

HIGH SCHOOL - ROUND 8A

TOSS-UP

1) Math – *Short Answer* Log base 100 of 50 is equal to log base 10 of 50 divided by log base 10 of what number?

ANSWER: 100

BONUS

1) Math – *Short Answer* A bag contains 22 socks: 6 are red, 8 are white, and 8 are blue. How many socks must you take out to be certain that you will have at least one pair of blue socks?

ANSWER: 16

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### TOSS-UP

2) Chemistry – *Short Answer* What is the molecular [*moh-LEK-yoo-lur*] geometry of methane?

ANSWER: TETRAHEDRAL

### BONUS

2) Chemistry – *Short Answer* A student mixes together aqueous [*AY-kwee-us*] equimolar solutions of calcium chloride and ammonium phosphate. Which two of the component ions stay in solution?

ANSWER: AMMONIUM AND CHLORIDE (ACCEPT IN ANY ORDER)

**TOSS-UP**

3) Energy – *Multiple Choice* Which of the following is a renewable, primary energy source?

- W) Nuclear
- X) Fossil
- Y) Geothermal
- Z) Electricity

ANSWER: Y) GEOTHERMAL

**BONUS**

3) Energy – *Short Answer* Fermilab physicists are conducting an experiment to look for the neutrinoless [*new-TREE-no-lis*] decay of muons [*MYOO-ons*]. What is the only particle that is formed in this hypothetical decay?

ANSWER: ELECTRON

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TOSS-UP

4) Physics – *Short Answer* If one wants to double the period of a simple pendulum, what ratio of new-to-old length is required?

ANSWER: 4 (ACCEPT: 4 TO 1)

BONUS

4) Physics – *Short Answer* A light ray hits a mirror on the ground at 25 degrees measured from the horizontal. What is the angle, in degrees, between the incident and reflected ray?

ANSWER: 130

TOSS-UP

5) Earth and Space – *Short Answer* What part of the nitrogen cycle can be performed by lightning?

ANSWER: NITROGEN FIXATION

BONUS

5) Earth and Space – *Short Answer* Intense California storms, poor Peruvian anchovy fishing, and high South American sea surface temperatures in Western South America are characteristic of what episodic event?

ANSWER: EL NINO (ACCEPT: ENSO)

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**TOSS-UP**

6) Biology – *Multiple Choice* In the Griffith experiment, nonpathogenic bacteria were found to be able to cause disease after being exposed to heat-killed virulent bacteria. Which of the following substances caused this transformation?

- W) Toxins
- X) Proteins
- Y) RNA
- Z) DNA

ANSWER: Z) DNA

**BONUS**

6) Biology – *Short Answer* What region of the human eye retina [*REHT-nah*] has the highest density of photoreceptors?

ANSWER: FOVEA (ACCEPT: FOVEA CENTRALIS)

**TOSS-UP**

7) Physics – *Short Answer* If an electron is placed half a meter away from the surface of a thin metallic shell of diameter 1 meter, what is the electric field, in volts per meter, at the center of the shell?

ANSWER: 0

**BONUS**

7) Physics – *Short Answer* What is the equivalent capacitance, in microfarads, of a 3-capacitor circuit consisting of 2-microfarad, 3-microfarad, and 4-microfarad capacitors connected in series?

ANSWER: 12/13

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TOSS-UP

8) Earth and Space – *Short Answer* What planet in the solar system is the most dense?

ANSWER: EARTH

BONUS

8) Earth and Space – *Short Answer* An extremely high-mass star will not undergo a supernova until the mass of its iron core exceeds what limit?

ANSWER: CHANDRASEKHAR LIMIT (ACCEPT: 1.4 SOLAR MASSES)

TOSS-UP

9) Energy – *Multiple Choice* The Peter Auger cosmic ray observatory is operated by DOE scientists from Fermilab. Which of the following statements is TRUE of how cosmic rays are detected by this observatory?

- W) The observatory detects cosmic rays by measuring the local electric field
- X) The observatory directly observes cosmic rays interacting with water
- Y) The observatory detects the shower of energetic particles produced by a cosmic ray
- Z) The observatory uses interferometry to detect cosmic rays

ANSWER: Y) THE OBSERVATORY DETECTS THE SHOWER OF ENERGETIC PARTICLES PRODUCED BY A COSMIC RAY

BONUS

9) Energy – *Short Answer* Scientists at SLAC [*slack*] have been studying the iron sulfur cluster in a group of liver-detoxifying enzymes to determine the source of their high activity towards a wide variety of substrates. What is the general name for this group of enzymes?

ANSWER: CYTOCHROME P450

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### TOSS-UP

10) Chemistry – *Short Answer* The total amount of useful work extractable from a chemical reaction at constant pressure and temperature is equal to the negative change in what state function?

ANSWER: GIBBS FREE ENERGY (ACCEPT: G)

### BONUS

10) Chemistry – *Short Answer* Identify all of the following three molecules that are matched correctly to their hybridization: 1) Xenon difluoride and  $dsp^3$ ; 2) Nitrogen tri-iodide and  $sp^2$ ; 3) Sulfur tetrafluoride and  $d^2sp^3$ .

ANSWER: 1

**TOSS-UP**

11) Biology – *Multiple Choice* Which of the following best describes the result of the first step of glycolysis [*glye-KAWL-eh-sis*] in a fibroblast?

- W) Glucose-6-phosphate is fully committed to the glycolysis [*glye-KAWL-eh-sis*] pathway
- X) Fructose-1,6-bisphosphate [*biss-FAWS-fate*] is split into two three-carbon sugars
- Y) ATP is extracted from glucose-6-phosphate
- Z) Glucose-6-phosphate can no longer exit the cell

ANSWER: Z) GLUCOSE-6-PHOSPHATE CAN NO LONGER EXIT THE CELL

**BONUS**

11) Biology – *Short Answer* In the Krebs cycle, oxidation steps of cycle intermediates are coupled with what type of reaction that reduces the number of carbons in the intermediates?

ANSWER: DECARBOXYLATION (ACCEPT: OXIDATIVE DECARBOXYLATION)



**TOSS-UP**

12) Math – *Short Answer* What is the greatest common factor of 36 and 92?

ANSWER: 4

**BONUS**

12) Math – *Short Answer* Expressing your answer in terms of  $m$ , evaluate the function  $f(x) = 3x^2 - 12x + 15$  when  $x$  is  $m - 4$ .

ANSWER:  $3m^2 - 36m + 111$

**TOSS-UP**

13) Earth and Space – *Multiple Choice* Which of the following is closest to the ratio of the absolute temperature at the Sun’s core to that of its surface?

- W) 25
- X) 250
- Y) 2,500
- Z) 25,000

ANSWER: Y) 2,500

**BONUS**

13) Earth and Space – *Short Answer* Identify all of the following three galaxies that are thought to have a supermassive black hole at or near their center: 1) Milky way; 2) Andromeda [*ann-DRAW-meh-dah*] Galaxy; 3) Whirlpool Galaxy.

ANSWER: ALL

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TOSS-UP

14) Biology – *Short Answer* What specific quantity on a reaction diagram does the addition of an enzyme change?

ANSWER: ACTIVATION ENERGY (ACCEPT: TRANSITION STATE ENERGY)

BONUS

14) Biology – *Multiple Choice* One purpose of fermentation is to regenerate which of the following reagents?

- W) NADH
- X) NAD⁺
- Y) FADH₂
- Z) FAD

ANSWER: X) NAD⁺

TOSS-UP

15) Physics – *Short Answer* Identify all of the following three quantities that are vector quantities:
1) Impulse; 2) Momentum; 3) Energy.

ANSWER: 1 AND 2

BONUS

15) Physics – *Short Answer* A 3-kilogram block slides along a horizontal surface, and the coefficient of kinetic friction between them is 0.5. The block's initial velocity is 20 meters per second. To the nearest second, how long does it take for the block to come to a stop?

ANSWER: 4

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**TOSS-UP**

16) Chemistry – *Short Answer* Mendeleev famously predicted the existence of eka-silicon in 1871 as well as a list of properties this theoretical element would have, many of which turned out to be correct when the element was discovered in 1886. What is the IUPAC name of this element?

ANSWER: GERMANIUM

**BONUS**

16) Chemistry – *Short Answer* Identify all of the following three quantities that are positive for the gas-phase decomposition reaction of carbon dioxide to form carbon monoxide and molecular oxygen at 300 kelvins: 1) Delta-H; 2) Delta-S; 3) Delta-G.

ANSWER: ALL



**TOSS-UP**

17) Math – *Short Answer* How many exterior angles does an octagon have?

ANSWER: 16 (DO NOT ACCEPT: 8)

**BONUS**

17) Math – *Short Answer* What are the coordinates of the vertex of the graph of  $y = -3x^2 - 12x - 7$ ?

ANSWER: (-2, 5) (ACCEPT:  $x = -2$  AND  $y = 5$ )

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TOSS-UP

18) Energy – *Multiple Choice* Researchers at SLAC [*slack*] are currently working on mining methods to expand proven resources of uranium. Which of the following contains the largest amount of uranium?

- W) Ocean water
- X) Salt mines
- Y) Gold deposits
- Z) Coal mines

ANSWER: W) OCEAN WATER

BONUS

18) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab discovered a protein important in DNA repair called XPG, whose function was often lost in breast, ovarian, and other cancer types. XPG is in what class of cancer-preventing genes, examples of which also include APC and p53?

ANSWER: TUMOR SUPPRESSOR

TOSS-UP

19) Earth and Space – *Short Answer* In a stream, what is the term for the sediment load that slides and rolls along the stream bed?

ANSWER: BED LOAD

BONUS

19) Earth and Space – *Short Answer* Rank the following three materials in increasing order of speed of P-waves when traveling through them: 1) Ultramafic; 2) Felsic; 3) Mafic.

ANSWER: 2, 3, 1

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**TOSS-UP**

20) Physics – *Multiple Choice* Which of the following adjacent pairs of thermodynamic processes are a part of a Carnot [*CAR-noh*] cycle?

- W) Isothermal expansion and isentropic [*eye-sen-TROH-pik*] expansion
- X) Isentropic compression and isochoric [*eye-soh-KOR-ik*] heating
- Y) Isentropic compression and isobaric [*eye-soh-BARE-ik*] heating
- Z) Isothermal compression and isochoric cooling

ANSWER: W) ISOTHERMAL EXPANSION AND ISENTROPIC EXPANSION

**BONUS**

20) Physics – *Short Answer* The force on an object was kept constant for 1 second and then changed to a new value for each successive second, for a total of five force values over a five-second time interval. All five forces were in the same direction and had magnitudes of 0 newtons, 5 newtons, 15 newtons, 5 newtons, and 0 newtons. What was the magnitude of the total impulse, in newton seconds, exerted on the object during this time?

ANSWER: 25

**TOSS-UP**

21) Chemistry – *Multiple Choice* Which of the following is not a Lewis acid?

- W) Aluminum chloride
- X) Ammonia
- Y) Carbon dioxide
- Z) Magnesium ion

ANSWER: X) AMMONIA

**BONUS**

21) Chemistry – *Short Answer* Rank the following three molecules in increasing order of their acidity in water: 1) Ethanol; 2) Ethyl mercaptan; 3) Acetic acid.

ANSWER: 1, 2, 3

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TOSS-UP

22) Math – *Short Answer* If the probability of it raining on a given day is 0.21, what is the probability of it NOT raining?

ANSWER: 0.79 (ACCEPT: 79/100)

BONUS

22) Math – *Short Answer* What is the area between the curves $y = x^3$ and $y = x^2 + 3$ between $x = 0$ and $x = 1$?

ANSWER: 37/12 (ACCEPT: 3 1/12)

TOSS-UP

23) Biology – *Short Answer* What plant hormones regulate cell division in the shoots and roots and are generally synthesized in the roots?

ANSWER: CYTOKININS

BONUS

23) Biology – *Short Answer* Identify all of the following four mutations that could result from a single-nucleotide substitution: 1) Silent; 2) Missense; 3) Nonsense; 4) Frameshift.

ANSWER: 1, 2, AND 3