

ROUND 13A

TOSS-UP

1) Biology – *Short Answer* What photosynthetic pathway, named after its discoverers, is also known as the light-independent pathway?

ANSWER: CALVIN-BENSON CYCLE (ACCEPT: CALVIN CYCLE)

BONUS

1) Biology – *Multiple Choice* Which of the following would be the most likely explanation for hypothyroidism in a patient whose iodine level is normal?

- W) Disproportionate production of T3 to T4
- X) Hyposecretion of TSH
- Y) Hypersecretion of TSH
- Z) Hypersecretion of MSH

ANSWER: X) HYPOSECRETION OF TSH

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### TOSS-UP

2) Energy – *Short Answer* What is the name of the compound in which methane is sequestered into water-ice, forming a crystal structure in which water molecules create a cage for a single methane molecule?

ANSWER: METHANE CLATHRATE (ACCEPT: METHANE HYDRATE, HYDROMETHANE, METHANE ICE, FIRE ICE, NATURAL GAS HYDRATE, AND GAS HYDRATE)

### BONUS

2) Energy – *Short Answer* In fluorescent tube lamps, what element forms a vapor inside of the tube that produces the short-wave ultraviolet light when excited by electricity?

ANSWER: MERCURY

### TOSS-UP

3) Math – *Short Answer* What adjective describes two angles that sum to 180 degrees?

ANSWER: SUPPLEMENTARY

### BONUS

3) Math – *Multiple Choice* What transformation occurs in going from the graph of  $f(x) = 0.5x^2 + x$  to the graph of  $g(x) = 0.5x^2 - x$ ?

- W) Horizontal shift right by 1 unit
- X) Horizontal shift left by 1 unit
- Y) Horizontal shift right by 2 units
- Z) Horizontal shift left by 2 units

ANSWER: Y) HORIZONTAL SHIFT RIGHT BY 2 UNITS

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TOSS-UP

4) Chemistry – *Multiple Choice* Consider a reaction vessel at equilibrium where gaseous oxygen and fluorine are reacting to generate liquid oxygen difluoride. The enthalpy of formation of oxygen difluoride is positive. Which of the following perturbations would increase the yield of oxygen difluoride?

- W) Increasing the volume of the reaction vessel
- X) Increasing the temperature of the reaction vessel
- Y) Increasing the pressure of the reaction vessel by adding helium gas
- Z) Removing oxygen gas from the reaction vessel

ANSWER: X) INCREASING THE TEMPERATURE OF THE REACTION VESSEL

BONUS

4) Chemistry – *Multiple Choice* Which of the following statements concerning lattice enthalpies is not true?

- W) Increasing ion size will produce a larger lattice enthalpy
- X) Cations and anions that are more highly charged will produce larger lattice enthalpies
- Y) Lattice enthalpy correlates with the percentage ionic character of a compound
- Z) Lattice enthalpies can be calculated by summing up electrostatic interactions between all pairs of ions

ANSWER: W) INCREASING ION SIZE WILL PRODUCE A LARGER LATTICE ENTHALPY

TOSS-UP

5) Earth and Space – *Multiple Choice* Which of the following is a reasonable conclusion from the observation that particles found in the Sun's chromosphere are more ionized than ions found in the photosphere?

- W) The photosphere and the chromosphere are composed of different ions
- X) The chromosphere is hotter than the photosphere
- Y) The photosphere is magnetically opposite the chromosphere
- Z) The chromosphere is cooler than the photosphere

ANSWER: X) THE CHROMOSPHERE IS HOTTER THAN THE PHOTOSPHERE

BONUS

5) Earth and Space – *Multiple Choice* What forces maintain neutron stars against gravitational collapse?

- W) Electromotive forces
- X) Frictional forces
- Y) Intermolecular forces
- Z) Nuclear forces

ANSWER: Z) NUCLEAR FORCES

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### TOSS-UP

6) Physics – *Short Answer* What scientist disproved the corpuscular theory of light with his 1801 double-slit experiment, lending credence to the wave model of light?

ANSWER: THOMAS YOUNG

### BONUS

6) Physics – *Short Answer* Four 3-ohm resistors are connected to a 9-volt battery. Three of the resistors are connected in series, while the fourth is connected parallel to the other three. How many cumulative watts of power are dissipated by the four resistors at a given instant?

ANSWER: 36

### TOSS-UP

7) Energy – *Multiple Choice* Which of the following is a notorious poison for the platinum catalyst in a polymer electrolyte membrane fuel cell?

- W) Carbon monoxide
- X) Carbon dioxide
- Y) Carbonate
- Z) Nitrogen

ANSWER: W) CARBON MONOXIDE

### BONUS

7) Energy – *Multiple Choice* Which of the following is not true regarding coal?

- W) Coal is formed when dead plant matter is converted to peat, then lignite
- X) China produces the most coal worldwide
- Y) Natural gas releases more carbon dioxide per kilowatt-hour than coal
- Z) Anthracite can be converted to graphite under high pressure and temperature

ANSWER: Y) NATURAL GAS RELEASES MORE CARBON DIOXIDE PER KILOWATT-HOUR THAN COAL

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TOSS-UP

8) Biology – *Multiple Choice* Which of the following techniques would one use to separate proteins based on size?

- W) Polymerase chain reaction
- X) E. coli transduction
- Y) SDS-polyacrylamide gel electrophoresis [*el-ek-troh-fer-ee-sihs*]
- Z) Enzyme-linked immunoprecipitation

ANSWER: Y) SDS-POLYACRYLAMIDE GEL ELECTROPHORESIS

BONUS

8) Biology – *Multiple Choice* Which of the following is true regarding the phylum Cnidaria [*nihd-air-ee-uh*]?

- W) Cnidarians include organisms such as flatworms and tapeworms
- X) Cnidarians usually have a motile medusa form and a non-motile polyp form
- Y) Cnidarians form three germ layers during development, one of which forms the coelem
- Z) Gastropoda is a class within the phylum Cnidaria

ANSWER: X) CNIDARIANS USUALLY HAVE A MOTILE MEDUSA FORM AND A NON-MOTILE POLYP FORM

TOSS-UP

9) Chemistry – *Short Answer* Identify all of the following three compounds that have more ionic character than lithium chloride: 1) Lithium fluoride; 2) Rubidium fluoride; 3) Lithium bromide.

ANSWER: 1 AND 2

BONUS

9) Chemistry – *Multiple Choice* Which of the following is the name for the type of isomerism, which is a subset of stereoisomerism, describing compounds that interconvert by rotation of single bonds?

- W) Constitutional isomerism
- X) Cis-trans isomerism
- Y) Enantiomerism
- Z) Conformational isomerism

ANSWER: Z) CONFORMATIONAL ISOMERISM

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### TOSS-UP

10) Math – *Multiple Choice* Set  $q$  contains all irrational numbers  $r$  such that  $0 < r < 1$ . Which of the following is true about  $q$ ?

- W) It is an empty set
- X) It has a countably infinite number of elements
- Y) It has an uncountably infinite number of elements
- Z) It has a nonzero finite number of elements

ANSWER: Y) IT HAS AN UNCOUNTABLY INFINITE NUMBER OF ELEMENTS

### BONUS

10) Math – *Multiple Choice* Consider a criminal trial in which the defendant is innocent until proven guilty. If the jury accepts the null hypothesis when the defendant is innocent, which of the following has occurred?

- W) The jury made the right decision
- X) The jury committed a type I error
- Y) The jury committed a type II error
- Z) The jury committed a type III error

ANSWER: W) THE JURY MADE THE RIGHT DECISION

### TOSS-UP

11) Earth and Space – *Multiple Choice* What stars provide a distance scale to the galaxies?

- W) Quasars
- Y) Pulsars
- Y) Red Giants
- Z) Cepheid Variables

ANSWER: Z) CEPHEID VARIABLES

### BONUS

11) Earth and Space – *Multiple Choice* Under what circumstances could the relative humidity exceed 100% without producing condensation in the air?

- W) No condensation nuclei
- X) Low dew point temperature
- Y) Super-adiabatic lapse rate
- Z) Low absolute humidity

ANSWER: W) NO CONDENSATION NUCLEI

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TOSS-UP

12) Physics – *Short Answer* What law of physics can be used to calculate the coherent and incoherent scattering angles in an x-ray crystallography experiment?

ANSWER: BRAGG'S LAW

BONUS

12) Physics – *Short Answer* Identify all of the following 3 statements that are true of magnetism: 1) When magnetic field lines are far apart, the field magnitude is large; 2) One tesla is equal to one newton per ampere-meter; 3) A straight segment of a conductor carrying current I in a uniform magnetic field B experiences a force F that is parallel to B .

ANSWER: 2

TOSS-UP

13) Biology – *Short Answer* Testosterone and other androgens are produced by what specialized cells that populate the seminiferous tubules?

ANSWER: LEYDIG CELLS

BONUS

13) Biology – *Multiple Choice* Which of the following is not a medically relevant difference between eukaryotic cells and bacterial cells?

- W) Differences in ribosome structure
- X) Presence of peptidoglycan layer in bacteria
- Y) Differences in genetic code
- Z) Presence of lipopolysaccharides [*lye-poh-poly-sak-kar-ides*] in bacteria

ANSWER: Y) DIFFERENCES IN GENETIC CODE

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### TOSS-UP

14) Earth and Space – *Short Answer* What type of optical aberration is unique to refracting telescopes relative to reflecting telescopes?

ANSWER: CHROMATIC ABERRATION

### BONUS

14) Earth and Space – *Multiple Choice* There are caves found in Bend, Oregon, just east of Mt. Jefferson. Based on their location, what type of rocks do you suspect make up these caves?

- W) Sedimentary
- X) Intrusive Igneous
- Y) Extrusive Igneous
- Z) Metamorphic

ANSWER: Y) EXTRUSIVE IGNEOUS

### TOSS-UP

15) Math – *Short Answer* Consider two lists of numbers, A and B, each with mean 10, that have a correlation coefficient  $r$  equal to 0.5. If all members of A are multiplied by 4 and all members of B are reduced by 7, what is the value of  $r$  for the two new lists?

ANSWER: 0.5 (ACCEPT: IT STAYS THE SAME)

### BONUS

15) Math – *Short Answer* Simplify cosine open parenthesis  $x + \pi/3$  close parenthesis + sine open parenthesis  $x + \pi/6$  close parenthesis.

ANSWER:  $\cos x$

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TOSS-UP

16) Chemistry – *Multiple Choice* In the Bohr model of the hydrogen atom, the energies of the allowed electronic states are inversely proportional to which of the following?

- W) Planck's constant
- X) The spin quantum number
- Y) The principal quantum number
- Z) The square of the principal quantum number

ANSWER: Z) THE SQUARE OF THE PRINCIPAL QUANTUM NUMBER

BONUS

16) Chemistry – *Multiple Choice* Consider an arbitrary one-step polar reaction where an electrophile E and a nucleophile N react to form a single adduct. Let HOMO [*hoe-moe*] signify highest-occupied molecular orbital, and LUMO [*lou-moe*] signify lowest unoccupied molecular orbital. Which of the following is true?

- W) The HOMO of N interacts with the LUMO of E
- X) The HOMO of E interacts with the LUMO of N
- Y) The HOMO of N interacts with the HOMO of E
- Z) The LUMO of N interacts with the LUMO of E

ANSWER: W) THE HOMO OF N INTERACTS WITH THE LUMO OF E

TOSS-UP

17) Physics – *Short Answer* What theorem states that the only properties a black hole possesses are charge, angular momentum, and mass?

ANSWER: NO-HAIR THEOREM

BONUS

17) Physics – *Short Answer* The Young's modulus for bone is 9×10^9 newtons per meters squared. What is the percent change in length of a tibia with a cross sectional area of 6 centimeters squared, if it experiences a compressive force of 5.4×10^3 newtons?

ANSWER: 0.1%

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### TOSS-UP

18) Earth and Space – *Short Answer* What type of nebula is formed as a star ejects ionized gas after its evolution through the asymptotic giant branch phase?

ANSWER: PLANETARY NEBULA

### BONUS

18) Earth and Space – *Multiple Choice* What is the relationship between the ages of stellar populations and their scale heights above the galactic disk?

- W) Younger stellar populations have a larger scale height
- X) Scale height is independent of stellar population age
- Y) The oldest and youngest stellar populations have a larger scale height than populations of intermediate age
- Z) Younger stellar populations have a smaller scale height

ANSWER: Z) YOUNGER STELLAR POPULATIONS HAVE A SMALLER SCALE HEIGHT

### TOSS-UP

19) Energy – *Multiple Choice* Which of the following sectors of natural gas production is projected to have the largest increase over the next 20 years?

- W) Shale gas
- X) Coal-bed methane
- Y) Onshore reserves
- Z) Offshore reserves

ANSWER: W) SHALE GAS

### BONUS

19) Energy – *Multiple Choice* Which of the following stellar reactions would be the dominant pathway by which a star of similar mass as our Sun converts hydrogen to helium?

- W) Proton-proton chain
- X) Triple-alpha process
- Y) R-process
- Z) Silicon burning

ANSWER: W) PROTON-PROTON CHAIN

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TOSS-UP

20) Math – *Short Answer* If $f(x)$ equals the fraction with numerator 1 and denominator open parenthesis $2x - 1$ close parenthesis cubed, which of the following is the numerator in the expression for the derivative of f with respect to x :

- W) -6
- X) -3
- Y) 1
- Z) 2

ANSWER: W) -6

BONUS

20) Math – *Short Answer* Evaluate the limit as x approaches 1 of x raised to the fraction with numerator 1 and denominator $x - 1$.

ANSWER: e

TOSS-UP

21) Physics – *Short Answer* Identify all of the following three observations that implied that light is a form of electromagnetic radiation: 1) Michelson-Morley experiment; 2) Faraday effect; 3) Davisson-Germer experiment.

ANSWER: 2

BONUS

21) Physics – *Short Answer* Identify all of the following 3 statements that are true of polarization: 1) The transmitted intensity of the electromagnetic wave is inversely proportional to the square of the electric field; 2) The Brewster angle is the angle of incidence at which the reflected ray is 100% polarized along a plane parallel to the reflecting surface; 3) If a substance can rotate the plane of polarization, it is said to be optically active.

ANSWER: 2 AND 3

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### TOSS-UP

22) Biology – *Short Answer* What genetic analysis tool, freely available from the National Center for Biotechnology Information, allows visitors to compare DNA sequences for similarities?

ANSWER: NCBI BLAST (ACCEPT: BLAST)

### BONUS

22) Biology – *Short Answer* What type of microscopy uses a spatial pinhole and point illumination to eliminate out-of-focus light and is commonly used to visualize specimens thicker than the focal depth of the lens?

ANSWER: CONFOCAL MICROSCOPY

### TOSS-UP

23) Chemistry – *Short Answer* The elements of Group 15 can exist in several different oxidation states. What element can only exist in positive oxidation states?

ANSWER: BISMUTH

### BONUS

23) Chemistry – *Short Answer* Order the following three species from the lowest to highest bond order in MO theory: 1)  $B_2$ , 2)  $B_2^+$ , 3)  $B_2^-$ .

ANSWER: 2, 1, 3