

## ROUND 6

### TOSS-UP

1) CHEMISTRY *Multiple Choice* Recycling code 2 indicates which of the following types of plastic?

- W) Polyvinyl chloride
- X) Polystyrene (read as: pahl-i-STYR-eeen)
- Y) High-density polyethylene
- Z) Polyethylene terephthalate

ANSWER: Y) HIGH-DENSITY POLYETHYLENE

### BONUS

1) CHEMISTRY *Short Answer* If 4.67 grams of butane reacts with 23.12 grams of molecular oxygen to produce 2.67 grams of carbon dioxide, what is the limiting reactant?

ANSWER: BUTANE

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### TOSS-UP

2) MATH *Multiple Choice* If the derivative of  $f(x)$  is positive on the closed interval  $[a, b]$ , then which of the following statements is TRUE?

- W)  $f(x)$  is increasing on  $[a, b]$
- X)  $f(x)$  has critical points at  $a$  and  $b$
- Y)  $f(x)$  is constant on  $[a, b]$
- Z)  $f(x)$  cannot have an inflection point on  $[a, b]$

ANSWER: W)  $f(x)$  IS INCREASING ON  $[a, b]$

### BONUS

2) MATH *Short Answer* Providing your answer in simplest form, give the volume in terms of  $\pi$  of a solid generated by revolving the region bounded by the graph of  $y = \ln(x)$  (read as:  $y$  equals the natural log of  $x$ ), the  $x$ -axis, the lines  $x = 1$ , and  $x = e$ , about the  $y$ -axis.

ANSWER:  $\frac{1}{2} \pi (e^2 + 1)$  [ACCEPT:  $\pi(\frac{e^2}{2} + \frac{1}{2})$ ]

**TOSS-UP**

3) PHYSICS *Short Answer* Using 9.8 meters per second squared for g and providing your answer to the nearest kilojoule, what is the gravitational potential energy of a 33 kilogram cart halfway down a 25-meter high slope that is 60 meters long?

ANSWER: 4

**BONUS**

3) PHYSICS *Short Answer* Assuming that the speed of sound in air is 343 meters per second and providing your answer to the nearest integer, what is the fundamental frequency in hertz produced by a pipe with a length of 3 meters that is open at both ends?

ANSWER: 57

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**TOSS-UP**

4) BIOLOGY *Short Answer* What is the common name of the seabird that has the largest wingspan of any living bird, up to 11.5 feet?

ANSWER: ALBATROSS (ACCEPT: WANDERING ALBATROSS)

**BONUS**

4) BIOLOGY *Short Answer* What adjective describes hormones that cause secretion of other hormones?

ANSWER: TROPIC

### TOSS-UP

5) CHEMISTRY *Multiple Choice* Sodium azide and potassium nitrate react to inflate an airbag during a car crash primarily by producing which of the following gases?

- W) Nitrogen
- X) Oxygen
- Y) Potassium oxide
- Z) Sodium nitrate

ANSWER: W) NITROGEN

### BONUS

5) CHEMISTRY *Short Answer* By name or number, identify all of the following four characteristics that are intensive properties of a bubble of air: 1) density, 2) radius, 3) percent oxygen, 4) temperature.

ANSWER: DENSITY, PERCENT OXYGEN, AND TEMPERATURE (ACCEPT: 1, 3, AND 4)

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### TOSS-UP

6) PHYSICS *Multiple Choice* Under which of the following conditions is the momentum of a system unchanged?

- W) The system is undergoing acceleration
- X) The system is acted upon by multiple forces
- Y) The net external forces are zero
- Z) The net internal forces are zero

ANSWER: Y) THE NET EXTERNAL FORCES ARE ZERO

### BONUS

6) PHYSICS *Short Answer* Providing your answer to the nearest hundredth, what is the moment of inertia in kilogram meters squared of a solid sphere with a mass of 2.5 kilograms and a radius of 30 centimeters?

ANSWER: 0.09

### TOSS-UP

7) EARTH AND SPACE *Multiple Choice* Which of the following best describes surface airflow in a northern hemisphere middle-latitude cyclone?

- W) Divergent and clockwise
- X) Divergent and counterclockwise
- Y) Convergent and clockwise
- Z) Convergent and counterclockwise

ANSWER: Z) CONVERGENT AND COUNTERCLOCKWISE

### BONUS

7) EARTH AND SPACE *Short Answer* Name the kind of equilibrium state, characterized by a balance between internal pressure and gravity, of the dense gas or fluid of any main sequence star.

ANSWER: HYDROSTATIC

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### TOSS-UP

8) PHYSICS *Multiple Choice* The single electron in the ground state of hydrogen is bound to the proton by 13.6 electron volts. If it is excited to the  $n = 2$  state, by which of the following energies, in electron volts, is it now bound?

- W) 3.4
- X) 6.8
- Y) 13.6
- Z) 54.4

ANSWER: W) 3.4

### BONUS

8) PHYSICS *Short Answer* A model truck with a mass of 1.0 kilogram is accelerated by an electric motor from rest to 0.8 meters per second in 20 milliseconds. What is the average power, in watts, delivered by the motor during this time?

ANSWER: 16

**TOSS-UP**

9) ENERGY *Multiple Choice* Which of the following BEST represents the percentage of global oil reserves located in North America?

- W) 5
- X) 10
- Y) 15
- Z) 20

ANSWER: W) 5

**BONUS**

9) ENERGY *Short Answer* To study fuel and water use by migrating birds, what controlled environment do researchers use in order to assess fat stores, protein mass, water, and immunological function when birds fly long distances?

ANSWER: WIND TUNNEL

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**TOSS-UP**

10) MATH *Short Answer* Simplify  $i^{17}$  completely.

ANSWER:  $i$

**BONUS**

10) MATH *Short Answer* Evaluate the following limit:  $\lim_{n \rightarrow \infty} \left(1 + \frac{3}{n}\right)^n$  (read as: the limit as  $n$  approaches infinity of open parenthesis 1 plus 3 over  $n$  close parenthesis to the power of  $n$ ).

ANSWER:  $e^3$

### TOSS-UP

11) EARTH AND SPACE *Short Answer* On Earth, what is the average time from one high tide to the next, in hours and minutes?

ANSWER: 12 HOURS AND 25 MINUTES (ACCEPT ANY ANSWER BETWEEN: 12:15 AND 12:45)

### BONUS

11) EARTH AND SPACE *Multiple Choice* Which of the following correctly generalizes how crystal size compares between extrusive and intrusive rocks?

- W) Extrusive rocks have larger crystals
- X) Intrusive rocks have larger crystals
- Y) Extrusive and intrusive rocks have comparable sizes of crystals
- Z) Crystal size is variable and unpredictable

ANSWER: X) INTRUSIVE ROCKS HAVE LARGER CRYSTALS

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### TOSS-UP

12) PHYSICS *Multiple Choice* Which of the following kinds of cells CANNOT be recharged?

- W) Dry
- X) Wet
- Y) Primary
- Z) Secondary

ANSWER: W) DRY

### BONUS

12) PHYSICS *Short Answer* A 600-newton worker is standing 1.00 meters from the left end of a 200-newton scaffold that is 3.00 meters long and supported by cables at each end. What is the tension in newtons in the right-hand cable?

ANSWER: 300

### TOSS-UP

13) EARTH AND SPACE *Multiple Choice* A fault is an example of which of the following types of strain?

- W) Brittle
- X) Elastic
- Y) Plastic
- Z) Dilational

ANSWER: W) BRITTLE

### BONUS

13) EARTH AND SPACE *Multiple Choice* Which of the following properties of felsic melts makes them more viscous than mafic melts?

- W) Higher temperature
- X) Higher volatile content
- Y) Higher silica content
- Z) Erupting at a higher elevation

ANSWER: Y) HIGHER SILICA CONTENT

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### TOSS-UP

14) ENERGY *Multiple Choice* Which of the following energy generation methods is the BEST source for baseload?

- W) Hydroelectric
- X) Wind
- Y) Solar
- Z) Tidal turbines

ANSWER: W) HYDROELECTRIC

### BONUS

14) ENERGY *Short Answer* If 50.0 grams of water cools from 35.10° Celsius to 26.05° Celsius, providing your answer to the nearest hundred, how much heat is released in joules?

ANSWER: 1,900

### TOSS-UP

15) BIOLOGY *Short Answer* Moths have evolved high-frequency hearing as a defense against which organisms?

ANSWER: BATS

### BONUS

15) BIOLOGY *Short Answer* Give the common name of a family of large Asian birds that has the following unique nesting characteristics: When a female is ready to lay eggs, she enters a hole in a tree and seals off the entrance, leaving just a narrow opening. Once sealed inside, she becomes dependent on the male, who passes food through the hole while she incubates and raises the chicks.

ANSWER: HORNBILLS

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### TOSS-UP

16) MATH *Multiple Choice* Which of the following statements is TRUE?

- W) A correlation of +0.8 is stronger than a correlation of -0.8
- X) A correlation of +0.8 is weaker than a correlation of -0.8
- Y) A correlation of +0.8 is just as strong as a correlation of -0.8
- Z) It is impossible to tell which correlation is stronger

ANSWER: Y) A CORRELATION OF +0.8 IS JUST AS STRONG AS A CORRELATION OF -0.8

### BONUS

16) MATH *Short Answer* Providing your answer in decimal form, what is the limit of  $\sum_{n=0}^{\infty} \frac{3^n + 4^n}{5^n}$   
(read as: the summation of  $n$  equals 0 to infinity of [pause] open parenthesis 3 to the  $n$  plus 4 to the  $n$  close parenthesis over 5 to the  $n$ )?

ANSWER: 7.5

**TOSS-UP**

17) BIOLOGY *Multiple Choice* Cephalopods belong to which of the following groups?

- W) Mollusks
- X) Annelids
- Y) Roundworms
- Z) Arthropods

ANSWER: W) MOLLUSKS

**BONUS**

17) BIOLOGY *Short Answer* By name or number, identify all of the following five animals that are even-toed ungulates: 1) peccaries, 2) camels, 3) goats, 4) bison, 5) horses.

ANSWER: PECCARIES, CAMELS, AND GOATS (ACCEPT: 1, 2, AND 3)

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**TOSS-UP**

18) ENERGY *Short Answer* Which country supplies the U.S. with 95% of its needed rare earth elements, key components in electronics, solar panels, and hybrid cars?

ANSWER: CHINA

**BONUS**

18) ENERGY *Short Answer* What kinds of electromagnetic emissions from the Crab Nebula were so stable that they were used for decades to calibrate space-borne instruments?

ANSWER: X-RAY

**TOSS-UP**

19) MATH *Short Answer* Considering the function  $f(x) = 2x^3 + 5x^2 + 4$ , what is the instantaneous rate of change at the point  $(-1, 7)$ ?

ANSWER: -4

**BONUS**

19) MATH *Short Answer* Find all values of  $c$  such that the given function is continuous from negative infinity to infinity:  $f(x) = c^2x$  when  $x \leq 2$ , and  $f(x) = (5/4)cx^2 + 3$  when  $x > 2$ .

ANSWER:  $-\frac{1}{2}, 3$

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**TOSS-UP**

20) BIOLOGY *Short Answer* Proteins have different levels of structure. Which level of structure is identified with hydrogen bonds at regular intervals that produce alpha helices and beta-pleated sheets?

ANSWER: SECONDARY

**BONUS**

20) BIOLOGY *Multiple Choice* If a student were to analyze the liquid in the nephrons of humans and the nephridia of earthworms, which of the following pairs of substances might be found in both organisms?

- W) Salts and urea
- X) Salts and sugar
- Y) Sugar and urea
- Z) Sugar and ammonia

ANSWER: W) SALTS AND UREA

**TOSS-UP**

21) MATH *Short Answer* What is the derivative of the integral of  $x^4$  with respect to  $x$ ?

ANSWER:  $x^4$

**BONUS**

21) MATH *Short Answer* Find the radius and the center, respectively, of the circle with the equation:  $x^2 + y^2 - 16x + 12y + 75 = 0$ ?

ANSWER: RADIUS = 5; CENTER = (8, -6)

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**TOSS-UP**

22) CHEMISTRY *Short Answer* What element corresponds to the electron configuration  $1s^2 2s^2 2p^5$ ?

ANSWER: FLUORINE

**BONUS**

22) CHEMISTRY *Multiple Choice* In which of the following sets of elements would all members be expected to have very similar chemical properties?

- W) Neon, oxygen, and fluorine
- X) Argon, bromine, and krypton
- Y) Magnesium, calcium, and barium
- Z) Aluminum, silicon, and phosphorus

ANSWER: Y) MAGNESIUM, CALCIUM, AND BARIUM

### TOSS-UP

23) EARTH AND SPACE *Multiple Choice* Which of the following most accurately provides the three necessary ingredients for thunderstorm formation?

- W) Moisture, lifting mechanism, instability
- X) Lifting mechanism, mountains, oceans
- Y) Stability, moisture, heat
- Z) Lifting mechanism, fronts, moisture

ANSWER: W) MOISTURE, LIFTING MECHANISM, INSTABILITY

### BONUS

23) EARTH AND SPACE *Multiple Choice* The image resolution of a large optical telescope is most directly related to which of the following?

- W) Focal length of the objective
- X) Diameter of the objective
- Y) Atmospheric conditions of the observing site
- Z) Astigmatism of the optical system

ANSWER: Y) ATMOSPHERIC CONDITIONS OF THE OBSERVING SITE

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### TOSS-UP

24) CHEMISTRY *Multiple Choice* Which of the following is an example of effusion?

- W) The formation of snowflakes in the upper atmosphere
- X) A hot air balloon flight
- Y) The evaporation of water from a lake
- Z) A bike tire losing air after running over a nail

ANSWER: Z) A BIKE TIRE LOSING AIR AFTER RUNNING OVER A NAIL

### BONUS

24) CHEMISTRY *Short Answer* When hydrochloric acid in an aqueous solution reacts with solid sodium bicarbonate, what are the products?

ANSWER: CARBON DIOXIDE, WATER, AND SODIUM CHLORIDE (ACCEPT: CARBON DIOXIDE GAS, LIQUID WATER, AND AQUEOUS SODIUM CHLORIDE)

### TOSS-UP

25) BIOLOGY *Multiple Choice* Which of the following monomers CANNOT be converted into an intermediate that can be used for cellular respiration?

- W) Fatty acids
- X) Glycerol
- Y) Amino acids
- Z) Nucleic acids

ANSWER: Z) NUCLEIC ACIDS

### BONUS

25) BIOLOGY *Short Answer* What is the name for the technique in which DNA is digested using restriction enzymes, separated using gel electrophoresis, transferred to a filter, treated with an alkaline solution, and radioactively probed to search for specific DNA sequences?

ANSWER: SOUTHERN BLOT (DO NOT ACCEPT: BLOT, NORTHERN BLOT OR WESTERN BLOT)