

HIGH SCHOOL - ROUND 1

TOSS-UP

1) Earth and Space – *Multiple Choice* Which of the following best describes the luster of cut diamonds?

W) Adamantine [*ad-ah-MAN-teen*]

X) Vitreous [*VIH-tree-us*]

Y) Pitchy

Z) Resinous [*REH-zin-us*]

ANSWER: W) ADAMANTINE

BONUS

1) Earth and Space – *Multiple Choice* The evolution of oxygenic photosynthesis marked a significant change in Earth history that led to permanent changes in the redox state of Earth's atmosphere and had lasting impacts on Earth's organisms. Which of the following best describes when the evolution of oxygenic photosynthesis occurred relative to the Cambrian Explosion?

W) One billion years after the Cambrian Explosion

X) The same time as the Cambrian Explosion

Y) Two billion years before the Cambrian Explosion

Z) Three billion years before the Cambrian Explosion

ANSWER: Y) TWO BILLION YEARS BEFORE THE CAMBRIAN EXPLOSION

TOSS-UP

2) Biology – *Short Answer* The most common high-energy intermediate used to drive biological reactions contains what nucleobase?

ANSWER: ADENINE

BONUS

2) Biology – *Short Answer* What type of plant cell opens and closes stomata in leaves?

ANSWER: GUARD CELLS

TOSS-UP

3) Math – *Multiple Choice* When in standard position, which of the following angles has its terminal side in the fourth quadrant?

- W) $3\pi/2$
- X) $5\pi/4$
- Y) $8\pi/5$
- Z) $13\pi/6$

ANSWER: Y) $8\pi/5$

BONUS

3) Math – *Short Answer* How many different five-digit integers are palindromes that contain three different digits?

ANSWER: 648

TOSS-UP

4) Chemistry – *Short Answer* When performing a titration [*tie-TRAY-shun*], what point is defined as the point at which the indicator changes color?

ANSWER: ENDPOINT (DO NOT ACCEPT: EQUIVALENCE POINT)

BONUS

4) Chemistry – *Multiple Choice* Which of the following solutions or substances will have the highest vapor pressure at room temperature?

- W) Water with 0.1 mole fraction sodium chloride
- X) Water with 0.1 mole fraction sucrose
- Y) Water with 0.1 mole fraction ethanol
- Z) Pure water

ANSWER: Y) WATER WITH 0.1 MOLE FRACTION ETHANOL

TOSS-UP

5) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab are using nanoscale imaging techniques to study a biological process that is analogous to a process plants use, but in which the water splitting is artificially produced. What biological process is this?

ANSWER: PHOTOSYNTHESIS

BONUS

5) Energy – *Short Answer* Researchers at Los Alamos National Lab are studying how to convert sugars to fuels. One of the sets of reactions they are studying converts glucose into what three-carbon alkane?

ANSWER: PROPANE

TOSS-UP

6) Physics – *Short Answer* A 5-kilogram mass is dropped from rest. In meters per second, how fast is it falling after 2 seconds?

ANSWER: 19.6

BONUS

6) Physics – *Short Answer* Given that the thermal expansion coefficient for steel is ten to the negative five per degree Celsius, then, in meters, how much will a 1200-meter bridge expand if the temperature rises from negative 3 degrees Celsius to 5 degrees Celsius?

ANSWER: 0.096

TOSS-UP

7) Biology – *Short Answer* The skeletons of Chondrichthyans [*kon-DRIK-thee-ans*] are composed of what structural tissue?

ANSWER: CARTILAGE

BONUS

7) Biology – *Short Answer* The cohesion-tension hypothesis attempts to explain the movement of liquid through what plant system?

ANSWER: XYLEM

TOSS-UP

8) Earth and Space – *Multiple Choice* Kepler's first law of planetary motion addresses which of the following aspects of orbiting bodies?

- W) The relationship between orbital period and distance from the Sun
- X) The relationship between mass and rotational period
- Y) The shape of orbits
- Z) The area swept out by an orbiting body

ANSWER: Y) THE SHAPE OF ORBITS

BONUS

8) Earth and Space – *Short Answer* What type of reflecting telescope has a secondary mirror deflect the light by 90 degrees so that it is focused at an eyepiece on the side of the telescope?

ANSWER: NEWTONIAN

TOSS-UP

9) Energy – *Short Answer* Researchers at Argonne National Lab are using, as a catalyst in the water-splitting reaction, a metal that has high resistance to corrosion and is found in higher abundance in meteorites than in the Earth's crust. What metal are they using?

ANSWER: IRIDIUM (ACCEPT: IR)

BONUS

9) Energy – *Short Answer* Researchers at Oak Ridge National Lab have discovered a new solid catalyst to convert gaseous methane to methanol. Because the catalyst is not the same phase as the reactants, it can be said to be what type of catalyst?

ANSWER: HETEROGENEOUS

TOSS-UP

10) Math – *Multiple Choice* Riemann [*REE-monn*] sums are most directly related to which of the following?

- W) Average rate of change
- X) Derivatives
- Y) Definite integrals
- Z) Indefinite integrals

ANSWER: Y) DEFINITE INTEGRALS

BONUS

10) Math – *Short Answer* What is the limit as x approaches zero of the fraction with numerator sine squared of x plus open parenthesis sine of x^2 close parenthesis, and denominator x^2 ?

ANSWER: 2

TOSS-UP

11) Chemistry – *Multiple Choice* Which of the following pairs of compounds have the same empirical formula?

- W) Water and hydrogen peroxide
- X) Methane and ethane
- Y) Glucose and formaldehyde
- Z) Carbon monoxide and carbon dioxide

ANSWER: Y) GLUCOSE AND FORMALDEHYDE

BONUS

11) Chemistry – *Short Answer* Identify all of the following three statements that are always TRUE of chemical equilibrium: 1) Adding a reactant always results in an equilibrium shift to the right; 2) Decreasing the temperature of a reaction always results in a decrease in the equilibrium constant K ; 3) Adding a product to a reaction always results in a decrease in K .

ANSWER: NONE

TOSS-UP

12) Physics – *Short Answer* If a rigid body is experiencing no net torque [*tork*] and no net forces, it is said to be in what state?

ANSWER: EQUILIBRIUM (ACCEPT: DYNAMIC EQUILIBRIUM, MECHANICAL EQUILIBRIUM; DO NOT ACCEPT: STATIC EQUILIBRIUM)

BONUS

12) Physics – *Short Answer* Consider a square ABCD where there is a one-ohm resistor on each side of the square. If there is also a one-ohm resistor bridging the AC diagonal, what is the equivalent resistance in ohms between points A and C?

ANSWER: 1/2 (ACCEPT: 0.5)

TOSS-UP

13) Earth and Space – *Multiple Choice* A location contains deposits of poorly-sorted mixtures of sediment and rocks, including large boulders. Which of the following geological processes is most likely responsible for these deposits?

- W) River flow
- X) Glacier flow
- Y) Wind erosion
- Z) Volcanic activity

ANSWER: X) GLACIER FLOW

BONUS

13) Earth and Space – *Short Answer* Identify all of the following three statements that are true of reverse faults: 1) They form in extensional environments; 2) The footwall moves up relative to the hanging wall; 3) They are common at divergent plate boundaries.

ANSWER: NONE OF THEM

TOSS-UP

14) Math – *Short Answer* Consider a restaurant that sells pizza to each of five customers. If the probability that at most one purchases a cheese pizza is 0.43, what is the probability that at least two purchase a cheese pizza?

ANSWER: 0.57 (ACCEPT: 57%)

BONUS

14) Math – *Short Answer* You inscribe a circle in a square and then you hit the square with 100 randomly-placed darts. To the nearest whole number how many of the darts would you expect to land in the circle?

ANSWER: 79

TOSS-UP

15) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab have developed organic dyes capable of converting near-infrared light into visible light for use in solar cell devices. What is the minimum number of 1600-nanometer photons that a dye must absorb in order to emit a single 400-nanometer photon?

ANSWER: 4

BONUS

15) Energy – *Multiple Choice* What property of carbon nanotubes contributes to their usefulness in electronics applications?

- W) Length
- X) Tensile Strength
- Y) Conductivity
- Z) Flexibility

ANSWER: Y) CONDUCTIVITY

TOSS-UP

16) Biology – *Short Answer* What is the adjective for a plant species that possesses two types of sporangia?

ANSWER: HETEROSPOROUS

BONUS

16) Biology – *Short Answer* Identify all of the following three Cnidarians [*nye-DARE-ee-enz*] that do NOT experience a medusa phase in their life cycles: 1) Sea wasp; 2) Star coral; 3) Sea anemone.

ANSWER: 2, 3

TOSS-UP

17) Physics – *Multiple Choice* Which of the following pairs of strains are most predominant in a bent beam?

- W) Pressure and shear
- X) Tension and shear
- Y) Tension and compression
- Z) Shear and compression

ANSWER: Y) TENSION AND COMPRESSION

BONUS

17) Physics – *Short Answer* A particular planet has a mass that is one-four hundredth that of the Earth and a radius that is one-eighth that of the Earth. Expressed as a percentage of g , what is the surface acceleration due to gravity on this planet?

ANSWER: 16 (ACCEPT: 16% OF g)

TOSS-UP

18) Chemistry – *Short Answer* One major use of hydrogen industrially is in what industrial process that produces ammonia?

ANSWER: HABER [*HAH-bur*] PROCESS (ACCEPT: HABER-BOSCH PROCESS)

BONUS

18) Chemistry – *Short Answer* Rank the following four elements in increasing order of melting point: 1) Sodium; 2) Cesium; 3) Potassium; 4) Lithium.

ANSWER: 2, 3, 1, 4

TOSS-UP

19) Earth and Space – *Short Answer* What was the first planet discovered with the aid of a telescope?

ANSWER: URANUS

BONUS

19) Earth and Space – *Short Answer* Rank the following three stellar spectral types in terms of increasing temperature: 1) A; 2) M; 3) F.

ANSWER: 2, 3, 1

TOSS-UP

20) Math – *Short Answer* What is the remainder when 6 factorial is divided by 7?

ANSWER: 6

BONUS

20) Math – *Short Answer* One of the zeroes of the polynomial $x^3 - 7x^2 + 9x - 63$ is the complex number $3i$. What is the value of the real zero of the polynomial?

ANSWER: 7

TOSS-UP

21) Biology – *Short Answer* What is the adjective for the type of enzyme inhibition that involves an inhibitor that mimics the shape of the substrate, thereby blocking the active site?

ANSWER: COMPETITIVE

BONUS

21) Biology – *Short Answer* Indole-acetic acid is an example of what class of plant hormones?

ANSWER: AUXINS

TOSS-UP

22) Physics – *Short Answer* An electron in a particle accelerator passes through an electric field such that the change in its potential energy is 15 electron-volts. In volts, what is the magnitude of the potential difference in the field from the point where the electron exited to the point where it entered?

ANSWER: 15

BONUS

22) Physics – *Short Answer* Consider the two displacement vectors $3\mathbf{i}$ meters and $-4\mathbf{j}$ meters. Identify all of the following three statements that are true of this system: 1) Their dot product is zero; 2) They are perpendicular to each other; 3) Their cross product is zero.

ANSWER: 1, 2

TOSS-UP

23) Chemistry – *Short Answer* The equilibrium constant for a particular chemical reaction is 1.25 times ten to the negative two. What is the equilibrium constant for the reverse reaction?

ANSWER: 80

BONUS

23) Chemistry – *Short Answer* What is the systematic name of the compound NaOCl?

ANSWER: SODIUM HYPOCHLORITE