

MIDDLE SCHOOL - ROUND 16A

TOSS-UP

1) Energy – *Short Answer* Scientists at the National Energy Technology Lab recovered cores from the ocean floor that contain exotic ices. Under the high pressure of the ocean floor, these ices are composed of a molecular cage that traps what combustible gas?

ANSWER: METHANE (ACCEPT: NATURAL GAS, CH₄)

BONUS

1) Energy – *Multiple Choice* Fermi National Lab scientists studied the creation of a top quark by a collision of a proton and an anti-proton. Which of the following particles is created concomitantly [*Kon-koh-MIT-ent-lee*] in order to obey conservation laws?

- W) Up quark
- X) Bottom quark
- Y) Anti-top quark
- Z) Strange quark

ANSWER: Y) ANTI-TOP QUARK

TOSS-UP

2) Physical Science – *Short Answer* How many moles of hydrogen atoms does one mole of ammonium bicarbonate contain?

ANSWER: 5

BONUS

2) Physical Science – *Multiple Choice* Which of the following chemical formulas best describes the following statement: "Methanol is converted to formaldehyde by reaction with oxygen?"

- W) NH₂Cl liquid yields NH₂Cl aqueous
- X) C₁₆H₃₀O₂ plus H₂ yields C₁₆H₃₂O₂
- Y) CH₄O plus O₂ yields CH₂O plus H₂O
- Z) CaO plus H₂O yields Ca(OH)₂

ANSWER: Y) CH₄O PLUS O₂ YIELDS CH₂O PLUS H₂O

TOSS-UP

3) Earth and Space – *Multiple Choice* Which of the following is closest to the ratio of freshwater stored as groundwater to that in glaciers and ice sheets?

- W) 1 to 1
- X) 2 to 1
- Y) 5 to 1
- Z) 10 to 1

ANSWER: X) 2 TO 1

BONUS

3) Earth and Space – *Multiple Choice* Which of the following typically occurs during El Niño?

- W) Trade winds blow east to west along the equator
- X) Australia has increased rainfall
- Y) A band of warm water develops in the eastern Pacific
- Z) The Atlantic hurricane season is more severe

ANSWER: Y) A BAND OF WARM WATER DEVELOPS IN THE EASTERN PACIFIC.

TOSS-UP

4) Life Science – *Short Answer* Anabolic steroids, which have been controversially used as performance-enhancing drugs by athletes, are usually derivatives of what naturally-occurring hormone of similar function?

ANSWER: TESTOSTERONE

BONUS

4) Life Science – *Short Answer* Order the following four steps of sensory signal propagation chronologically: 1) Transmission; 2) Transduction; 3) Interpretation; 4) Stimulus.

ANSWER: 4, 2, 1, 3

TOSS-UP

5) Physical Science – *Short Answer* What is the name of the quantity that must be applied to a system to change its angular momentum?

ANSWER: TORQUE

BONUS

5) Physical Science – *Multiple Choice* The man-made satellites at the lowest orbits generally orbit at a distance of 150 kilometers above Earth. Which of the following best explains why?

- W) At this distance, they feel minimal gravitational attraction to Earth
- X) At this distance, they feel minimal air resistance from Earth's atmosphere
- Y) It is impossible to travel fast enough to maintain an orbit below this altitude
- Z) This is the height at which geostationary orbits can be maintained

ANSWER: X) AT THIS DISTANCE, THEY FEEL MINIMAL AIR RESISTANCE FROM EARTH'S ATMOSPHERE

TOSS-UP

6) Math – *Short Answer* In the set of integers from 1 through 10, inclusive, let A be the set of those that are even, and let B be the set of those that are multiples of 3. How many elements are in A union B ?

ANSWER: 7

BONUS

6) Math – *Short Answer* What are the coordinates of the vertex of the parabola with equation $y = 4x^2 + 2x - 3$?

ANSWER: $(-1/4, -13/4)$ (ACCEPT: $(-1/4, -3 \frac{1}{4})$, $(-0.25, -3.25)$)

TOSS-UP

7) Earth and Space – *Multiple Choice* The Earth's inner core accounts for approximately what percentage of the Earth's total mass?

- W) 2
- X) 10
- Y) 21
- Z) 33

ANSWER: W) 2

BONUS

7) Earth and Space – *Multiple Choice* What type of unconformity is created when shale is deposited on top of an eroded sandstone layer?

- W) Disconformity
- X) Nonconformity
- Y) Angular unconformity
- Z) Time unconformity

ANSWER: W) DISCONFORMITY

TOSS-UP

8) Energy – *Multiple Choice* Scientists at Oak Ridge National Lab are using X-ray diffraction to understand the structure of enzymes that pump antibiotics out of bacteria. Which of the following is TRUE of these enzymes?

- W) They do not require ATP
- X) They have become more widespread in response to antibiotic therapy
- Y) They are fibrous proteins
- Z) They are made of RNA

ANSWER: X) THEY HAVE BECOME MORE WIDESPREAD IN RESPONSE TO ANTIBIOTIC THERAPY

BONUS

8) Energy – *Multiple Choice* Scientists at SLAC have been using machine learning to predict new metallic compounds that are amorphous. Which of the following materials is amorphous?

- W) Diamond
- X) Snowflake
- Y) Glass
- Z) Table salt

ANSWER: Y) GLASS

TOSS-UP

9) Math – *Short Answer* What are the distinct prime factors of 120?

ANSWER: 2, 3, AND 5

BONUS

9) Math – *Short Answer* According to Descartes' [*day-KARTZ*] rule of signs, what are the possible numbers of negative real zeroes the polynomial $x^5 + 3x^4 - 3x^3 + 2x^2 + 11x - 13$ may have?

ANSWER: 2 AND 0 (must give both answers)

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**TOSS-UP**

10) Life Science – *Short Answer* What type of passive transport occurs through protein channels?

ANSWER: FACILITATED DIFFUSION

**BONUS**

10) Life Science – *Multiple Choice* Which of the following best explains the phenomenon of industrial melanism in moths?

- W) Darker moths were better camouflaged from predators and were selected for
- X) Moths became darker over time as more soot accumulated within their bodies
- Y) Increased soot caused individual moths to alter their pigment levels, which propagated to later generations
- Z) Moths actively changed their camouflage patterns to camouflage better

ANSWER: W) DARKER MOTHS WERE BETTER CAMOUFLAGED FROM PREDATORS AND WERE SELECTED FOR

### TOSS-UP

11) Earth and Space – *Short Answer* What was the first planet discovered since antiquity?

ANSWER: URANUS

### BONUS

11) Earth and Space – *Short Answer* Aten [*AH-tin*] asteroids are a group of asteroids that cross the orbit of what planet?

ANSWER: EARTH

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### TOSS-UP

12) Energy – *Short Answer* Computational scientists at Oak Ridge National Lab are studying transition states in chemical reactions. What class of substances are thought to exert their main effect by binding and stabilizing transition states of chemical reactions?

ANSWER: CATALYSTS (ACCEPT: ENZYMES)

### BONUS

12) Energy – *Short Answer* Scientists at SLAC National Accelerator Lab are analyzing data from the Fermi gamma-ray space telescope. One instrument on board this telescope is used to study long-duration gamma-ray bursts, which are thought to be associated with what type of massive supernova?

ANSWER: HYPERNOVA

### TOSS-UP

13) Math – *Short Answer* What is the coefficient of the  $ab$  term in the trinomial expansion of open parenthesis  $6a - 4b + 5c$  close parenthesis squared?

ANSWER:  $-48$

### BONUS

13) Math – *Short Answer* Madison went shopping in two stores with her birthday gift money. In the first store, she spent two-thirds of what she had plus \$2. In the second store, she spent four-fifths of what was left plus \$1. She then had \$3 left. How many dollars did she begin with?

ANSWER: 66

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### TOSS-UP

14) Life Science – *Multiple Choice* When compared to animals, plants rank second in total numbers of species. Which of the following groups of animals is itself more diverse than plants?

- W) Vertebrates
- X) Mammals
- Y) Bacteria
- Z) Insects

ANSWER: Z) INSECTS

### BONUS

14) Life Science – *Short Answer* What lobe of the cerebrum is the primary visual cortex located in?

ANSWER: OCCIPITAL

### TOSS-UP

15) Earth and Space – *Multiple Choice* What is the location of the densest water mass in Earth's oceans?

- W) Antarctic bottom water
- X) North Atlantic deep water
- Y) North Pacific intermediate water
- Z) Circumpolar deep water

ANSWER: W) ANTARCTIC BOTTOM WATER

### BONUS

15) Earth and Space – *Short Answer* Identify all of the following three rock-weathering processes that are physical weathering: 1) Frost wedging; 2) Exfoliation; 3) Oxidation.

ANSWER: 1, 2

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### TOSS-UP

16) Physical Science – *Multiple Choice* Which of the following real gases would behave most like an ideal gas at room temperature and pressure?

- W) Hydrogen
- X) Water
- Y) Propane
- Z) Ammonia

ANSWER: W) HYDROGEN

### BONUS

16) Physical Science – *Short Answer* What is the pH of a 1-millimolar solution of sodium hydroxide?

ANSWER: 11



### TOSS-UP

17) Life Science – *Short Answer* What type of heart chamber primarily functions to receive blood from the venous system?

ANSWER: ATRIUM

### BONUS

17) Life Science – *Multiple Choice* Which of the following is an example of a frameshift mutation?

- W) Changing one nucleotide into another
- X) Adding one nucleotide in the middle of a gene
- Y) Deleting three nucleotides in the middle of a gene
- Z) Adding three nucleotides in the middle of a gene

ANSWER: X) ADDING ONE NUCLEOTIDE IN THE MIDDLE OF A GENE

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### TOSS-UP

18) Math – *Short Answer* How many edges does a pentagonal prism have?

ANSWER: 15

### BONUS

18) Math – *Short Answer* How many numbers from 1 to 100, inclusive, are not divisible by 2 or by 3?

ANSWER: 33

### TOSS-UP

19) Earth and Space – *Short Answer* What is the only satellite in the solar system known to have a substantial atmosphere?

ANSWER: TITAN

### BONUS

19) Earth and Space – *Short Answer* Rank the following three celestial objects in increasing order of density: 1) Brown dwarf; 2) White dwarf; 3) Neutron star.

ANSWER: 1, 2, 3

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### TOSS-UP

20) Physical Science – *Multiple Choice* Which of the following statements is true of a reaction that has a very large equilibrium constant?

- W) It requires the input of energy
- X) It favors formation of reactants
- Y) It is endergonic
- Z) It is spontaneous

ANSWER: Z) IT IS SPONTANEOUS

### BONUS

20) Physical Science – *Short Answer* To the nearest whole radian per second, what is the angular speed of an object that makes a complete uniform circular revolution every second?

ANSWER: 6

**TOSS-UP**

21) Math – *Short Answer* What is the slope of a line perpendicular to the line that contains the points (2, 2) and (4, 9)?

ANSWER:  $-2/7$

**BONUS**

21) Math – *Short Answer* The numerals for the counting numbers are written in order, beginning with 1. What is the 219<sup>th</sup> digit written?

ANSWER: 9

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**TOSS-UP**

22) Life Science – *Short Answer* What cell type transmits electrical impulses in the human brain?

ANSWER: NEURONS

**BONUS**

22) Life Science – *Short Answer* RNA polymerase [*pah-LIM-er-ace*] "knows" where to start transcribing a gene because it binds what regions of DNA?

ANSWER: PROMOTERS

### TOSS-UP

23) Physical Science – *Short Answer* Consider the gravitational force between two objects, one with mass  $A$  and the other with mass  $B$ . By what factor would the gravitational force be multiplied if the objects were kept at the same distance from each other, but had masses of  $2A$  and  $3B$ , respectively?

ANSWER: 6

### BONUS

23) Physical Science – *Short Answer* An ideal gas with molar mass 26 is kept at 200 kelvins and at 4 atmospheres of pressure, and is found to have a density of 1.6 grams per liter. What is the density, in grams per liter, of a different ideal gas with molar mass 52 if it is at a temperature of 400 kelvins and a pressure of 2 atmospheres?

ANSWER: 0.8