

## ROUND 15

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### TOSS-UP

1) EARTH AND SPACE *Short Answer* Name the world's first successful meteorological satellite, launched from Cape Canaveral on April 1, 1960, which demonstrated the advantage of mapping the Earth's cloud cover from satellite altitudes?

ANSWER: TIROS (ACCEPT: TELEVISION INFRARED OBSERVATION SATELLITE)

### BONUS

1) EARTH AND SPACE *Short Answer* By name or number, identify where fine-grained terrigenous deposits are most likely to form: 1) abyssal plains, 2) atolls, 3) deep-sea fans, 4) continental margins, or 5) elevated oceanic ridges.

ANSWER: ABYSSAL PLAINS (ACCEPT: 1)

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### TOSS-UP

2) PHYSICS *Multiple Choice* Which of the following particles are classified as baryons?

- W) Weak boson
- X) Graviton
- Y) Neutrino
- Z) Neutron

ANSWER: Z) NEUTRON

### BONUS

2) PHYSICS *Short Answer* A food shipper pushes a wooden crate of lettuce with a total mass of 14 kilograms across a concrete floor with a constant horizontal force of magnitude 40 newtons. In a straight-line displacement of magnitude 0.50 meters, the speed of the crate decreases from 0.60 meters per second to 0.20 meters per second. How much work, in joules, is done by the horizontal force?

ANSWER: 20

### TOSS-UP

3) EARTH AND SPACE *Multiple Choice* Which of the following systems of climate classification is the best-known and most used?

- W) Trewartha
- X) Klaus
- Y) Köppen
- Z) Strahler

ANSWER: Y) KÖPPEN

### BONUS

3) EARTH AND SPACE *Short Answer* By name or number, identify all of the following five sedimentary structures that would indicate the direction of water flow: 1) ripple marks, 2) parallel lamination, 3) flute casts, 4) streamlined islands, 5) cross-bedding.

ANSWER: RIPPLE MARKS, FLUTE CASTS, STREAMLINED ISLANDS, AND CROSS-BEDDING (1, 3, 4 AND 5)

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### TOSS-UP

4) ENERGY *Short Answer* What specific compound has emerged as a potential redox active material choice for two-step thermochemical cycling due to its rapid fuel production kinetics and high selectivity?

ANSWER: CERIUM (IV) OXIDE (ACCEPT:  $\text{CeO}_2$ , CERIA, CERIC OXIDE)  
(DO NOT ACCEPT: CERIUM OXIDE, CERIUM (III) OXIDE, CERIUM (II) OXIDE)

### BONUS

4) ENERGY *Short Answer* A nuclear power plant is situated on the bank of a river. The power plant produces 200 megawatts of power and releases  $1.5 \times 10^{13}$  joules of heat per day into the river through the cooling system. If the flow rate of the river is  $5.0 \times 10^4$  kilograms per second and the specific heat of water is  $4.2 \times 10^3$  joules per kilogram degree Celsius, what is the maximum temperature increase of the river water due to the cooling system, in degrees Celsius to the nearest integer?

ANSWER: 1

### TOSS-UP

5) BIOLOGY *Short Answer* What kind of cells, present in most human tissues characteristically surrounding blood vessels and nerves, has been coined the twin of basophile granulocytes (read as: GRAHN-yuh-lōe-syts)?

ANSWER: MAST

### BONUS

5) BIOLOGY *Short Answer* An unknown substance is tested by 2 reagents. The Lugol's test yields a black color while the Benedict's test yields a light blue color. Amylase is added and then the substance is retested. The second Lugol's test is negative, while the second Benedict's test yields a red color. What substances were present before and after, respectively, the amylase was added?

ANSWER: POLYSACCHARIDE (ACCEPT: STARCH, DO NOT ACCEPT: GLYCOGEN) AND MONOSACCHARIDE (ACCEPT: SIMPLE SUGAR, REDUCING SUGAR)

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### TOSS-UP

6) MATH *Short Answer* Linear correlation coefficients must lie between what two values?

ANSWER: -1 AND 1

### BONUS

6) MATH *Multiple Choice* The sum of the squares of reciprocals of all positive integers equals which of the following?

- W)  $\sqrt{\pi}$
- X)  $\pi/3$
- Y)  $\pi^2/6$
- Z)  $\pi^3/12$

ANSWER: Y)  $\pi^2/6$

**TOSS-UP**

7) BIOLOGY *Short Answer* What genus of bacteria uses horizontal gene transfer to cause tumors in plants?

ANSWER: *AGROBACTERIUM*

**BONUS**

7) BIOLOGY *Short Answer* An F1 individual is heterozygous for each of 4 traits, A, B, C, and D, and is allowed to self-fertilize. What is the probability that the offspring will be AaBBccDd?

ANSWER: 1/64

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**TOSS-UP**

8) ENERGY *Multiple Choice* Plasmas are considered strongly coupled when the ratio of the average distance between the particles to the distance of closest approach is which of the following?

- W) Small
- X) Large
- Y) Roughly equal to one
- Z) Roughly equal to zero

ANSWER: W) SMALL

**BONUS**

8) ENERGY *Short Answer* Assuming an equal concentration of each substance, by name or number, order the following four choices in terms of radiative forcing, from greatest to least: 1) carbon dioxide, 2) methane, 3) fluorocarbons, 4) nitrous oxide.

ANSWER: FLUOROCARBONS, NITROUS OXIDE, METHANE, CARBON DIOXIDE (ACCEPT: 3, 4, 2, 1)

### TOSS-UP

9) PHYSICS *Multiple Choice* Which of the following best represents a closed system?

- W) A 2-liter bottle filled with aquatic plants, a fish, water, and a bit of air, sealed with a tight lid and placed in a window
- X) A terrarium with a closed lid, some plants, and a live boa constrictor
- Y) The Earth
- Z) The universe

ANSWER: Z) THE UNIVERSE

### BONUS

9) PHYSICS *Short Answer* An electron microscope enables observation of detail on a virus down to 6 nanometers. Given  $h$  as  $6.6 \times 10^{-34}$  joule seconds and the mass of the electron as  $9.1 \times 10^{-31}$  kilograms, providing your answer in scientific notation with two significant digits, how fast, in meters per second, must an electron in the microscope be moving to observe detail of this size?

ANSWER:  $1.2 \times 10^5$

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### TOSS-UP

10) BIOLOGY *Multiple Choice* Which of the following statements is NOT true about the G protein hormone receptor system?

- W) It is an example of membrane-based signal transduction
- X) It results in an amplification of the original signal
- Y) The hormone is a ligand for the G protein
- Z) The G protein must be able to move along the membrane

ANSWER: Y) THE HORMONE IS A LIGAND FOR THE G PROTEIN

### BONUS

10) BIOLOGY *Multiple Choice* Some disease-causing microbes attack the body by turning on or off specific signal transduction pathways. In the disease cholera, for example, a toxin from the bacterium *Vibrio cholera* enters intestinal cells and chemically modifies G proteins. Once modified, the G proteins can no longer cleave GTP into GDP. Which of the following would you expect to see within the intestinal cells of a person with cholera?

- W) The G proteins remain activated and continually activate adenylyl cyclase
- X) The G proteins cannot become activated and cannot activate adenylyl cyclase
- Y) The G protein subunits do not separate from each other
- Z) The receptor in the membrane is continually activated

ANSWER: W) THE G PROTEINS REMAIN ACTIVATED AND CONTINUALLY ACTIVATE ADENYLYL CYCLASE

### TOSS-UP

11) MATH *Multiple Choice* Which of the following is NOT true?

- W) A rational function's graph may intersect its horizontal asymptote
- X) A rational function's graph may intersect one of its vertical asymptotes
- Y) The function  $f(x) = -1/x$  is its own inverse
- Z) The function  $f(x) = -x$  is its own inverse

ANSWER: X) A RATIONAL FUNCTION'S GRAPH MAY INTERSECT ONE OF ITS VERTICAL ASYMPTOTES

### BONUS

11) MATH *Short Answer* A rectangular box has the dimensions 6 inches by 10 inches by 12 inches. What is the length of the space diagonal in inches, in simplest radical form?

ANSWER:  $2\sqrt{70}$

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### TOSS-UP

12) CHEMISTRY *Short Answer* To identify the chemical compounds dissolved in a sample, a student dips a clean piece of nichrome wire into the sample and burns it in a flame. By name or number, identify all of the following five substances that might be present if the flame burns blue: 1) selenium, 2) sodium, 3) arsenic, 4) boron, 5) lead.

ANSWER: SELENIUM, ARSENIC, LEAD (ACCEPT: 1, 3, 5)

### BONUS

12) CHEMISTRY *Short Answer* Given that the balanced chemical equation for the reaction of oxygen and ethane is:  $2\text{C}_2\text{H}_6(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$ , if 16 grams of  $\text{O}_2$  react with excess  $\text{C}_2\text{H}_6$ , to the nearest gram, how many grams of  $\text{CO}_2$  will be formed?

ANSWER: 13

### TOSS-UP

13) EARTH AND SPACE *Short Answer* What kind of surveying attempts to determine what the sea floor looks like, focusing on water depth and nature of sea floor material, and supporting activities such as nautical charting, dredging, coastal engineering, and offshore resource development?

ANSWER: HYDROGRAPHIC

### BONUS

13) EARTH AND SPACE *Short Answer* In Long Island's Peconic Bays, a bloom of small marine algae called *Aureococcus anophagefferens* (read as: ohr-ee-oh- KOH-kuhs ah-noh-fah-geh-FEH-rehns) turned the water a deep brown. By name or number, identify all of the following four organisms that were physically harmed by this brown tide: 1) scallops, 2) eelgrass, 3) humans, 4) mussels.

ANSWER: SCALLOPS, EELGRASS, MUSSELS (ACCEPT: 1, 2, 4)

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### TOSS-UP

14) CHEMISTRY *Short Answer* How many lone pairs of electrons are on the phosphorus atom in PF<sub>3</sub>?

ANSWER: 1

### BONUS

14) CHEMISTRY *Short Answer* Given the balanced chemical equation:  
$$\text{H}_2\text{SO}_{4(\text{aq})} + 2\text{NaOH}_{(\text{aq})} \rightarrow \text{Na}_2\text{SO}_{4(\text{aq})} + 2\text{H}_2\text{O}_{(\text{l})}$$
in an acid-base titration, 25 milliliters of 0.2 molar H<sub>2</sub>SO<sub>4</sub> were required to neutralize 100 milliliters of NaOH solution. Providing your answer as a decimal to the nearest tenth, what is the molarity of the NaOH solution?

ANSWER: 0.1

### TOSS-UP

15) BIOLOGY *Short Answer* What cellular process, associated with regeneration, can spontaneously occur in lower animals but not in humans?

ANSWER: DEDIFFERENTIATION

### BONUS

15) BIOLOGY *Short Answer* By number, order the following four steps from earliest to latest in an action potential: 1) sodium channel inactivation gates close and gated potassium channels open; 2) leak potassium channels are open and all gated channels are closed; 3) activation gates of some sodium channels open; 4) voltage gated sodium activation channels open.

ANSWER: 2, 3, 4, 1

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### TOSS-UP

16) CHEMISTRY *Multiple Choice* Which of the following molecules contains only one non-bonding pair of valence electrons?

W) HCN

X)  $\text{NH}_4^+$

Y)  $\text{C}_2\text{H}_4$

Z)  $\text{N}_2$

ANSWER: W) HCN

### BONUS

16) CHEMISTRY *Short Answer* Given the balanced equation:  $2\text{C}_4\text{H}_{10(g)} + 13\text{O}_{2(g)} \rightarrow 8\text{CO}_{2(g)} + 10\text{H}_2\text{O}_{(g)}$ , what is the percent yield of water if 15 moles of water is obtained when 4 moles of butane is burned in excess oxygen?

ANSWER: 75%

**TOSS-UP**

17) MATH *Short Answer* What is the name of the point at which the three angle bisectors of a triangle intersect?

ANSWER: INCENTER

**BONUS**

17) MATH *Short Answer* Each of the following equations represents a plane:  $x - y = 6$ ;  $2x - 3z = 16$ ;  $2y + z = 4$ . At which point  $(x, y, z)$ , will they intersect?

ANSWER: (8, 2, 0)

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**TOSS-UP**

18) PHYSICS *Short Answer* Air resistance is a function of the effective cross sectional area of the body, the drag coefficient, and what other two variables?

ANSWER: AIR DENSITY AND VELOCITY

**BONUS**

18) PHYSICS *Short Answer* A 2.0 kilogram possum hangs from a tree limb 5 meters above the ground. Assuming that the gravitational potential energy is zero at  $y = 0$  and that  $g$  is 9.8 meters per second squared, what is the gravitational potential energy, to the nearest joule, of the possum-Earth system if we take the reference point  $y = 0$  to be 1.0 meters above the limb?

ANSWER: -20

### TOSS-UP

19) BIOLOGY *Multiple Choice* In ecology, there are two rules that identify relationships between the animal's habitat and its shape and structure. Bergmann's rule predicts that body size decreases in proximity to the equator, while Allen's rule predicts that appendages increase in size in proximity to the equator. Which of the following represents the basis for these predictions?

- W) Small animals have a higher survival rate at the equator because of the dense foliage
- X) There is less competition for food in the Arctic, so animals can grow larger
- Y) Animals with a low surface area to volume ratio can conserve heat more easily
- Z) The foundation for understanding both rules is based on Gloger's rule

ANSWER: Y) ANIMALS WITH A LOW SURFACE AREA TO VOLUME RATIO CAN CONSERVE HEAT MORE EASILY

### BONUS

19) BIOLOGY *Short Answer* By name or number, identify all of the following five interactions that are typically interspecific and result in one species benefitting while the other is harmed: 1) mutualism, 2) amensalism, 3) parasitism, 4) commensalism, 5) herbivory.

ANSWER: PARASITISM, HERBIVORY (ACCEPT: 3 AND 5)

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### TOSS-UP

20) CHEMISTRY *Short Answer* What is the hybridization of the xenon atom in xenon tetrafluoride?

ANSWER:  $sp^3d^2$

### BONUS

20) CHEMISTRY *Short Answer* A 2.00 mole sample of ammonium nitrate is decomposed in a bomb calorimeter. The temperature of the calorimeter increases by 12 Kelvin. The heat capacity of the system is 1.5 kilojoules per Kelvin. What is the molar heat of decomposition of ammonium nitrate in kilojoules?

ANSWER: 9

### TOSS-UP

21) PHYSICS *Multiple Choice* Assuming negligible air resistance, which of the following statements is TRUE about two-dimensional projectile motion?

- W) The vertical motion is dependent on the horizontal motion
- X) The horizontal motion is dependent on the vertical motion
- Y) The horizontal motion and vertical motion are both dependent on the projectile's acceleration vector
- Z) The horizontal motion and vertical motion are independent of each other

ANSWER: Z) THE HORIZONTAL MOTION AND VERTICAL MOTION ARE INDEPENDENT OF EACH OTHER

### BONUS

21) PHYSICS *Short Answer* A falling cat reaches a first terminal speed of 100 kilometers per hour while it is tucked in and then stretches out, doubling its effective cross-sectional area without changing its drag coefficient. Providing your answer to the nearest ten, how fast is it falling in meters per second when it reaches a new terminal speed?

ANSWER: 70

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### TOSS-UP

22) EARTH AND SPACE *Short Answer* What is the term for the global variation in sea level brought about by a change in the volume of water occupying the ocean basins?

ANSWER: EUSTASY

### BONUS

22) EARTH AND SPACE *Multiple Choice* Which of the following was the LEAST common use of a typical astrolabe?

- W) Finding the time of day
- X) Finding the time of a celestial event
- Y) Reference for celestial positions
- Z) Maritime navigational instrument

ANSWER: Z) MARITIME NAVIGATIONAL INSTRUMENT

### TOSS-UP

23) PHYSICS *Multiple Choice* Which of the following is the most accurate description of charging by induction?

- W) It depends on putting two objects in actual physical contact with each other
- X) It depends on the use of friction
- Y) It depends on the use of a ground to redistribute charges
- Z) It depends on gain of electrons during chemical reactions

ANSWER: Y) IT DEPENDS ON THE USE OF A GROUND TO REDISTRIBUTE CHARGES

### BONUS

23) PHYSICS *Short Answer* Providing your answer in scientific notation with one significant digit, calculate the de Broglie wavelength, in meters, of a car with a mass of 1600 kilograms traveling at a speed of 40 meters per second.

ANSWER:  $1 \times 10^{-38}$

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### TOSS-UP

24) ENERGY *Multiple Choice* Which of the following is NOT an advantage of radio-frequency accelerators?

- W) The technology is well established
- X) Emittance dominates transverse beam dynamics during acceleration and storage, rather than space charge
- Y) Obtaining the required ion energy is straightforward due to the high acceleration gradients in radio-frequency structures
- Z) Storage rings are not needed since beams can be compressed in length as they are accelerated

ANSWER: Z) STORAGE RINGS ARE NOT NEEDED SINCE BEAMS CAN BE COMPRESSED IN LENGTH AS THEY ARE ACCELERATED

### BONUS

24) ENERGY *Short Answer* By name or number, order the following processes from first to last in a gas turbine operating under an actual Brayton cycle: 1) heat rejection, 2) expansion, 3) heat addition, 4) compression.

ANSWER: COMPRESSION, HEAT ADDITION, EXPANSION, HEAT REJECTION (ACCEPT: 4, 3, 2, 1)

### TOSS-UP

25) MATH *Multiple Choice* You are conducting an experiment. In a large elementary school, you select two age-matched groups of students. Group 1 follows a normal schedule. Group 2 spends 30 minutes a day in art class in addition to their other classes. You want to test whether learning art makes a student less likely to get in trouble. You consider a student in trouble if he or she was sent to the principal's office at any time during the year. The data you collect would BEST be analyzed by which of the following?

- W) Two populations, difference in means, paired data
- X) Two populations, difference in means, unpaired data
- Y) Two populations, difference in proportions
- Z) Two populations, contingency table

ANSWER: Y) TWO POPULATIONS, DIFFERENCE IN PROPORTIONS

### BONUS

25) MATH *Short Answer* Water flows at 10 cubic feet per minute into a cylinder with a radius of 5 feet and height of 12 feet. Providing your answer as a fraction in simplest form in terms of  $\pi$ , how fast is the water rising in feet per minute when the height is 4 feet?

ANSWER:  $\frac{2}{5\pi}$