

HIGH SCHOOL - ROUND 3A

TOSS-UP

1) Energy – *Multiple Choice* Two years after carbon dioxide was sequestered by the Pacific Northwest National Lab near Wallula, Washington, the material was converted into mineral substances resembling what type of sedimentary rock?

- W) Rock gypsum
- X) Limestone
- Y) Coal
- Z) Rock salt

ANSWER: X) LIMESTONE

BONUS

1) Energy – *Short Answer* Identify all of the following three statements that are true regarding nuclear energy in the United States: 1) Most common reactors are thermal reactors; 2) Most common reactors use U-235 as a fuel; 3) Water can be used as a moderator.

ANSWER: ALL

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### TOSS-UP

2) Earth and Space – *Short Answer* What star has the lowest apparent magnitude as observed from Earth?

ANSWER: THE SUN (ACCEPT: SOL)

### BONUS

2) Earth and Space – *Short Answer* What type of star must be present prior to a Type One-A supernova?

ANSWER: WHITE DWARF

### TOSS-UP

3) Biology – *Short Answer* Before amino acids can be used in translation, the free amino acid must be bonded to what class of molecules?

ANSWER: tRNA

### BONUS

3) Biology – *Short Answer* Certain plants have leaves in which bundle-sheath cells are tightly packed around veins, which are then surrounded by mesophyll [*MEH-zoh-fill*] cells. This anatomy is associated with plants that perform what type of photosynthesis?

ANSWER: C4 (ACCEPT: HATCH-SLACK PATHWAY, HATCH-SLACK CYCLE)

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TOSS-UP

4) Chemistry – *Multiple Choice* Which of the following terms best describes the relationship between 1-butanol [*one-BYOO-tan-all*] and 4-butanol?

- W) Structural isomers
- X) Same compound
- Y) Diastereomers [*dye-ah-STARE-ee-oh-murz*]
- Z) Enantiomers [*en-AN-tee-oh-mirs*]

ANSWER: X) SAME COMPOUND

BONUS

4) Chemistry – *Short Answer* Identify all of the following three statements that are true of xenon [*ZEE-non*] tetrafluoride: 1) It is tetrahedral [*tetrah-HEE-drul*]; 2) It has no net dipole [*DYE-pole*] moment; 3) It contains two unpaired electrons.

ANSWER: 2

TOSS-UP

5) Physics – *Short Answer* A 1,000-kilogram block of density 800 kilograms per cubic meter is placed in a fluid of density 1,000 kilograms per cubic meter. What percentage of the block’s total volume floats above the surface of the fluid?

ANSWER: 20

BONUS

5) Physics – *Multiple Choice* A lightning bolt strikes a power station, transmitting a current of 30,000 amps for 100 microseconds into it, which is currently charging a 2,000-milliampere-hour battery. Assuming that the charge from the lightning bolt is perfectly transmitted into the battery, which of the following percentages is closest to the percentage of the battery that it would charge?

- W) Less than 1
- X) 25
- Y) 50
- Z) 75

ANSWER: W) LESS THAN 1



TOSS-UP

6) Math – *Short Answer* What value of x minimizes the function f of x equals $x^2 - 6x + 2$?

ANSWER: 3

BONUS

6) Math – *Multiple Choice* If $f(x)$ = the square root of open parenthesis $x + 4$ close parenthesis and $g(x)$ = the square root of open parenthesis $x - 4$ close parenthesis, what is the domain of the function $f(x)$ divided by $g(x)$?

- W) All real numbers greater than 4
- X) All real numbers greater than or equal to 4
- Y) All real numbers greater than or equal to -4
- Z) All real numbers between -4 and 4

Answer: W) All real numbers greater than 4

TOSS-UP

7) Biology – *Short Answer* Under limited nutrient conditions Bacillus [*bah-SIL-us*] subtilis [*SUB-dil-iss*] initiates a morphological change, notably documented by Robert Koch [*coke*], that results in the formation of what structure?

ANSWER: ENDOSPORE (ACCEPT: SPORE)

BONUS

7) Biology – *Short Answer* What is the term for phages [*FAY-jiz*] that can reproduce using both the lytic [*LIH-tik*] and lysogenic [*lye-soh-JEN-ik*] cycle?

ANSWER: TEMPERATE

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**TOSS-UP**

8) Chemistry – *Multiple Choice* Which of the following acids is triprotic [*try-PRO-tic*]?

- W) Sulfuric acid
- X) Hydrocyanic acid [*HIGH-droh-sigh-AN-ik*]
- Y) Pyruvic acid [*pie-ROO-vik*]
- Z) Arsenic acid

ANSWER: Z) ARSENIC ACID

**BONUS**

8) Chemistry – *Short Answer* Rank the following three liquids in increasing order of solubility in water at STP: 1) Hexane; 2) Ethanol; 3) Ethyl acetate.

ANSWER: 1, 3, 2

**TOSS-UP**

9) Physics – *Short Answer* The grand unified theory joins together all of the fundamental forces except which one?

ANSWER: GRAVITY

**BONUS**

9) Physics – *Short Answer* Bill pulls a sled with 10 newtons of force using a rope that is angled 60 degrees above the horizontal. How much work in joules does he perform on the sled if he pulls the sled for 3 meters over the course of 4 seconds?

ANSWER: 15

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TOSS-UP

10) Earth and Space – *Short Answer* To what geologic era would you travel if you wanted to observe living dinosaurs?

ANSWER: MESOZOIC

BONUS

10) Earth and Space – *Multiple Choice* In a cooling magma chamber, which of the following minerals will crystallize first?

- W) Quartz
- X) Feldspar
- Y) Amphibole [*AM-fih-bowl*]
- Z) Olivine

ANSWER: Z) OLIVINE

TOSS-UP

11) Math – *Short Answer* What is 27 raised to the $\frac{4}{3}$ power?

ANSWER: 81

BONUS

11) Math – *Short Answer* One endpoint of a diameter of a sphere centered at $(3, 4, -7)$ is $(5, -6, 2)$. What are the coordinates of the other endpoint of that diameter?

ANSWER: $(1, 14, -16)$ (ACCEPT: $x = 1, y = 14, \text{ AND } z = -16$)

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**TOSS-UP**

12) Energy – *Short Answer* SLAC [*slack*] researchers recently published a report on the development of a new, cheap catalyst for the oxygen-evolving reaction relevant to fuel production. On what molecule do these catalysts act to evolve oxygen?

ANSWER: WATER (ACCEPT:  $\text{H}_2\text{O}$ )

**BONUS**

12) Energy – *Short Answer* Identify all of the following three types of waves that can be modeled and predicted using the current iteration of the Community Atmosphere Model, currently being used by Lawrence Berkeley National Lab researchers: 1) Tsunamis [*su-NAH-meas*]; 2) Tidal bores; 3) Wind wave.

ANSWER: 2 AND 3

**TOSS-UP**

13) Chemistry – *Multiple Choice* When performing bomb calorimetry [*cal-or-IH-metree*], which of the following physical quantities is being held constant?

- W) Pressure
- X) Volume
- Y) Temperature
- Z) Entropy [*EN-troh-pee*]

ANSWER: X) VOLUME

**BONUS**

13) Chemistry – *Short Answer* Rank the following three molecules in terms of increasing dipole [*DYE-pole*] moment: 1) O-dihydroxybenzene [*dye-high-droxee-BEN-zeen*]; 2) M-dihydroxybenzene; 3) P-dihydroxybenzene.

ANSWER: 3, 2, 1

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TOSS-UP

14) Math – *Multiple Choice* Which of the following is true about the function f of $x = \cosine$ of x ?

- W) It is neither even nor odd
- X) It has the horizontal asymptote $y = 1$
- Y) It has period 2π
- Z) It is not differentiable at $x = 0$

ANSWER: Y) IT HAS PERIOD 2π

BONUS

14) Math – *Short Answer* Simplify the following expression involving the complex number i :
 $4i + 3i^2 + 2i^3 + i^4$

ANSWER: $-2 + 2i$ (DO NOT ACCEPT: $2i - 2$)

TOSS-UP

15) Energy – *Short Answer* SLAC [*slack*] scientists recently developed a new technique for probing the electronic structure of solid materials via high harmonic generation, or HHG. In this technique, light is produced via the oscillations of what subatomic particle?

ANSWER: ELECTRON

BONUS

15) Energy – *Short Answer* Chemists at Lawrence Berkeley National Lab developed ReACT [*REE-act*] protein-labeling technology to address the fact that, while previous bioconjugation techniques were very effective at labeling sulfur atoms, they often disrupted the function of the protein. This is because previous techniques labeled what amino acid?

ANSWER: CYSTEINE



TOSS-UP

16) Physics – *Short Answer* What form of magnetism is demonstrated when a material's magnetic moment opposes the direction of an externally-applied magnetic field?

ANSWER: DIAMAGNETISM

BONUS

16) Physics – *Short Answer* If a radioactive element's half-life is 60 days, then, to the nearest whole number, how many grams of a 1-kilogram sample remain after 300 days?

ANSWER: 31

TOSS-UP

17) Earth and Space – *Multiple Choice* Which of the following is the term for the set of planets that will exhibit a full range of phases as observed from Earth?

- W) Terrestrial
- X) Jovian
- Y) Inferior
- Z) Superior

ANSWER: Y) INFERIOR

BONUS

17) Earth and Space – *Short Answer* Main-sequence stars larger than our sun can fuse hydrogen into helium using what cycle, which involves the usage of carbon as a catalyst?

ANSWER: CNO CYCLE (ACCEPT: CARBON-NITROGEN-OXYGEN CYCLE)



TOSS-UP

18) Biology – *Short Answer* Identify all of the following three Linnaean [*lin-AY-in*] classifications that apply to the leopard: 1) Carnivora [*car-NIV-or-ah*]; 2) Chordata [*kor-DAH-tah*]; 3) Canidae [*KAN-ih-dee*].

ANSWER: 1 AND 2

BONUS

18) Biology – *Short Answer* Identify all of the following three organisms that are part of the phylum [*FYE-lum*] Coniferophyta [*kaw-nif-er-AW-fih-tah*]: 1) Sequoia; 2) Orchid; 3) Douglas fir.

ANSWER: 1 AND 3

TOSS-UP

19) 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 most probable sum of the two numbers rolled?

ANSWER: 11

BONUS

19) Math – *Short Answer* What is 8 to the power of log base 2 of 5?

ANSWER: 125

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**TOSS-UP**

20) Biology – *Short Answer* In the citric acid cycle, how many molecules of NADH are generated from the conversion of citrate to isocitrate?

ANSWER: ZERO

**BONUS**

20) Biology – *Short Answer* What plant hormone, which can be synthesized by almost all known plants, is responsible for stomatal closure during dry stress?

ANSWER: ABSCISIC ACID (ACCEPT: ABA)

### TOSS-UP

21) Physics – *Short Answer* The function describing an object's position is transformed into a function describing velocity by what operation from calculus?

ANSWER: DERIVATIVE (ACCEPT: DIFFERENTIATION, DERIVATIVE OPERATION)

### BONUS

21) Physics – *Short Answer* Two 6-kilogram masses are connected by a spring with a force constant of 300 newtons per meter. If the spring is compressed by five centimeters, what is the initial acceleration, in meters per second squared, of one of the masses?

ANSWER: 2.5

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TOSS-UP

22) Chemistry – *Short Answer* Identify all of the following three chemicals whose addition will increase the percent ionization [*eye-on-ih-ZAY-shun*] of acetic acid in a solution: 1) Water; 2) Concentrated acetic acid; 3) Concentrated hydrochloric acid.

ANSWER: 1

BONUS

22) Chemistry – *Short Answer* Identify all of the following three reactions that would favor reactants over products: 1) A reaction with K_{eq} of 3; 2) A reaction with positive ΔG ; 3) An endothermic reaction with negative ΔS .

ANSWER: 2 AND 3

TOSS-UP

23) Earth and Space – *Short Answer* What type of well has water coming out of the ground freely because the pressure surface is above ground level?

ANSWER: FLOWING ARTESIAN (DO NOT ACCEPT: ARTESIAN)

BONUS

23) Earth and Space – *Short Answer* What type of unconformity occurs when layers of rock are deposited on an erosional surface of horizontal, undeformed rock?

ANSWER: DISCONFORMITY