

ROUND 4A

TOSS-UP

1) Biology – *Multiple Choice* The three-dimensional or folded shape of a protein is what hierarchical structure level?

- W) Primary
- X) Secondary
- Y) Tertiary
- Z) Quaternary

ANSWER: Y) TERTIARY

BONUS

1) Biology – *Multiple Choice* Which of the following is NOT a basis for assays to measure cell numbers or cell proliferation?

- W) Presence of cell proliferation antigens
- X) Rate of DNA replication
- Y) Rate of RNA replication
- Z) Measurement of ATP concentration

ANSWER: Y) RATE OF RNA REPLICATON

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### TOSS-UP

2) Energy – *Multiple Choice* Which of the following does not perform a chemical reaction during operation?

- W) Combustion engine
- X) Rocket engine
- Y) Batteries
- Z) Wind turbine

ANSWER: Z) WIND TURBINE

### BONUS

2) Energy – *Multiple Choice* Which of the following best explains why propane is stored in liquid form rather than as a gas?

- W) It is less flammable as a liquid
- X) It takes up much less space as a liquid
- Y) It is easier to burn as a liquid
- Z) It is a liquid at room temperature

ANSWER: X) IT TAKES UP MUCH LESS SPACE AS A LIQUID

**TOSS-UP**

3) Physics – *Multiple Choice* Which of the following thermodynamic properties is not a state function?

- W) Energy
- X) Enthalpy [*EN-thul-pee*]
- Y) Heat
- Z) Entropy [*EN-troh-pee*]

ANSWER: Y) HEAT

**BONUS**

3) Physics – *Short Answer* What principle in physics states that pressure changes on an incompressible, enclosed, static fluid are evenly distributed?

ANSWER: PASCAL'S LAW (ACCEPT: PASCAL'S OR PASCAL'S PRINCIPLE)



**TOSS-UP**

4) Earth and Space – *Multiple Choice* What type of metamorphism occurs when magma is injected into crustal rock and the heat of the intrusion causes the crustal rock to metamorphose?

- W) Contact
- X) Regional
- Y) Burial
- Z) Hydrothermal

ANSWER: W) CONTACT

**BONUS**

4) Earth and Space – *Short Answer* The volume of Lake Michigan is 5 times 10 to the 12 cubic meters. If the flow rate of water into Lake Michigan is 5 times 10 to the 10 cubic meters per year, how long, in years to one significant digit, is the residence time of water in lake Michigan?

ANSWER: 100

**TOSS-UP**

5) Chemistry – *Multiple Choice* Which of the following elements is the most electronegative?

- W) Beryllium
- X) Sodium
- Y) Calcium
- Z) Cesium

ANSWER: W) BERYLLIUM

**BONUS**

5) Chemistry – *Multiple Choice* Which of the following is an assumption of the ideal gas law?

- W) The volume of individual molecules is negligible compared to the volume of the container
- X) All molecules travel at the same velocity
- Y) Molecules only interact through dipole [*DYE-pole*]-dipole forces
- Z) Molecules do not collide with each other

ANSWER: W) THE VOLUME OF INDIVIDUAL MOLECULES IS NEGLIGIBLE COMPARED TO THE VOLUME OF THE CONTAINER



**TOSS-UP**

6) Math – *Short Answer* In a room of 12 people, two meet for a handshake. How many different such meetings could take place?

ANSWER: 66

**BONUS**

6) Math – *Short Answer* If  $x$  is inversely proportional to  $y^2$  and if  $x = 3$  when  $y = 4$ , what is the value of  $x$  when  $y = 6$ ?

Answer:  $4/3$  (ACCEPT:  $1\ 1/3$ )

**TOSS-UP**

7) Energy – *Multiple Choice* What nonrenewable energy source represents the greatest percentage of US energy consumption?

- W) Coal
- X) Natural gas
- Y) Propane
- Z) Petroleum

ANSWER: Z) PETROLEUM

**BONUS**

7) Energy – *Multiple Choice* According to the U.S. Energy Information Administration, which of the following sectors consumed the most energy in the United States in 2014?

- W) Commercial
- X) Residential
- Y) Transportation
- Z) Industrial

ANSWER: Z) INDUSTRIAL

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TOSS-UP

8) Math – *Short Answer* If a equals 6 cosine theta and b equals 6 sine theta, what is the square root of open parenthesis $a^2 + b^2$ close parenthesis?

ANSWER: 6

BONUS

8) Math – *Short Answer* What is the median of the set of the first 2017 even positive integers?

ANSWER: 2018

TOSS-UP

9) Chemistry – *Short Answer* How many d electrons are present in a cobalt ion in the +2 state?

ANSWER: 7

BONUS

9) Chemistry – *Short Answer* Rank the following four elements in terms of increasing melting point:

1) Boron; 2) Sodium; 3) Lithium; 4) Tungsten.

ANSWER: 2, 3, 1, 4 (ACCEPT: SODIUM, LITHIUM, BORON, TUNGSTEN)

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**TOSS-UP**

10) Biology – *Multiple Choice* In what part of a plant is the casparian strip located?

W) The bark

X) The stomatal guard cells

Y) The endodermis of the root

Z) The stem cortex

ANSWER: Y) THE ENDODERMIS OF THE ROOT

**BONUS**

10) Biology – *Short Answer* What type of symmetry do platyhelminths [*plat-ih-HELL-minths*] possess?

ANSWER: BILATERAL

**TOSS-UP**

11) Physics – *Short Answer* Given a graph with acceleration on the y-axis and time on the x-axis, what physical quantity does the area under the curve represent?

ANSWER: VELOCITY (ACCEPT: CHANGE IN VELOCITY)

**BONUS**

11) Physics – *Multiple Choice* If one left-circularly polarized laser beam and one right-circularly polarized laser beam with the same amplitude and frequency are combined into a single beam, what is the polarization of the resulting beam?

- W) Circular
- X) Elliptical
- Y) Linear
- Z) Unpolarized

ANSWER: Y) LINEAR



**TOSS-UP**

12) Earth and Space – *Multiple Choice* Which of the following minerals is not a carbonate?

- W) Rhodochrosite
- X) Fluorite
- Y) Azurite
- Z) Calcite

ANSWER: X) FLUORITE

**BONUS**

12) Earth and Space – *Short Answer* A star has five times the radius of the Sun, and the temperature in kelvins of its surface is twice that of the Sun. How many times as luminous as the Sun is it?

ANSWER: 400

### TOSS-UP

13) Math – *Short Answer* How many faces does a hexagonal pyramid have?

ANSWER: 7

### BONUS

13) Math – *Short Answer* Two dice are rolled. What is the probability that the results are the same or that the sum is 8?

ANSWER: 5/18

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TOSS-UP

14) Energy – *Multiple Choice* DOE researchers are studying unique chemical bonds formed by interactions between lithium cations [*CAT-eye-onz*] and organo-aluminum compounds. Which of the following bonds are formed by these interactions?

- W) Two-center one-electron bonds
- X) Two-center two-electron bonds
- Y) Three-center two-electron bonds
- Z) Four-center one-electron bonds

ANSWER: Y) THREE-CENTER TWO-ELECTRON BONDS

BONUS

14) Energy – *Short Answer* Identify all of the following three statements that are true regarding ethanol fuel: 1) E15 is a renewable fuel; 2) Ethanol blender pumps are most commonly found in the Midwest; 3) E15 produces less carbon monoxide emissions than pure gasoline.

ANSWER: 2 AND 3

TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following materials would make the best aquitard?

- W) Sand
- X) Limestone
- Y) Clay
- Z) Gravel

ANSWER: Y) CLAY

BONUS

15) Earth and Space – *Multiple Choice* Which of the following statements is NOT true regarding neutron stars?

- W) They are supported by electron degeneracy pressure
- X) Pulsars are thought to be a type of neutron star
- Y) After initial neutrino burn-off, neutron stars cool slowly due to their small surface area
- Z) The center of the Crab Nebula is a neutron star

ANSWER: W) THEY ARE SUPPORTED BY ELECTRON DEGENERACY PRESSURE

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**TOSS-UP**

16) Biology – *Short Answer* What type of muscle is found in the intestinal wall?

ANSWER: SMOOTH (ACCEPT: SMOOTH MUSCLE)

**BONUS**

16) Biology – *Multiple Choice* Metallothionein [*meh-talloh-THIGH-uh-nin*] is a protein that has been engineered into rice in order to promote iron uptake in the small intestine. This is because iron uptake requires which of the following elements?

- W) Phosphorus
- X) Selenium
- Y) Sulfur
- Z) Chlorine

ANSWER: Y) SULFUR

### TOSS-UP

17) Physics – *Multiple Choice* A 10,000-kilogram truck is rolling at 2 meters per second when 5000 kilograms of cargo is dropped into it. Which of the following, in meters per second, is closest to the truck's speed afterwards?

- W) 1
- X) 1.3
- Y) 1.5
- Z) 2

ANSWER: X) 1.3

### BONUS

17) Physics – *Short Answer* Identify all of the following three statements that are true of light: 1) Diffraction is an example of the wave-nature of light; 2) Interference is an example of the wave-nature of light; 3) The energy carried by light is directly proportional to frequency.

ANSWER: ALL (ACCEPT: 1, 2, 3)

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TOSS-UP

18) Chemistry – *Multiple Choice* What is the most likely type of interaction between the side chains of the amino acids leucine [*LOO-seen*] and phenylalanine [*Fennel-AL-ah-neen*]?

- W) Ionic
- X) Hydrophobic
- Y) Hydrogen bonding
- Z) Dipole [*DYE-pole*]-dipole

ANSWER: X) HYDROPHOBIC

BONUS

18) Chemistry – *Short Answer* Consider the SN2 reaction of 1-chloropentane with the azide [*AY-zide*] ion. What is the LUMO [*LOO-mo*] of the electrophile in this reaction?

ANSWER: SIGMA-STAR ORBITAL (ACCEPT SIGMA-STAR C-Cl ORBITAL, SIGMA ANTIBONDING C-Cl ORBITAL)

TOSS-UP

19) Earth and Space – *Short Answer* Which of the four terrestrial planets is most unlike the others in density?

ANSWER: MARS

BONUS

19) Earth and Space – *Multiple Choice* What phenomenon is believed to be the main driver in the accelerated expansion of the universe?

- W) Dark matter
- X) Black hole evaporation
- Y) Dark energy
- Z) Quantum gravity

ANSWER: Y) DARK ENERGY

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### TOSS-UP

20) Chemistry – *Short Answer* Identify all of the following three statements concerning enthalpy [*EN-thul-pee*] that are TRUE: 1) The enthalpy [*EN-thul-pee*] of formation of diamond is equal to zero; 2) The enthalpy change of an isothermal contraction is less than zero; 3) The enthalpy of solution of ammonium nitrate is greater than zero.

ANSWER: 3

### BONUS

20) Chemistry – *Short Answer* Identify all of the following three compounds that have a standard enthalpy of formation of zero: 1) Ozone; 2) Diamond; 3) Rhombic sulfur.

ANSWER: 3

**TOSS-UP**

21) Physics – *Short Answer* In a viscous fluid, what is the type of flow characterized by having layers of currents that are all parallel to the flow?

ANSWER: LAMINAR (ACCEPT: STREAMLINE)

**BONUS**

21) Physics – *Short Answer* An ideal pendulum has a period of 1 second. If its mass is multiplied by 3 and its length is multiplied by 4, in seconds, what is the new period of the pendulum?

ANSWER: 2

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TOSS-UP

22) Math – *Short Answer* What is 4 times 3 squared?

ANSWER: 36

BONUS

22) Math – *Short Answer* Johnny is asked by his teacher to subtract 4 from a number and multiply the result by 5. Instead, he subtracts 5 and then multiplies the result by 4, giving him 168. What is the correct answer to the teacher's question?

ANSWER: 215

TOSS-UP

23) Biology – *Short Answer* What type of cells are found in the lacunae [*lah-KOO-nay*] of cartilage?

ANSWER: CHONDROCYTES

BONUS

23) Biology – *Short Answer* Identify all of the following three cell types that are leukocytes [*LOO-koh-sites*]:

1) Eosinophil [*ee-oh-SIN-oh-fil*]; 2) Basophil [*BAY-zoh-fil*]; 3) Erythrocyte [*eh-RITH-roh-site*].

ANSWER: 1 AND 2