

32/41

Initials of First and Last Name: WF

UCLA 9-digits Student ID : XXXXXXXXXX

Discussion Section (Meeting Date/ Time) : Friday, 10-11:50

ASTRONOMY 5, Nov. 15, 2018

UCLA Dept. Physics & Astronomy

Second Mid-Term Examination Ver. A

Please Read these Instructions

Bubble-in your name and student ID number on the Scantron. Show your Photo ID when turning in the exam, and put your initials and student ID number on the front of this exam at the top right of this page.

Read each question carefully *before* marking your answer on the Scantron. *There are no trick questions, but some answers may seem similar until you think it through.*

Please do your own work; cheating will not be tolerated.

NOTE: *No one may leave the classroom during the first 30 minutes of the exam, even if you are completely finished. If you finish early please sit very quietly until permitted to leave. It is much too disruptive to have people leave while others are working.*

Some information which may be useful:

G	=	7	x	10^{-11}	$\text{m}^3/\text{kg}\cdot\text{sec}^2$
h	=	7	x	10^{-34}	$\text{kg}\cdot\text{m}^2/\text{sec}$
c	=	3	x	10^8	m/sec
m_H (mass of a hydrogen atom)	=	1.6	x	10^{-27}	kg
M_\oplus (mass of Earth)	=	6	x	10^{24}	kg
M_\odot (mass of Sun)	=	2	x	10^{30}	kg

L_{\odot} (luminosity of Sun)	=	4	x	10^{26}	kg-m ² /sec ³
R_{\oplus} (radius of Earth)	=	6	x	10^6	m
1 Radian (of angle) = $180^{\circ}/\pi$	=	57 ^o	=	200,000	arc seconds
E	=	mc ²			
1 parsec	=	3	x	10^{16}	m
1 year	=	3	x	10^7	seconds
E	=	hf			
F	=	ma			
V	=	Hd			

$$F = \frac{GM_1M_2}{R^2}$$

$$L = 4\pi R^2 \sigma T^4$$

$$B = \frac{L}{4\pi R^2}; W = \frac{c}{f}$$

$$V_{\text{esc}} = \text{Sqrt}(2GM/R^2)$$

$$W = 0.2\text{cm/T}$$

$$a = \frac{V^2}{R}$$

EXAM STARTS HERE

- Which is NOT one of the things we look for in a habitable planet that could support life?
 - Stable circular orbit
 - Lies in habitable zone
 - No runaway greenhouse effect
 - Liquid water
 - Orbiting a star at least 8 times the mass of the Sun
- The *radial velocity curve* of a star with an orbiting planet is a plot of the radial velocity of the star versus time. The *amplitude* of the curve is related to
 - The planet's radius
 - The planet's mass
 - The orbital period
 - The orbital shape or eccentricity
 - The distance from the Earth to the star

3. If the radial velocity curve is very asymmetric in appearance, rather than a perfect sinusoidal shape, this means that the exoplanet:
- has an eccentric orbit
 - has more mass than Jupiter
 - orbits much closer to its star than the Earth is to the Sun
 - orbit is viewed exactly edge-on as seen from Earth
 - is non-spherical
4. Why does the Doppler shift method of detecting extrasolar planets only give us the *minimum* mass of the orbiting planet?
- Because we usually don't know the diameter of the planet
 - Because we usually don't know the density of the planet
 - Because we usually don't know the inclination of the orbital plane
 - Because we usually don't know the mass of the parent star all that well
 - Because we only measure the speed of the star moving away from us, but not coming towards us
5. To calculate the density of a planet we need to measure its _____ and _____; the Doppler method gives the first factor and the transit method the second.
- Radius; mass
 - Mass; radius
 - Mass; temperature
 - Temperature; radius
 - Distance; temperature
6. Stars less luminous than the Sun have
- Narrower habitable zones, decreasing the odds of finding habitable planets and lifetimes too short for life to appear
 - Narrower habitable zones, decreasing the odds of finding habitable planets but much longer lifetimes allowing life to appear and evolve
 - Wider habitable zones, increasing the odds of finding habitable planets but lifetimes too short for life to appear
 - Wider habitable zones, increasing the odds of finding habitable planets and much longer lifetimes allowing life to appear and evolve
 - The same size habitable zones as the Sun.
7. Which type of bond represents a weak chemical bond?
- Hydrogen bond
 - Ionic bond
 - Covalent bond
 - Polar Covalent bond
 - Electronic bond

8. Suppose that an alien civilization very far away is attempting to detect planets in our Solar System using the transit method. By what factor would the dip in the brightness of the Sun increase when Jupiter transits in front of it, than when Earth transits in front of it? Jupiter is about 300 times as massive as the Earth, and its radius is about 10 times as large as Earth's radius.
- A. 10
 - B. 100
 - C. 300
 - D. 3,000
 - E. 90,000
9. The monomers that make up proteins are called _____.
- a. Nucleotides
 - b. Sugars
 - c. Amino acids
 - d. Fatty acids
 - e. Hydrocarbons
10. The pH of lemon juice is about 2.0, whereas tomato juice's pH is about 4.0. Approximately how much of an increase in hydrogen ion concentration is there between tomato juice and lemon juice?
- a. 2 times
 - b. 10 times
 - c. 100 times
 - d. 1000 times
 - e. 10,000 times
11. One problem with the habitable zone around a very low-luminosity star is that:
- a. It is so close to the star that any planet there would likely become tidally locked, always facing the same side towards the star
 - b. There could not be any seasonal variations
 - c. There could not be any liquid water present on a planet in that zone
 - d. That planet could not hold onto an atmosphere
 - e. That star would have such a short lifetime, there would not be a chance for life to develop and evolve
12. The genetic code is believed to have originally used two letters. In that situation what was the maximum number of amino acids that could be coded for by DNA?
- a. 2
 - b. 4
 - c. 16
 - d. 20
 - e. 64

13. The situation of having more than one planet inside a star's habitable zone:
- Is known to exist in only 1 or 2 systems so far
 - Is so common, it is the normal situation
 - Could happen, but could never be found by the transit method
 - Can only occur in systems lacking any gas giants
 - Is a physical impossibility
14. Having Jupiter in our Solar System:
- protects us from most collisions with other small bodies
 - prevented small bodies from falling into the inner Solar System in its early stages of formation
 - helps keep Earth warmer than it would otherwise be
 - has prolonged the life of our Sun
 - has no effect on the planets of the inner Solar System
15. Adding a COOH group to the end of a hydrocarbon can make the molecule into a:
- acid
 - base
 - nonpolar molecule
 - carbohydrate
 - sugar
16. Which is NOT true of Hydrocarbons:
- They can have branches
 - They can have rings
 - They can be very long
 - They can only be liquid at room temperature
 - They consist of C and H atoms.
17. What is the importance to us on Earth of having a large natural satellite relatively nearby?
- it stabilizes the tilting of Earth's rotation axis to remain fairly close to the axis of the solar system (ecliptic) plane
 - it increases the Earth's nighttime temperature
 - it increases volcanic activity
 - it stops ocean tides from occurring
 - we could migrate there in the near future
18. Many chemical reactions take place in cells that could hardly occur in the natural environment, or maybe at extremely slow rates. This is because:
- the rules of chemistry are different inside cells
 - enzymes made out of proteins catalyze reactions to make them much more likely
 - the pH level in cells is extremely different from that, say, of ocean water
 - all of those reactions require the presence of dissolved oxygen and CO₂
 - these reactions can only take place within a narrow temperature range of a few degrees

19. Which is NOT a complex polysaccharide carbohydrate?
- starch
 - chitin
 - cellulose
 - glucose
 - glycogen
20. A common ancestry for all life forms on Earth is evidenced by the fact that amino acids found in living cells ...
- use a different set of amino acids, depending on what branch of the tree of life they are on.
 - are all left-handed molecules
 - are an equal mixture of left-handed and right-handed molecules.
 - are all right-handed molecules.
 - are an unequal mixture of left-handed and right-handed molecules, right-handed being most abundant.
21. ____ % of the base pairs in the DNA of a typical bacterium actually code for genes; ____ % of the base pairs in human DNA actually code for genes.
- 100; 100
 - 90; 90
 - 90; 2
 - 2; 90
 - 2; 2
22. What gas molecule would you look for in the spectrum of the atmosphere of a terrestrial-type exoplanet, if you wanted to find evidence for photosynthetic life, such as we have on the Earth?
- ozone, O_3
 - carbon dioxide, CO_2
 - methane, CH_4
 - nitrogen, N_2
 - hydrogen, H_2
23. Replacing the -H at the end of a hydrocarbon chain like ethane, with an -OH results in:
- alcohol
 - propane
 - water
 - methane
 - no stable molecule we know of

24. Mammalian chromosomes are found only in the _____ of the cell.
- a. cytoplasm
 - b. ribosomes
 - c. nucleus
 - d. mitochondria
 - e. chloroplasts
25. Detecting new extrasolar planets by observing a transit event involves which of the following?
- a) detecting regular changes in the positions of the parent stars with respect to more distant stars as the parent stars move in response to the planet's gravity
 - b) detecting Doppler shifts in the spectra of the parent stars
 - c) observing a large field of stars and finding instances of a temporary diminution of a star's brightness as a planet passes in front of it
 - d) direct detection of reflected starlight
 - e) observing a large field of stars and finding instances of a temporary increase in a star's brightness as a star or planet passes in front of it
26. We believe the mitochondrion originated as a separate free-living bacterium which got engulfed by a cell because:
- a. mitochondria perform photosynthesis
 - b. mitochondria in animals and plants use different chemicals and different reactions to produce energy
 - c. mitochondria have their own separate DNA different from that of the cell
 - d. there is always only one mitochondrion per cell
 - e. today eating mitochondria is a major food source for animals
27. Why is the 'continuously habitable zone' around a star smaller than the habitable zone that is around it at this moment?
- a. planets are constantly expanding or contracting their orbits
 - b. the star becomes brighter over time, rendering the inner part of its habitable zone UN-inhabitable (too hot) later on
 - c. the star becomes dimmer over time, rendering the outer part of its habitable zone UN-inhabitable (too cold) later on
 - d. the habitable zone expands if fresh supplies of water ice are brought into the inner planetary system
 - e. WAIT! Actually, the habitable zone around a star maintains the same size until the star dies.

28. Phospholipids:

- a. are combinations of fatty acids and a PO_4 group
- b. are completely non-polar
- c. attract water molecules from any direction (ie., are always hydrophilic).
- d. cannot be used in any kind of cell membrane
- e. are the primary hormones and energy sources in cells

29. Which is the best definition of Darwinian fitness?

- a. The ability of a population to survive in any environment, compared to other populations.
- b. The ability of an individual to survive and reproduce in any potential environment, compared to other individuals of that population.
- c. The ability of an individual to kill its rivals.
- d. The ability of a species to survive in a certain environment, compared to other species.
- e. The ability of a species to survive over time, compared to other species.

30. Silicon has a chemistry similar to that of carbon, so why is it disfavored as a possible basis for life elsewhere?

- A. It is very rare compared to carbon.
- B. Silicon is a larger atom than carbon, so it takes up too much space inside the cell.
- C. Silicon forms weaker bonds with other atoms than carbon.
- D. Silicon dioxide is a rock (quartz), so its mobility is extremely limited, while carbon dioxide is a mobile gas.
- E. C and D

31. Atoms with a positive or negative electrical charge are:

- A. isotopes
- B. microwaves
- C. ions
- D. neutrons
- E. protons

32. Which of the following situations involving a planet in a binary star system is potentially viable for habitability?
- A. A very close binary star system with a planet orbiting at a distance far larger than the separation of the binary stars.
 - B. A binary system in which the size of the planetary orbit is similar to the stellar separation.
 - C. A binary system in which the planet is orbiting just one of the stars, and the other star is much further away than the size of the planetary orbit.
 - D. A and C
 - E. None of the above - habitability is not possible in a binary system because the planetary orbits are necessarily chaotic.
33. Ionic bonds:
- A. Are what holds common table salt together
 - B. are always stronger than covalent bonds
 - C. are based on the strong and weak nuclear forces
 - D. are produced when two nuclei share a single electron
 - E. are what binds the electron to the proton in a single hydrogen atom
34. A pH of 6.5 is:
- A. Weakly acidic
 - B. Extremely basic
 - C. Weakly basic
 - D. Neutral
 - E. Extremely acidic
35. ATP stores energy by:
- a. attaching a glucose molecule to it
 - b. the work done overcoming electric repulsion, when a phosphate group is joined to ADP
 - c. absorbing photons
 - d. absorbing heat
36. The "s orbital" (zero angular momentum) is the innermost shell for an electron to orbit in. It is FULL when it contains how many electrons?
- a. 1
 - b. 2
 - c. 4
 - d. 8
 - e. 10

37. The two things that must always be on the end of an amino acid are:
- a. an NH_2 group and an OH group
 - b. an NH_2 group and a COOH group
 - c. an OH group and a COOH group
 - d. an NH_2 group and a PO_4 group
 - e. a COOH group and a PO_4 group
38. A "condensation reaction":
- a. produces messenger RNA from DNA
 - b. makes a long hydrocarbon chain
 - c. links the H from one molecule with the OH from another, joining them by releasing a water molecule
 - d. is the reason that ice floats on water
 - e. is, for example, when a sodium and a chlorine atom join up
39. Proteins:
- a. are only used to build structures or cause motion in cells
 - b. perform their functions by their 3-D shapes which are determined by how they are folded up
 - c. are long chains ("polymers") of carbohydrate molecules
 - d. are only produced inside the cell nucleus
 - e. are linked together in chains to form molecules of nucleic acid
40. The presence of a gas giant planet could indicate the presence of a habitable environment, even if it is well beyond its star's "habitable zone" because:
- a. the gas giant may have very large moons (like Ganymede), with atmospheres (like Titan) which could be habitable
 - b. in the cloud decks of the gas giant, ammonia and methane would make a habitable region
 - c. the gas giant may have nearby moons (like Europa and Enceladus), which could have habitable regions beneath their surfaces
 - d. far below the cloud decks of the gas giant, the high pressure makes a global ocean which could support life
41. Which of the following is characteristic of viruses?
- a. cannot reproduce themselves outside another living cell
 - b. contain nucleic acids (DNA and RNA) and proteins
 - c. form inert crystals under certain conditions
 - d. all of the above
 - e. none of the above
-

FIFTEEN (15) SHORT ANSWER QUESTIONS—3 points each

Try to use the space provided, if you need more, use the other side of the page, clearly indicating exactly where and what is part of your answer.

+2
42. How do "hot Jupiters" violate the predictions of the nebular hypothesis for the formation of planetary systems? What is the likely explanation for the existence of "hot Jupiters"?

The nebular hypothesis posits that gas giants should exist further away from stars than commonly observed, because it is there that they can pick up ice and enough mass to attract hydrogen and helium. ~~So the~~ likely explanation for hot Jupiters is that as they gather mass in a protoplanetary disk, the mass on the inner part of the disk tugs them inward; thus they migrate from where they originally form.

+3
43. Name and explain 3 differences between prokaryotic and eukaryotic cells.

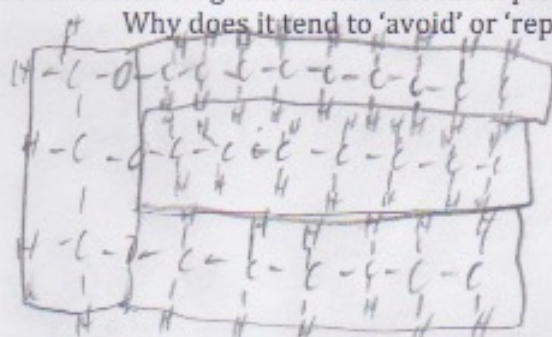
Prokaryotic cells have free floating RNA, whereas the DNA of eukaryotic cells is enclosed within the nucleus protecting it. This is an upgrade because it protects the DNA. Also, prokaryotes do not have organelles, whereas eukaryotes do, meaning that eukaryotes are more compartmentalized. Prokaryotes can only exist as a single cell, whereas eukaryotes can form more complex systems due to their organelles, and this helps to create plants and animals.

+2
44. What is the general chemical formula for a carbohydrate?

In order to have a carbohydrate, we must have $C_2H_2O_2$ and this is closely related to photosynthesis, because it uses both H_2O and CO_2

45. Use a labeled diagram to show the main pieces of a triglyceride.
Why does it tend to 'avoid' or 'repel' water?

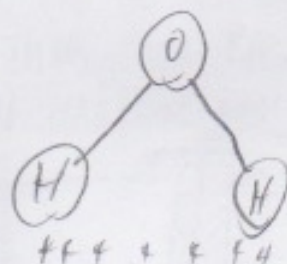
3



you have your fatty acids at the top and then long glyceride chains.
It's hydrophobic because it's nonpolar.

46. Draw a schematic diagram of a water molecule, showing where the positive and negative charge excesses tend to be found.

3

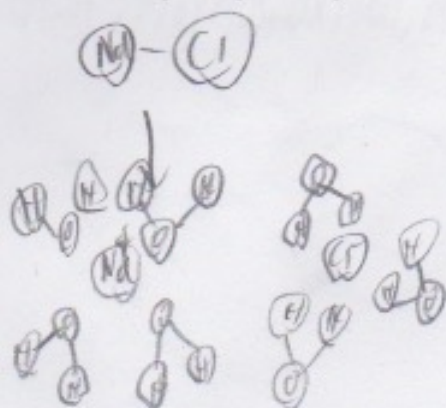


because of the covalent bond in water,
oxygen holds electrons closer to it,
so the hydrogen end tends to be more
positive, and the oxygen more negative.

47. Why did it make an important difference during its evolution whether the Earth's surface had too little land, or too much?

early earth's surface was important because it determined
the rate of CO_2 capture from the air. The more land, the
more CO_2 capture from continental limestone, so if we had had
large continents early on, the earth would have been too cold.

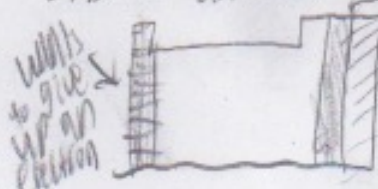
48. Show an atomic-scale schematic diagram of how water molecules can dissolve a salt crystal (of NaCl).



3

49. Explain the fundamental factor that makes the Periodic Table, ...periodic. A labeled diagram should help.

The periodicity of the periodic table is closely related to the Pauli exclusion principle and the fact that only so many electrons can take up a given orbital. Thus some elements want to give up an electron to fill up last orbital and some want to gain some.



2.5

50. Explain 3 differences between RNA and DNA

RNA is only a single helix, whereas DNA is a double helix and that's because DNA has rungs of 2 nitrogenous bases, where RNA only has one. Also instead of cytosine, RNA has uracil, which is very similar, perhaps bridging the evolutionary gap between the two. DNA has hydrogen bonds that can be broken apart easily, but also hold together, where RNA does not have those hydrogen bonds.

51. What are the 4 most common elements which make up all living things (half point each, total of 2 points).

Carbon, Hydrogen, Oxygen, and Nitrogen

2

52. What was the main idea of Lamarck's theory of evolution, and how/why is it wrong?

Lamarck's theory of evolution proposed that organisms "try very hard" over their lifetimes to become better, and by doing so are able to pass on their skills to the next generation but this is wrong because this information is not encoded in our genes. Excluding cultural means, our knowledge dies with us.

3

53. Give three advantages that water has over other potential liquids as a medium for harboring life.

Water has a high heat capacity - can absorb tons of heat
Water is a great solvent - making it convenient to store ions and different organic molecules in
Water is less dense as a solid - ice then floats meaning that oceans aren't frozen through, and life can exist beneath the surface.

3

54. Name and explain 3 differences between plant cells and animal cells.

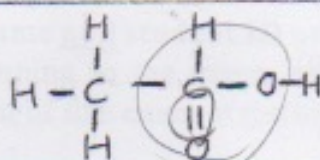
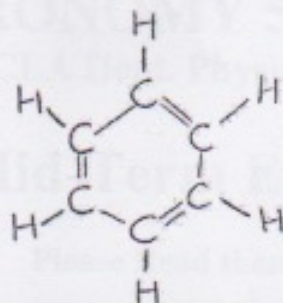
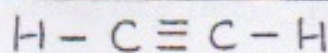
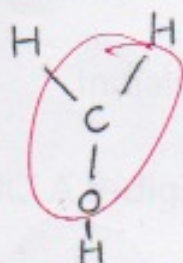
- cell walls
- plant cells are rigid in structure because they use the carbohydrate cellulose for their structure, whereas animal cells are more flexible.
 - plant cells perform photosynthesis to get energy where animal cells perform glycolysis, breaking down the products of photosynthesis. plant cells also have an additional organelle, chloroplast, which is used to perform photosynthesis.

15

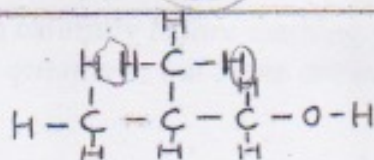
55. MOLECULAR DETECTIVE.

Three of these 5 schematic diagrams below show real molecules that are stable and electrically neutral. TWO, however, are fakes that I made up.

Spot the fakes and show me HOW YOU FIGURED THAT OUT.



Carbon can form at most 4 bonds



these two areas would repel each other