

HIGH SCHOOL - ROUND 2

TOSS-UP

1) Chemistry – *Multiple Choice* If a barometer were constructed using water instead of mercury, by what factor would the height of the mercury barometer be multiplied to give the height of the water barometer?

W) 1 over 13.6

X) 1

Y) 13.6

Z) 33.2

ANSWER: Y) 13.6

BONUS

1) Chemistry – *Short Answer* To the nearest degree Celsius, what is the boiling point at standard pressure of a 2-molal [*moh-LAHL*] solution of urea in water?

ANSWER: 101

TOSS-UP

2) Physics – *Short Answer* If a sound wave traveling in air has a frequency of 5,000 hertz, how far, in centimeters, does the wave travel in a single period?

ANSWER: 6.8

BONUS

2) Physics – *Short Answer* Consider a solid spherical conductor that has a small spherical cavity in its center. You place an excess charge on the conductor and wait for it to reach equilibrium. Identify all of the following three places that some of the excess charge can be found: 1) Surface of the conductor; 2) Surface of the cavity; 3) Between the surfaces of the conductor and cavity.

ANSWER: 1

TOSS-UP

3) Energy – *Short Answer* Fermi National Accelerator Lab scientists, as a part of the SENSEI [*SEN-say*] collaboration, are trying to detect dark matter particles with specialized "skipper" CCDs. CCDs are composed of what semiconductor element?

ANSWER: SILICON

BONUS

3) Energy – *Short Answer* Scientists at Ames Lab are studying the formation of alumina under various conditions. What is the chemical formula of alumina?

ANSWER: Al_2O_3

TOSS-UP

4) Biology – *Short Answer* What is the general term for metabolic reactions that release energy by breaking down complex molecules?

ANSWER: CATABOLIC (ACCEPT: CATABOLISM)

BONUS

4) Biology – *Short Answer* What plant ground tissue type performs a majority of the metabolic functions of a plant and plays a relatively small role in structural support?

ANSWER: PARENCHYMA [*puh-RENG-kuh-muh*]

TOSS-UP

5) Math – *Multiple Choice* Which of the following cannot be the rightmost two digits, in order, of the square of an integer?

- W) 24
- X) 27
- Y) 56
- Z) 89

ANSWER: X) 27

BONUS

5) Math – *Short Answer* What is the average of the first 10 prime numbers?

ANSWER: 12.9 (ACCEPT: 129/10, 12 9/10)

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**TOSS-UP**

6) Earth and Space – *Multiple Choice* Which of the following tectonic plates is largest?

- W) African
- X) Arabian
- Y) Eurasian
- Z) Pacific

ANSWER: Z) PACIFIC

**BONUS**

6) Earth and Space – *Short Answer* An atom of uranium-238 undergoes two beta-minus decays and four alpha decays. What is the mass number of the product?

ANSWER: 222

### TOSS-UP

7) Chemistry – *Short Answer* Identify all of the following three compounds that contain both covalent and ionic bonds: 1) Phosphorus oxychloride; 2) Ammonium sulfate; 3) Potassium chloride.

ANSWER: 2

### BONUS

7) Chemistry – *Short Answer* A weak acid has a  $K_a$  of 1.6 times ten to the negative fifth. Assuming that dissociation is small, what is the percent dissociation of a one-molar solution of this acid in water?

ANSWER: 0.4 (ACCEPT: 0.4 PERCENT)

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### TOSS-UP

8) Physics – *Short Answer* If the half-life of a radioisotope is 25,000 years, what fraction of an original sample will remain after 100,000 years?

ANSWER: ONE SIXTEENTH (ACCEPT: 6.25%, 0.0625)

### BONUS

8) Physics – *Short Answer* At a bottling factory, a robotic arm automatically raises a 4000-newton palette up 6 meters to load it into a canning machine every 5 minutes. In watts, how much average power is required to operate the robotic arm?

ANSWER: 80

### TOSS-UP

9) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab have been studying a silencer protein known as PRC2. PRC2 silences genes by chemically modifying what proteins around which DNA is wound?

ANSWER: HISTONES

### BONUS

9) Energy – *Short Answer* Scientists at Oak Ridge National Lab are studying alloys composed of rare-earth elements. Identify all of the following three metals that may be examined in these studies: 1) Cerium; 2) Cesium; 3) Tellurium [*te-LOOR-ee-um*].

ANSWER: 1

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### TOSS-UP

10) Math – *Multiple Choice* The function  $y = f$  of  $x$  has zeroes at 4 and 12. If its graph is vertically stretched using a factor of 2, what are the zeroes of the result?

- W) 2 and 6
- X) 4 and 12
- Y) 6 and 14
- Z) 8 and 24

ANSWER: X) 4 AND 12

### BONUS

10) Math – *Short Answer* What is the ratio of the volume of a sphere of diameter  $\pi$  to the volume of a cube with edge length  $\pi$ ?

ANSWER:  $\pi/6$  (ACCEPT:  $(1/6)\pi$ )

**TOSS-UP**

11) Earth and Space – *Short Answer* What is the most abundant gas in Mars' atmosphere?

ANSWER: CARBON DIOXIDE (ACCEPT: CO2)

**BONUS**

11) Earth and Space – *Short Answer* Neutron stars are generally created as remnants of what type of supernovae [*super-NOH-vee*]?

ANSWER: TYPE TWO (ACCEPT: TWO, ONE B, ONE C)

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TOSS-UP

12) Biology – *Multiple Choice* What phylum [*FYE-lum*] of animals contains organisms that do not possess tissues?

- W) Cnidaria [*nye-DARE-ee-ah*]
- X) Porifera
- Y) Nematoda
- Z) Echinodermata [*eh-kye-noh-der-MAH-tah*]

ANSWER: X) PORIFERA

BONUS

12) Biology – *Short Answer* Pterosaurs [*TERR-oh-sores*] were the first tetrapods to evolve what key characteristic of their clade?

ANSWER: FLIGHT (ACCEPT: POWERED FLIGHT, WINGED FLIGHT)

TOSS-UP

13) Math – *Short Answer* Two cars leave from the same spot, driving directly away from each other on a straight road, at 20 and 30 miles per hour, respectively. How many minutes will it take for the two cars to be 10 miles apart?

ANSWER: 12

BONUS

13) Math – *Short Answer* If f of x equals the natural log of cosine x , what is f prime of $\pi/3$?

ANSWER: $-\sqrt{3}$

TOSS-UP

14) Physics – *Multiple Choice* Which of the following conditions is sufficient for describing a system in unstable equilibrium?

- W) Net force is zero
- X) Net force is at a minimum
- Y) Potential energy is at a strict minimum
- Z) Potential energy is at a strict maximum

ANSWER: Z) POTENTIAL ENERGY IS AT A STRICT MAXIMUM

BONUS

14) Physics – *Short Answer* The acceleration function for a particle's motion is differentiable [*dif-ur-EN-sha-bul*] and integrable [*IN-tah-grah-bul*] everywhere. Identify all of the following three quantities that can be determined with no additional information: 1) The position of the particle at a particular time; 2) The change in position of the particle over a given period of time; 3) The change in velocity of the particle over a given period of time.

ANSWER: 3

TOSS-UP

15) Energy – *Multiple Choice* Scientists at SLAC National Lab recently began construction on the Deep Underground Neutrino Experiment, or DUNE, in South Dakota. What property of neutrinos are scientists at DUNE trying to measure?

- W) Spin
- X) Temperature
- Y) Charge
- Z) Mass

ANSWER: Z) MASS

BONUS

15) Energy – *Short Answer* Scientists at Brookhaven National Lab are researching ways to increase oil production in the leaves of plants. In what plant structure do oils, such as soybean oil or cocoa butter, normally accumulate?

ANSWER: SEEDS

TOSS-UP

16) Earth and Space – *Multiple Choice* What is the term for minerals that are indicators of the metamorphic environment in which the rock was formed?

- W) Grade minerals
- X) Index minerals
- Y) Foliation minerals
- Z) Thermo-metric minerals

ANSWER: X) INDEX MINERALS

BONUS

16) Earth and Space – *Short Answer* Identify all of the following three rocks that can have a glassy texture: 1) Coal; 2) Obsidian; 3) Pumice.

ANSWER: 2, 3

TOSS-UP

17) Chemistry – *Short Answer* What is the primary industrial ore of aluminum?

ANSWER: BAUXITE

BONUS

17) Chemistry – *Short Answer* What is the name of a molecule with a 5-membered ring and the molecular formula C_5H_8 ?

ANSWER: CYCLOPENTENE

TOSS-UP

18) Biology – *Multiple Choice* Which of the following best describes how a serine protease catalyzes amide-bond-breaking reactions?

- W) The enzyme stabilizes the products
- X) The enzyme stabilizes the reactants
- Y) The enzyme increases the activation energy
- Z) The enzyme provides a mechanism with lower-energy intermediates

ANSWER: Z) THE ENZYME PROVIDES A MECHANISM WITH LOWER-ENERGY INTERMEDIATES

BONUS

18) Biology – *Multiple Choice* The organisms that form truffles are predominantly part of what group of fungi?

- W) Chytrids [*KIH-trids*]
- X) Glomeromycetes [*glo-mair-oh-MY-seets*]
- Y) Basidiomycetes [*bah-sid-ee-oh-MY-seets*]
- Z) Ascomycetes [*az-koh-MY-seets*]

ANSWER: Z) ASCOMYCETES

TOSS-UP

19) Math – *Short Answer* If f of x equals $3x^2 - x + 2$, what is f 's prime of 3?

ANSWER: 17

BONUS

19) Math – *Short Answer* If the product of cosine x and sine x is $2/9$, what is the value of open parenthesis cosine x minus sine x close parenthesis squared?

ANSWER: $5/9$

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**TOSS-UP**

20) Physics – *Multiple Choice* Kepler's second law states that each planet moves so that a line from the sun to the planet sweeps out equal areas in equal periods of time. It is a direct result of the conservation of which of the following physical quantities?

- W) Linear momentum
- X) Linear kinetic energy
- Y) Angular momentum
- Z) Angular kinetic energy

ANSWER: Y) ANGULAR MOMENTUM

**BONUS**

20) Physics – *Short Answer* Consider a spring-mass system that has an angular frequency of 6 radians per second. If the mass is 2 kilograms, then in newtons per meter, what is the value of the spring constant for this oscillator?

ANSWER: 72

**TOSS-UP**

21) Earth and Space – *Short Answer* The Saros cycle describes the period of time between successive alignments of what three solar system bodies?

ANSWER: EARTH, SUN, AND MOON (any order)

**BONUS**

21) Earth and Space – *Short Answer* In stellar fusion, what isotope is the primary product of the proton-proton chain?

ANSWER: HELIUM-4

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**TOSS-UP**

22) Biology – *Short Answer* Mature plant cells have the ability to de-differentiate and then give rise to all of the cell types found in the adult organism. What is the term for this potential?

ANSWER: TOTIPOTENT (ACCEPT: TOTIPOTENCY; DO NOT ACCEPT: PLURIPOTENT)

**BONUS**

22) Biology – *Short Answer* What is the adjective for organisms that lay eggs that hatch outside the mother's body?

ANSWER: OVIPAROUS

### TOSS-UP

23) Chemistry – *Short Answer* Aldehydes [*AL-deh-hides*] and ketones have what functional group in common?

ANSWER: CARBONYL

### BONUS

23) Chemistry – *Short Answer* Identify all of the following three elements that are considered nonmetals: 1) Radon; 2) Europium; 3) Americium.

ANSWER: 1