

## ROUND 10A

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### TOSS-UP

1) CHEMISTRY *Short Answer* Rank the following three acids from strongest to weakest: iodous [*eye-OH-duhs*] acid, bromic acid, bromous acid.

ANSWER: BROMIC ACID, BROMOUS ACID, IODOUS ACID

### BONUS

1) CHEMISTRY *Multiple Choice* Like many thermodynamic quantities, the critical temperature of a substance is strongly dependent on the intermolecular forces present. Which of the following compounds has the highest boiling point?

- W) N<sub>2</sub>
- X) H<sub>2</sub>S
- Y) CO<sub>2</sub>
- Z) CH<sub>4</sub>

ANSWER: X) H<sub>2</sub>S

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### TOSS-UP

2) MATH *Short Answer* What is the absolute value of the difference between the arithmetic mean and the positive geometric mean of the numbers 1 and 25?

ANSWER: 8

### BONUS

2) MATH *Short Answer* In a collection of red, blue, and green marbles, there are 25% more red marbles than blue marbles, and there are 60% more green marbles than red marbles. If there are 50 red marbles, what is the total number of marbles in the collection?

ANSWER: 170

### TOSS-UP

3) PHYSICS *Multiple Choice* A stone is dropped out of a horizontally moving train. Which of the following is the shape of the path that the stone follows before hitting the ground?

- W) Straight line
- X) Circular
- Y) Hyperbolic
- Z) Parabolic

ANSWER: Z) PARABOLIC

### BONUS

3) PHYSICS *Short Answer* If in a given DC circuit we double the voltage and halve the resistance, by what factor will the power be multiplied?

ANSWER: 8

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### TOSS-UP

4) EARTH AND SPACE *Multiple Choice* Which of the following metamorphic products forms from impact metamorphism?

- W) Stishovite [**STISH-uh-vyt**]
- X) Eclogite [**EK-luh-jyt**]
- Y) Zeolite [**ZEE-uh-lyt**]
- Z) Phyllite [**FIL-yt**]

ANSWER: W) STISHOVITE

### BONUS

4) EARTH AND SPACE *Short Answer* You find a white or clear mineral in massive form. What characteristic will diagnostically distinguish whether that mineral is calcite, quartz, or halite?

ANSWER: HARDNESS

### TOSS-UP

5) CHEMISTRY *Multiple Choice* Which of the following fatty acids has the highest melting point?

- W) Capric
- X) Stearic [**stee-AR-ik**]
- Y) Palmitic
- Z) Lauric

ANSWER: X) STEARIC

### BONUS

5) CHEMISTRY *Short Answer* An unknown gas effuses through a tiny hole at a rate half that of methane. The molar mass of methane is 16 grams per mole. What is the molar mass of the unknown gas in grams per mole to the nearest whole number?

ANSWER: 64

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### TOSS-UP

6) BIOLOGY *Short Answer* What is the defining functional structure of the kidney?

ANSWER: THE NEPHRON

### BONUS

6) BIOLOGY *Multiple Choice* Which of the following techniques would you use to determine the 3-D structure of a protein?

- W) Mass spectrophotometry
- X) Nuclear magnetic resonance
- Y) X-ray crystallography [**kris-tl-OG-ruh-fee**]
- Z) Atomic absorption spectroscopy

ANSWER: Y) X-RAY CRYSTALLOGRAPHY

### TOSS-UP

7) ENERGY *Multiple Choice* Which of the following statements is NOT true regarding solar cookers?

- W) Solar cookers that contain parabolic reflectors can cause fires
- X) Their use is limited by the weather
- Y) They do not reach high enough temperatures to sterilize water
- Z) They use no fuel

ANSWER: Y) THEY DO NOT REACH HIGH ENOUGH TEMPERATURES TO STERILIZE WATER

### BONUS

7) ENERGY *Short Answer* Rank in descending order the coercive force typical for the following three materials: 1) pure iron; 2) rare earth magnet; 3) hard steel.

ANSWER: RARE EARTH MAGNET, HARD STEEL, PURE IRON (ACCEPT: 2, 3, 1)

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### TOSS-UP

8) EARTH AND SPACE *Short Answer* During which two months is the apparent motion of the Sun in the sky greatest?

ANSWER: DECEMBER AND JANUARY

### BONUS

8) EARTH AND SPACE *Multiple Choice* Which of the following environments would form foliated metamorphic rock?

- W) At a passive margin
- X) In a continental craton
- Y) At the surface of an active volcano
- Z) In the accretionary [*uh-kree-shun-UH-ri*] wedge above a subducting plate

ANSWER: Z) IN THE ACCRETIONARY WEDGE ABOVE A SUBDUCTING PLATE

### TOSS-UP

9) MATH *Short Answer* Set  $Q$  contains all positive integers that are the differences of squares of consecutive prime numbers. What is the smallest element of  $Q$  that is greater than or equal to 10?

ANSWER: 16

### BONUS

9) MATH *Short Answer* If the line  $y = \frac{1}{2}x + 5$  [***y equals half x plus five***] is rotated 270 degrees clockwise around its x-intercept, what is the equation of its image?

ANSWER:  $y = -2x - 20$

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### TOSS-UP

10) BIOLOGY *Multiple Choice* Which of the following is NOT true when comparing the 4 steps of aerobic respiration to the 2 steps of anaerobic respiration?

W) Both utilize compounds other than glucose, such as lipids, for energy

X) Both recycle NADH [***N-A-D-H***] to NAD<sup>+</sup> [***N-A-D plus***]

Y) Both have steps occurring in the cytoplasm

Z) Only one produces pyruvate [***py-ROO-vayt***]

ANSWER: Z) ONLY ONE PRODUCES PYRUVATE

### BONUS

10) BIOLOGY *Short Answer* Identify all of the following four choices that would NOT be visible under a standard laboratory light microscope when visualizing a plant cell: 1) nucleus; 2) mRNA [***M-R-N-A***]; 3) cell wall 4) chloroplast.

ANSWER: 2 (ACCEPT: mRNA)

### TOSS-UP

11) CHEMISTRY *Multiple Choice* The most accurate Lewis structure of phosphoric acid had one hydrogen atom bonded directly to the central phosphorous atom and two bonded to oxygen atoms. Given this information, which of the following terms best describes how phosphoric acid actually behaves in water?

- W) Monoprotic
- X) Diprotic
- Y) Triprotic
- Z) Amphiprotic [*am-fi-PRUH\_tik*]

ANSWER: X) DIPROTIC

### BONUS

11) CHEMISTRY *Short Answer* Identify all of the following compounds that will dissolve in water in an endothermic fashion: 1) ammonium nitrate; 2) sodium hydroxide; 3) sulfuric acid.

ANSWER: 1 (ACCEPT: AMMONIUM NITRATE)

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### TOSS-UP

12) Physics *Multiple Choice* What is the magnitude of the force, in newtons, experienced by a 1 coulomb charge travelling 10 meters per second at a 30-degree angle with respect to a uniform magnetic field of magnitude 0.1 tesla?

- W) 0.5
- X) 1
- Y) 10
- Z) 100

ANSWER: W) 0.5

### BONUS

12) PHYSICS *Short Answer* Indicate, by number, all of the following three statements that explain why the actual acceleration due to gravity at any point on the Earth's surface would be different from the value calculated for that point using Newton's law of gravitation: 1) The earth's mass is not uniformly distributed; 2) The earth is not perfectly spherical; 3) The earth is rotating.

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

### TOSS-UP

13) EARTH AND SPACE *Short Answer* What kind of tectonic setting created the Ural Mountains [**YOOR-uhl**]?

ANSWER: CONTINENT-CONTINENT CONVERGENT MARGIN (ACCEPT: CONTINENT-CONTINENT CONVERGENT BOUNDARY OR CONTINENT-CONTINENT CONVERGENCE)

### BONUS

13) EARTH AND SPACE *Multiple Choice* Why does shale split along planes?

- W) Compression during burial aligns mineral grains in planes
- X) Shale is composed of equidimensional grains
- Y) Shale contains large mineral grains
- Z) Ionic bonds between the planes are weaker than covalent bonds within the planes

ANSWER: W) COMPRESSION DURING BURIAL ALIGNS MINERAL GRAINS IN PLANES

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### TOSS-UP

14) BIOLOGY *Multiple Choice* In photosynthesis, where do electrons derived from water first enter the process?

- W) Photosystem II reaction center
- X) Photosystem I reaction center
- Y) Both light-harvesting complexes
- Z) P700 chlorophylls

ANSWER: W) PHOTOSYSTEM II REACTION CENTER

### BONUS

14) BIOLOGY *Multiple Choice* What location in a seed is equivalent to the embryonic leaf?

- W) Radicle
- X) Cotyledon [**kat-uhl-EED-uhn**]
- Y) Hypocotyl [**hy-puh-KOT-l**]
- Z) Epicotyl [**ep-i-KOT-l**]

ANSWER: X) COTYLEDON

### TOSS-UP

15) CHEMISTRY *Multiple Choice* Which of the following instruments would most likely be used in a lab to measure the concentration of a species in aqueous **[AK-wee-uhs]** solutions?

- W) Infrared spectrometer
- X) Mass spectrometer
- Y) Spectrophotometer
- Z) Buchner funnel

ANSWER: Y) SPECTROPHOTOMETER

### BONUS

15) CHEMISTRY *Short Answer* In a standard cell, a zinc electrode placed in a 1 molar  $Zn^{2+}$  solution is connected to a nickel electrode placed in a 1 molar  $Ni^{2+}$  solution. The 2 solutions are connected with a salt bridge. The standard reduction potential of  $Zn^{2+}$  **[Z-N two plus]** is -0.76 Volts. If the standard electromotive force of this cell is +0.48 Volts, what is the standard reduction potential of  $Ni^{2+}$  **[N-i two plus]** in volts?

ANSWER: -0.28

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### TOSS-UP

16) ENERGY *Multiple Choice* Converting a power generating plant from coal to natural gas will reduce sulfur emissions by approximately which of the following percentages?

- W) 20%
- X) 50%
- Y) 70%
- Z) 90%

ANSWER: X) 50%

### BONUS

16) ENERGY *Short Answer* Identify all of the following four compounds that can be metabolized by humans to produce ATP: 1) maltose; 2) cellobiose **[sel-oh-BY-ohs]**; 3) glutamine **[GLOO-tuh-meem]**; 4) palmitate **[PAL-mi-tayt]**.

ANSWER: 1, 3 AND 4 (ACCEPT: MALTOSE, GLUTAMINE AND PALMITATE)

### TOSS-UP

17) MATH *Short Answer* The value of  $a^2 - 2b^2 + c^2$  [***a squared minus two b squared plus c squared***], where  $a$ ,  $b$ , and  $c$  are consecutive odd integers in increasing order, is a constant. What is it?

ANSWER: 8

### BONUS

17) MATH *Short Answer* What is the largest prime factor of the quantity  $5^{2014} + 5^{2015} + 5^{2016}$  [***five to the power of two thousand and fourteen plus five to the power of two thousand and fifteen plus five to the power of two thousand and sixteen***]?

ANSWER: 31

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### TOSS-UP

18) BIOLOGY *Multiple Choice* In the spring of 2013 a group of researchers from the University of Alberta were able to revive an organism that had been trapped in glacial ice for approximately 400 years. What was the organism?

- W) An insect
- X) An ameba
- Y) A bryophyte [***BRY-uh-fyt***]
- Z) A tardigrade [***TAHR-di-grayd***]

ANSWER: Y) A BRYOPHYTE

### BONUS

18) BIOLOGY *Short Answer* Chemoautotrophs [***kee-moh-AW-tuh-trofs***] produce energy by oxidizing inorganic substances in their surroundings. Name all of the domains that include organisms with chemoautotrophic metabolisms.

ANSWER: BACTERIA AND ARCHAEA

### TOSS-UP

19) PHYSICS *Short Answer* What type of radiation, also known as braking radiation, is emitted whenever a charged particle is deflected by another charged particle?

ANSWER: BREMSSTRAHLUNG RADIATION

### BONUS

19) PHYSICS *Multiple Choice* Which of the following was the cause of the collapse of the Tacoma Narrows suspension bridge in 1940?

- W) Aeroelastic flutter causing standing wave oscillations
- X) Too much weight passing over the center of the bridge
- Y) Bolt snapping due to mechanical resonance caused by marching soldiers
- Z) Iron beams cracking and failing

ANSWER: W) AEROELASTIC FLUTTER CAUSING STANDING WAVE OSCILLATIONS

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### TOSS-UP

20) ENERGY *Multiple Choice* Often, investors in energy projects will use a discount rate to evaluate the net present value of future energy sales. If analysts decided to change the discount rate of a wind project from 3% to 7%, how would the net present value of future energy from the project change given constant supply and market costs?

- W) Decrease
- X) Increase
- Y) Stay the same
- Z) Depends on consumption

ANSWER: W) DECREASE

### BONUS

20) ENERGY *Short Answer* In the uranium fuel cycle, yellowcake Uranium is converted into what gas, which is then shipped to a gaseous diffusion plant for enrichment?

ANSWER: URANIUM HEXAFLUORIDE

### TOSS-UP

21) MATH *Multiple Choice* If the equation  $x^2 - 2Kx + 9 = 0$  [***x squared minus two K x plus nine equals zero***] has two equal roots, which of the following is a possible value of K?

- W) -3
- X) -1
- Y) 2
- Z) 4

ANSWER: W) -3

### BONUS

21) MATH *Short Answer* Consider the number 144 written in base  $x$ , where  $x$  is a positive integer. Indicate all of the following three values for  $x$  where 144 base  $x$  is a perfect square: 5, 8, 12.

ANSWER: 5, 8, 12 (ACCEPT: ALL OF THEM)

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### TOSS-UP

22) CHEMISTRY *Multiple Choice* Which of the following pairs does NOT correctly match the raw material and feedstock with its primary petrochemical?

- W) Natural gas with methanol
- X) Ethane with ethylene [***ETH-uh-leen***]
- Y) Propane with cyclopropane
- Z) Naphtha with benzene

ANSWER: Y) PROPANE WITH CYCLOPROPANE

### BONUS

22) CHEMISTRY *Short Answer* An ideal gas is confined to an airtight piston that allows the gas to expand and contract but prevents gas from entering or exiting the piston. Initially, the temperature of the gas is 300 Kelvin, and the gas occupies a volume of 10 Liters when an external pressure of 1 atmosphere is applied. The gas is then heated to 600 Kelvin, and the pressure is increased to 5 atmospheres. To one significant figure, what is the new volume of the gas in liters?

ANSWER: 4 liters

### TOSS-UP

23) BIOLOGY *Multiple Choice* A decrease in which of the following would NOT result in a decrease in blood pressure?

- W) Heart rate
- X) Diameter of arterioles [*ahr-TEER-ee-ohls*]
- Y) Cardiac output
- Z) Stroke volume

ANSWER: X) DIAMETER OF ARTERIOLES

### BONUS

23) BIOLOGY *Multiple Choice* Which of the following is true regarding the major difference between cellulose and glycogen [*GLY-kuh-juhn*]?

- W) Cellulose is a polymer of galactose [*guh-LAK-thos*], while glycogen is a polymer of glucose
- X) Cellulose is mostly found in animal cells, while glycogen is mostly found in plant cells
- Y) Cellulose consists of beta glycosidic [*gly-kuh-SY-dik*] linkages, while glycogen consists of alpha glycosidic linkages
- Z) Cellulose is highly branched, while glycogen is linear

ANSWER: Y) CELLULOSE CONSISTS OF BETA GLYCOSIDIC LINKAGES, WHILE GLYCOGEN CONSISTS OF ALPHA GLYCOSIDIC LINKAGES