

HIGH SCHOOL - ROUND 7A

TOSS-UP

1) Biology – *Short Answer* In what organelle does the Calvin cycle occur?

ANSWER: CHLOROPLAST

BONUS

1) Biology – *Short Answer* In humans, the inactive X chromosome condenses into a compact structure called what?

ANSWER: BARR BODY

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### TOSS-UP

2) Earth and Space – *Short Answer* What is the term for areas of the ocean floor that are relatively flat and found 5 to 6 kilometers below sea level?

ANSWER: ABYSSAL PLAINS

### BONUS

2) Earth and Space – *Multiple Choice* If a metamorphic rock was subjected to high temperature and pressure deep in the crust long enough to reach equilibrium with its environment, which of the following would be most useful for determining the temperature and pressure range at which it formed?

- W) Elemental analysis
- X) Mineralogical analysis
- Y) Grain-size analysis
- Z) Stress-strain analysis

ANSWER: X) MINERALOGICAL ANALYSIS

### TOSS-UP

3) Energy – *Short Answer* Scientists at the National Energy Technology Lab have been working with ION in Norway to evaluate the "Advanced Liquid Absorbent System" that works to capture and sequester what chemical produced by combustion?

ANSWER: CARBON DIOXIDE (ACCEPT: CO<sub>2</sub>)

### BONUS

3) Energy – *Short Answer* Scientists at Oak Ridge National Lab are working on a novel accelerated membrane-based gas separation process that will be used to separate what molecule from flue gas?

ANSWER: CARBON DIOXIDE (ACCEPT: CO<sub>2</sub>)

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TOSS-UP

4) Chemistry – *Multiple Choice* Which of the following elements is LEAST likely to violate the octet rule?

- W) Carbon
- X) Sulfur
- Y) Phosphorous
- Z) Xenon [**ZEE-non**]

ANSWER: W) CARBON

BONUS

4) Chemistry – *Short Answer* A chemist prepares a 10%-by-mass aqueous [**AY-kwee-us**] solution of a salt with a formula unit mass of 200 grams per mole. To two significant digits and in molal [**moh-LAHL**], what is the molality of this solution?

ANSWER: 0.56

TOSS-UP

5) Physics – *Short Answer* What principle of quantum mechanics states that two electrons cannot have the same quantum numbers?

ANSWER: PAULI EXCLUSION PRINCIPLE

BONUS

5) Physics – *Short Answer* A 1-kilogram block slides down a straight ramp. If the normal force on the block is 6 newtons, then to the nearest newton, what is the force along its direction of motion?

ANSWER: 8

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**TOSS-UP**

6) Math – *Short Answer* A pair of ten-sided dice, each with the numbers one through 10 printed on the faces, is rolled. What is the probability that the two numbers rolled are different?

ANSWER: 9/10 (ACCEPT: 0.9, 90%)

**BONUS**

6) Math – *Short Answer* What number must be ADDED to both the numerator and denominator of  $\frac{4}{9}$  to get  $\frac{8}{3}$ ?

ANSWER: -12

**TOSS-UP**

7) Earth and Space – *Multiple Choice* The Richter scale is a base-10 logarithmic scale. What feature of an earthquake is multiplied by a factor of 10 for a unit increase on the Richter *[RIK-tur]* scale?

- W) Total energy radiated by an earthquake
- X) Fault rupture velocity
- Y) Seismic *[SIZE-mic]* wave amplitude
- Z) Seismic moment

ANSWER: Y) SEISMIC WAVE AMPLITUDE

**BONUS**

7) Earth and Space – *Short Answer* Identify all of the following three minerals that possess two planes of cleavage: 1) Mica; 2) Pyroxene *[pie-ROX-een]*; 3) Olivine.

ANSWER: 2

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TOSS-UP

8) Biology – *Multiple Choice* Chlorophyll *a* and *b* most strongly absorb which of the following colors of light?

- W) Red
- X) Yellow
- Y) Green
- Z) Blue

ANSWER: Z) BLUE

BONUS

8) Biology – *Short Answer* Identify all of the following three groups of plants that have nitrogen-fixing root nodules: 1) Peanuts; 2) Soybean; 3) Alfalfa.

ANSWER: ALL

TOSS-UP

9) Physics – *Short Answer* What mechanical property of a material characterizes its stiffness as a ratio of its stress to strain?

ANSWER: YOUNG'S MODULUS (ACCEPT: ELASTIC MODULUS)

BONUS

9) Physics – *Short Answer* Light travels 1.8 times as fast in a vacuum as in a given material. If the wavelength of the light in the material is 395 nanometers, what would be its wavelength, in nanometers, in a vacuum?

ANSWER: 711

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**TOSS-UP**

10) Math – *Short Answer* If a universal set contains 24 elements, how many elements are in the complement of a set with 9 elements?

ANSWER: 15

**BONUS**

10) Math – *Short Answer* Evaluate  $12^2 + 22^2 + 32^2$ .

ANSWER: 1652

### TOSS-UP

11) Chemistry – *Short Answer* What is the name for the functional group in organic chemistry that consists of a carbon atom double-bonded to an oxygen atom, and is a component of aldehydes and ketones [*KEE-tones*]?

ANSWER: CARBONYL [*carboh-NEEL*]

### BONUS

11) Chemistry – *Short Answer* Identify all of the following three atoms that have a higher first ionization [*eye-on-ih-ZAY-shun*] energy than lithium: 1) Sodium; 2) Beryllium [*beh-RILL-ee-um*]; 3) Magnesium.

ANSWER: 2 AND 3

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TOSS-UP

12) Energy – *Short Answer* Berkeley lab scientists are studying “gateway” proteins associated with the nuclear pore complex, which are responsible for blocking aberrant strands of what RNA-polymerase [*paw-LIM-er-ace*] II-synthesized macromolecule?

ANSWER: MESSENGER RNA (ACCEPT: mRNA)

BONUS

12) Energy – *Short Answer* Scientists at SLAC [*slack*] recently used the SSRL to study the protein complex Cascade that is associated with the bacterial immune system and is of recent interest due to potential uses for gene editing. With what prokaryotic [*PRO-care-ee-AW-tic*] DNA segments is Cascade associated?

ANSWER: CRISPR (ACCEPT: CLUSTERED REGULARLY INTERSPACED SHORT PALINDROMIC REPEATS)

TOSS-UP

13) Earth and Space – *Multiple Choice* Which of the following is closest to the average length of time an individual sunspot will persist on the surface of the sun?

- W) 1 hour
- X) 50 days
- Y) 10 years
- Z) 500 years

ANSWER: X) 50 DAYS

BONUS

13) Earth and Space – *Multiple Choice* Which of the following most accurately describes the strength of Mercury's magnetic field at the planet's surface?

- W) Not detectable
- X) About the same as that of the Moon
- Y) About one-hundreth that of the Earth
- Z) About half that of the Earth

ANSWER: Y) ABOUT ONE-HUNDRETH THAT OF THE EARTH

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### TOSS-UP

14) Chemistry – *Short Answer* In the Lewis structure of the cyanide anion [*AN-eye-on*], how many electrons belong SOLELY to the nitrogen atom?

ANSWER: TWO

### BONUS

14) Chemistry – *Short Answer* Identify all of the following three compounds that have a hybridization [*HIGH-brih-dye-ZAY-shun*] scheme requiring d-orbitals in VSEPR theory: 1) Xenon [*ZEE-non*] tetrafluoride; 2) Xenon tetroxide [*teh-TROX-ide*]; 3) Xenon difluoride.

ANSWER: 1 AND 3

**TOSS-UP**

15) Math – *Short Answer* What is the cosine of 240 degrees?

ANSWER:  $-1/2$  (ACCEPT:  $-0.5$ )

**BONUS**

15) Math – *Short Answer* The shortest side of a 3-4-5 right triangle lies on the  $x$ -axis. If the triangle is rotated about the  $x$ -axis, what is the volume of the resulting shape?

ANSWER:  $16\pi$



**TOSS-UP**

16) Physics – *Short Answer* A 60-kilogram sprinter accelerates horizontally off the starting block at 18 meters per second squared. What horizontal force, in newtons, does the sprinter exert on the block?

ANSWER: 1080

**BONUS**

16) Physics – *Short Answer* A 9-kilogram ball traveling at 5 meters per second undergoes an elastic collision with a 6-kilogram block that is stationary before the collision. What is the kinetic energy, in joules, of the block after the collision?

ANSWER: 108

**TOSS-UP**

17) Biology – *Short Answer* What is the term for paired chromosomes that carry genes controlling the same set of inherited characteristics?

ANSWER: HOMOLOGS (ACCEPT: HOMOLOGOUS)

**BONUS**

17) Biology – *Short Answer* Calcitonin [*kal-sih-TOE-nin*] and CGRP are different proteins that originate from the same gene due to alternative actions in what process?

ANSWER: SPLICING (ACCEPT: mRNA SPLICING)

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TOSS-UP

18) Energy – *Multiple Choice* Scientists at Brookhaven National Lab have developed a method to stimulate the anabolic [*AN-ah-BAWL-ik*] reactions in the smooth endoplasmic [*EN-doh-PLAZ-mik*] reticulum [*reh-TIK-yoo-lum*] of plant leaves. These findings could result in better feedstock for production of which of the following?

- W) Biofuel
- X) Fertilizer
- Y) Paper
- Z) Lumber

ANSWER: W) BIOFUEL

BONUS

18) Energy – *Short Answer* At the present, the negative electrode in most commercial lithium-ion batteries is composed primarily of what element?

ANSWER: CARBON

TOSS-UP

19) Math – *Short Answer* What is the limit as x approaches 3 of the absolute value of open parenthesis $3x - 2$ close parenthesis?

ANSWER: 7

BONUS

19) Math – *Short Answer* In a coordinate plane, identify all of the following four properties that are preserved under a rotation: 1) Distance; 2) Collinearity; 3) Slope; 4) Angle measure.

ANSWER: 1, 2, AND 4

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**TOSS-UP**

20) Physics – *Short Answer* A 70-kilogram Olympic athlete jumps 55 centimeters into the air. What is his change in gravitational potential energy to the nearest integer multiple of ten joules?

ANSWER: 380

**BONUS**

20) Physics – *Short Answer* A 70-kilogram electrician places a ladder against a wall, such that it makes a 60-degree angle with the wall, and then climbs 2 meters up the ladder. What is the magnitude of the work, to the nearest joule, that gravity does on the electrician?

ANSWER: 686

**TOSS-UP**

21) Chemistry – *Short Answer* Rank the following three elements in increasing order of electron affinity:  
1) Lithium; 2) Oxygen; 3) Sulfur.

ANSWER: 1, 3, 2

**BONUS**

21) Chemistry – *Short Answer* Rank the following three elements in increasing order of first ionization  
[eye-on-ih-ZAY-shun] energy: 1) Potassium; 2) Lithium; 3) Sodium.

ANSWER: 1, 3, 2

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TOSS-UP

22) Earth and Space – *Short Answer* Neptune appears a shade of blue because of what atmospheric gas
mixed in with hydrogen and helium?

ANSWER: METHANE (ACCEPT: CH₄)

BONUS

22) Earth and Space – *Short Answer* Place the following three layers of the Sun's atmosphere in order of
increasing distance from its surface: 1) Corona; 2) Photosphere; 3) Chromosphere.

ANSWER: 2, 3, 1

TOSS-UP

23) Biology – *Short Answer* Sickle cell anemia is an example of heterozygote [*hetero-ZYE-goat*] advantage because it protects against what disease?

ANSWER: MALARIA

BONUS

23) Biology – *Short Answer* What type of neuron is responsible for relaying information between other neurons?

ANSWER: INTERNEURONS (ACCEPT: RELAY NEURON, INTERMEDIATE NEURON)