 (a) Orbited the Earth
 (b) Orbited the Sun interior to Earth's Orbit
 (c) Orbited the Sun exterior to Earth's Orbit
- (4) Retrograde Motion occurs when *greatest*
 (a) Earth moves backwards in its orbit
 (b) Mars moves backwards in its orbit
 (c) Earth overtakes Mars as it goes around the Sun
 (d) Mars overtakes Earth as it goes around the Sun

Fundamentals:

- (5) Which of the following is not a molecule?
 (a) Water (b) Carbon (c) Carbon Dioxide (d) Ammonia
- (6) Can an element go directly from solid to gas phase, or does it always have to pass through a liquid phase?
 (a) Yes, always liquid
 (b) No, always directly to gas
 (c) No, sometimes directly to gas
- (8) How many planets are there in the solar system (official number only please!)
 (a) Eight (b) Nine (c) Ten (d) One
- (9) How many stars are there in the Galaxy (ballpark figure)?
 (a) Ten (b) A Thousand (c) A million (d) A hundred billion
- (10) Approximately what fraction of the mass in the Universe is in baryons (aka the stuff we're made of)?
 (a) a few percent (b) 50 percent (c) 75 percent (d) 100 percent
- (11) The composition of the Sun is mostly
 (a) Hydrogen (b) Helium (c) Carbon (d) Iron
- (12) Discuss what information we can gain about a star or planet if we measure it's spectrum.
Describe what we mean by a spectrum and what features thereof convey the information.
(5 points)
- (13) How was most of the Carbon and Oxygen in the Earth originally produced?
 (a) From the Big Bang
 (b) During the formation of the Milky Way
 (c) Nuclear Burning in Stars
 (d) Chemical reactions on Earth

- (14) Of these inner solar system planets, which is much hotter on the surface than the Earth?
 (a) Mercury (b) Venus (c) Mars (d) Vulcan
- (15) Why do we think the Ice line is important for forming gas giants like Jupiter?
 (a) They would boil away if they were closer to the Sun
 (b) Cool temperatures are needed for sufficient solid mass to condense to form the core
 (c) If they were too cold, then they could not retain a magnetic field and would lose their atmospheres
- (16) Which is the only Solar System Moon to have a substantial Atmosphere?
 (a) Io (b) Europa (c) Titan (d) Earth's Moon, a.k.a. "The" Moon
- (17) Discuss the concept of the Radioactive half-life, and how it can be used to measure the ages of rocks.
 (5 points)

Geologic Foundations:

- (18) Igneous rock results from
 (a) Molten rock that cools
 (b) Compression of silt in rivers
 (c) High pressure deformation of sedimentary rock
- (19) If fossil A is found in a deeper layer underground than fossil B, it is
 (a) Younger (b) Older (c) Depth isn't correlated with age
- (20) Approximately how old is the Earth?
 (a) 1 million years (b) 1 billion years (c) 4.5 billion years (d) 14 billion years
- (21) Relative to the composition of Earth's mantle, is the core
 (a) less dense (b) more dense (c) homogeneously mixed
- (22) What is subduction?
 (a) The process of emitting gases into the atmosphere via volcanoes
 (b) The process of the atmosphere absorbing the heat emitted by the Earth surface
 (c) The process by which crust is buried by plate tectonics and melted
- (23) Which is not a greenhouse gas?
 (a) Water (b) Carbon Dioxide (c) Methane (d) ATP
- (24) Describe how the CO₂ cycle acts as a thermostat to maintain the surface temperature of the Earth
 (6 points)
carbonate rocks outgassing, feedback loop
- (25) How did the Moon form?
 (a) Capture from the Asteroid Belt
 (b) Result of a collision with a Mars-size body *(after differentiation started)*
 (c) Spun off of a rapidly spinning early Earth
- (26) The Earth's magnetic field is maintained by
 (a) Convection in the mantle/*outer core* (b) Winds in the atmosphere
 (c) The Solar wind (d) The Carbon Dioxide Cycle

Biological Foundations:

- (27) Darwin noted that Nature featured a competition for limited resources and that some individuals in a species were better suited than others. From this he concluded
 (a) Some individuals can acquire traits and pass them on to their offspring
 (b) Some individuals have an advantage in reproductive success over others
 (c) All life must have sprung from a common origin

- (28) Organic chemistry, upon which biology is based, is based on the element
 (a) Iron (b) Oxygen (c) Carbon (d) Nitrogen
- (29) Match the molecule to its biological role
 C (a) Water (b) ATP (c) DNA (A) Energy Storage
 A (b) ATP (B) Chemical Instruction Set
 B (c) DNA (C) Solvent and Medium
- (30) Which is not one of the domains on the Tree of life?
 (a) Bacteria (b) Archaea (c) Viruses (d) Eukarya
- (31) An organism that lives near a volcanic vent and gets its Carbon from dissolved Carbon dioxide, and its energy from chemical reactions with the volcano products, is classified as a
 (a) photoautotroph (b) chemoautotroph (c) photoheterotroph (d) chemoheterotroph
- (32) Humans are
 (a) photoautotroph (b) chemoautotroph (c) photoheterotroph (d) chemoheterotroph
- (33) Our genetic code relies on three letter words. How many potential words can be made using the bases in our DNA?
 (a) 16 (b) 20 (c) 64 (d) 128
- (34) Due to the substantial redundancy in our code, how independent amino acids do we actually use?
 (a) 16 (b) 20 (c) 64 (d) 128
- (35) Discuss why we think this redundancy may indicate that life originally used a simpler genetic code than the three base-pair words we see today. (4 points)

History of Life on Earth:

- (36) What is a Stromatolite?
~~(a)~~ A device used to study ancient life
 (b) A fossil that shares the pattern of modern day microbial mats
~~(c)~~ A fossil from the Cambrian explosion period
- (37) Even in metamorphic rock we can obtain some indication of biological activity due to
~~(a)~~ the presence of nanofossils
~~(b)~~ leftover traces of organic materials in the rock
 (c) Anomalous isotopic ratios of Carbon
- (38) Based on the available evidence, we anticipate that the delay between the formation of Earth and the start of life was
 (a) less than a billion years (b) two billion years (c) a thousand years
- (39) What is the source of energy used in the Miller-Urey experiment?
 (a) Electrical Discharges ~~(b)~~ Tidal Energy ~~(c)~~ Photosynthesis
- (40) The atmosphere of the Early Earth was
 (a) Oxygen Rich (b) Iron Rich (c) Oxygen Poor (d) Carbon Poor
- (41) What feature defines a Eukaryote?
 (a) having DNA (b) amino acids (c) a cell nucleus ~~(d)~~ having multiple cells
- (42) What was the Cambrian Explosion?
 (a) The explosion in diversity of multicellular life 540 million years ago
~~(b)~~ The appearance of single celled organisms after the Hadean
~~(c)~~ The Extinction of the Dinosaurs, 65 million years ago

- (43) What evidence in the K-T boundary sediments does not argue for an asteroid impact cause?
- (a) Iridium mixed into the layer
 (b) Presence of Soot in the layer
 (c) the absence of dinosaur fossils above that layer
 (d) the presence of solidified molten rock in that layer
- (44) How big does an asteroid have to be to be a genuine global threat, based on the Chicxulub impact?
- (a) centimeter size (b) meter size (c) 10 kilometer size (d) 1000 kilometer size
- (45) Discuss why we might consider the observation of a high Oxygen content in another planet's atmosphere to be an indicator of the presence of biological activity on that planet. (4 points)

A Few Hypotheticals:

True/Plausible or False/Implausible

- (46) We discover evidence that life began on a hilltop, not near a deep sea vent
 T F
- (47) The first self-replicating molecule made in a lab is single-strand, not double-strand like DNA.
 T F
- (48) A single celled organism is discovered that uses 12 different amino acids
 T F
- (49) We discover a planet with an active CO_2 cycle but no plate tectonics
 T F
- (50) NASA announces the discovery of an asteroid that will strike Earth in January 2237
 T F *50-100 years*
- (51) NASA announces the discovery of a young planet forming system 1500 light years away in Orion
 T F
- (52) NASA also announces plans to send a crew of astronauts to visit this planet
 T F
- (53) NASA announces the discovery of water-based life on a solar system comet near Pluto
 T F *ice*
- (54) Scientists recover microbes from Europa which use the some of the same chemicals as organisms on Earth, but with the opposite chirality (i.e. Europeans uses left handed molecules, while Earthlings use only right-handed molecules of this type)
 T F
- (55) Scientists announce the discovery of a special kind of Carbon-12, that is radioactive, even though regular Carbon-12 is not.
 T F *chirality - same chem - diff. chem properties*

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- History: 3
1. a
 2. b
 3. b
 4. b

- fundamental 8
5. b
 6. c
 - (no 7)
 8. a
 9. d
 10. a
 11. a

5

12. By measuring the star's or planet's spectrum, we can tell the temperature of the object by the spectrum of its wavelength, as well as the different chemical composition of the star or planet. we gain a distribution of light in its spectrum to therefore analyze various properties of the star or planet such as chemical composition. By a spectrum, we mean the distribution of light with characteristic wavelength and frequency emitted from a star or planet, and the position and variation of the "bands" (depending on whether it is a continuous spectrum, emission line spectrum, or absorption line spectrum) convey such information.

13. d
14. b
15. b
16. b

5

17. Radioactive half-life is described by the time it takes for a radioactive isotope to decay to "daughter products" such that half of the radioactive isotope remain. Particularly, such isotopes are radioactive, that is unstable and can potentially change into a different element by decay such as beta decay (lose electron from neutron produce a proton) forming a "daughter product".

original	daughter
1 half-life 50%	50%
2 half-lives 25%	25%
3 half-lives 12.5%	12.5%

By measuring the rate at which a radioactive isotope decays ^{to half its content}, half life is determined. Knowing the half-life, we can measure the ratio of the original isotope versus the "daughter products" of the radioactive isotope to determine the ages of rocks.

8
geologic
conditions

18. a

19. b

20. c

21. b

22. c

23. d

24. First off, the carbon dioxide (CO_2) cycle is the cycle involve outgassing CO_2 to the atmosphere $\rightarrow \text{CO}_2$ dissolved in rain \rightarrow erode sediments, carried by rivers \rightarrow into the ocean where dissolved CO_2 mixes into limestone forming shells of organisms \rightarrow organism dies and shells become part of carbonate rocks \rightarrow carbonate rock subduction \rightarrow repeat.

6
The CO_2 cycle acts as a thermostat due to various reasons. Carbonate rocks hold almost 170,000 times the CO_2 found in the atmosphere, thereby maintaining Earth's temperature in a moderate level as opposed to Venus, having smaller amounts of total CO_2 which is significantly hotter. In addition, when greenhouse gases increase, the rate of removal of CO_2 in the clathrate increases, thereby lowering the temperature of Earth. When greenhouse gases decrease, the rate of removal of CO_2 in the clathrate decreases, thereby raising the temperature of Earth. This feedback loop and the presence of lots of stored CO_2 in carbonate rocks are evidence that the CO_2 cycle acts as a thermostat to maintain the surface temperature of the Earth.

25. b

26. a

NN

Biological
Fundamentals

27. b

7 28. c

29. a. water - (C) solvent and medium

b. ATP - (A) energy storage +3

c. DNA - (B) chemical instruction set

30. c

31. b

32. d

33. c

34. b

4/4 35 Based on the investigation, most amino acids are translated from ^{and is mostly} dependent on the first two bases. As a result, such redundancy may indicate that life originally used a simpler genetic code, as the three base-pair words we see today are a bit more complex and is built upon the earlier two base-pair words.

History of
Life on Earth

9 36. b

37. c

38. a

39. a

40. c

41. c

42. a

43. c

44. c

4/4

45.

High oxygen content is an indicator of production of oxygen by organisms (photosynthetic), as oxygen is highly reactive. Because oxygen is highly reactive, it does not stay in the planet for long. As a result, there needs to be a continual supply of oxygen produced in some way in order to produce a high oxygen content in another planet's atmosphere - and that is an indicator of the presence of biological activity on that planet.

A Few

Hypothetical 46. F

8 47. T

48. T

49. F

~~50.~~ F

51. T

52. F

53. F

54. T

~~55.~~ T