

ROUND 6A

TOSS-UP

1) Physics – *Multiple Choice* Uniform circular motion is achieved by applying force in what direction?

- W) Toward the center of rotation
- X) Away from the center of rotation
- Y) In the direction of motion
- Z) Against the direction of motion

ANSWER: W) TOWARD THE CENTER OF ROTATION

BONUS

1) Physics – *Short Answer* What radioactive isotope of carbon is prominently used in radiometric dating?

ANSWER: CARBON-14 (ACCEPT: 14)

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### TOSS-UP

2) Chemistry – *Multiple Choice* Which of the following is considered a strong acid?

- W) Hydrofluoric acid
- X) Nitric acid
- Y) Formic acid
- Z) Nitrous acid

ANSWER: X) NITRIC ACID

### BONUS

2) Chemistry – *Multiple Choice* Which of the following polyprotic [*polly-PRO-tic*] acids has only two pKa values?

- W) Ascorbic acid
- X) Phosphoric [*faws-FOR-ik*] acid
- Y) Arsenic acid
- Z) Citric acid

ANSWER: W) ASCORBIC ACID

**TOSS-UP**

3) Math – *Multiple Choice*  $A$  and  $B$  are statements, and  $B$  is false. Which of the following is true regarding the statement " $B$  implies  $A$ ?"

- W) It is true regardless of the truth value of  $A$
- X) It is false regardless of the truth value of  $A$
- Y) It is true only when  $A$  is true and false otherwise
- Z) It is true only when  $A$  is false and false otherwise

ANSWER: W) IT IS TRUE REGARDLESS OF THE TRUTH VALUE OF  $A$

**BONUS**

3) Math – *Short Answer* The line with equation  $y = 5x + 4$  is reflected across the line  $y = x$ . What are the slope and  $y$ -intercept of its image, respectively?

ANSWER: SLOPE =  $1/5$ ,  $y$ -INTERCEPT =  $-4/5$  (ACCEPT: 0.2 and  $-0.8$ , respectively)



**TOSS-UP**

4) Earth and Space – *Multiple Choice* What type of fault created the Loma Prieta earthquake in 1989?

- W) Normal
- X) Reverse
- Y) Strike-slip
- Z) Thrust

ANSWER: Y) STRIKE-SLIP

**BONUS**

4) Earth and Space – *Short Answer* What is the parent rock of slate?

ANSWER: SHALE

### TOSS-UP

5) Energy – *Multiple Choice* Wind, moving water, sunlight, and heat from Earth’s interior are sources of what type of energy?

- W) Renewable
- X) Fossil
- Y) Alternative
- Z) Reusable

ANSWER: W) RENEWABLE

### BONUS

5) Energy – *Multiple Choice* Which of the following was not one of the top three carbon-dioxide-emitting countries in 2014?

- W) India
- X) China
- Y) United States
- Z) Russia

ANSWER: Z) RUSSIA

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TOSS-UP

6) Biology – *Multiple Choice* Which chamber in the heart has the highest systolic pressure?

- W) Right atrium
- X) Right ventricle
- Y) Left atrium
- Z) Left ventricle

ANSWER: Z) LEFT VENTRICLE

BONUS

6) Biology – *Short Answer* List the correct order of a secretory protein pathway from synthesis to secretion:
1) Golgi apparatus; 2) Endoplasmic reticulum [*reh-TIK-yoo-lum*]; 3) Plasma membrane.

ANSWER: 2, 1, 3 (ACCEPT: ENDOPLASMIC RETICULUM, GOLGI APPARATUS, PLASMA MEMBRANE)

TOSS-UP

7) Earth and Space – *Multiple Choice* What type of rock is found in most cave systems?

- W) Sandstone
- X) Granite
- Y) Basalt
- Z) Limestone

ANSWER: Z) LIMESTONE

BONUS

7) Earth and Space – *Short Answer* According to the Richter scale, to the nearest whole number, how many times as much energy does a 5.7 earthquake release as a 4.7 earthquake?

ANSWER: 32

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### TOSS-UP

8) Energy – *Multiple Choice* At the DOE's Advanced Photon Source, researchers are studying industrial catalysts used in petrochemical processing. Which of the following correctly describes most of these catalysts?

- W) Organic molecules
- X) Enzymes
- Y) Homogeneous inorganic
- Z) Heterogeneous inorganic

ANSWER: Z) HETEROGENEOUS INORGANIC

### BONUS

8) Energy – *Multiple Choice* Lawrence Berkeley National Lab scientists have been studying XPG, a protein found to play a role in protecting the body from cancer. Which of the following proteins likely plays a similar role to XPG?

- W) Phosphofructokinase [*faws-fo-frook-toh-KYE-nase*]
- X) p53
- Y) Aldolase
- Z) Carbonic anhydrase

ANSWER: X) p53

### TOSS-UP

9) Math – *Short Answer* A one-to-one function has its graph in the second quadrant. In which quadrant will the graph of its inverse lie?

ANSWER: FOURTH (ACCEPT: 4)

### BONUS

9) Math – *Short Answer* If the line tangent to the graph of the differentiable function  $f$  of  $x$  at the point  $(-2, 5)$  passes through the point  $(3.5, -3)$ , then what is value of the derivative of  $f$  of  $x$  when  $x = -2$ ?

ANSWER:  $-16/11$  (ACCEPT:  $-1 \frac{5}{11}$ )

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TOSS-UP

10) Chemistry – *Short Answer* What gas, whose methylated derivative is used in rocket fuels, is produced by bubbling ammonia through a sodium hypochlorite solution?

ANSWER: HYDRAZINE (ACCEPT: N_2H_4)

BONUS

10) Chemistry – *Short Answer* The isomerization reaction of a particular cis-alkene to its trans-isomer is first order. In terms of liters, moles, and seconds, what are the units for the rate constant of this reaction?

ANSWER: INVERSE SECONDS (ACCEPT: SECONDS TO THE NEGATIVE ONE, 1 OVER SECONDS)

TOSS-UP

11) Biology – *Multiple Choice* Grasses provide an example of a root system that is best described as which of the following?

- W) Monocot tap
- X) Dicot tap
- Y) Monocot fibrous
- Z) Dicot fibrous

ANSWER: Y) MONOCOT FIBROUS

BONUS

11) Biology – *Short Answer* If a Gram stain were performed on E. coli [*ee COLE-eye*] with saffranin [*SAFF-rah-nin*] as the counterstain, what color would the bacteria appear to be?

ANSWER: RED (ACCEPT: PINK)



TOSS-UP

12) Physics – *Short Answer* On a standing wave, what term refers to the points at which the amplitude is maximized?

ANSWER: ANTI-NODE (DO NOT ACCEPT: PEAK)

BONUS

12) Physics – *Short Answer* Suppose the Earth's radius were decreased by half but its mass remained the same. To one decimal place, by what factor will the surface escape velocity be multiplied?

ANSWER: 1.4 (DO NOT ACCEPT: $\sqrt{2}$)

TOSS-UP

13) Energy – *Short Answer* While fluorescent lamps have a much higher efficiency than incandescent bulbs, they require special disposal concerns due to their construction involving what heavy metal vapor?

ANSWER: MERCURY

BONUS

13) Energy – *Short Answer* What are the coolant and the moderator, respectively, in pressurized heavy water reactors?

ANSWER: HEAVY WATER AND HEAVY WATER (ACCEPT: DEUTERIUM OXIDE OR D₂O FOR HEAVY WATER)

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### TOSS-UP

14) Biology – *Short Answer* What is the repeating unit found in skeletal muscles?

ANSWER: SARCOMERE

### BONUS

14) Biology – *Multiple Choice* Chaperonins [*shap-ur-OH-ninz*] are involved in which of the following processes?

- W) Guiding metabolites to cellular compartments
- X) Ensuring proper protein folding
- Y) Breaking down ubiquitin [*you-BIH-kwih-tin*] tagged proteins
- Z) Breaking down disaccharides

ANSWER: X) ENSURING PROPER PROTEIN FOLDING

### TOSS-UP

15) Earth and Space – *Multiple Choice* What is the name for a stream that is similar to a braided stream but the mid-channel bars are much more stable than those found in a braided stream?

- W) Meandering
- X) Wandering
- Y) Anastomosing
- Z) Sinuous

ANSWER: Y) ANASTOMOSING

### BONUS

15) Earth and Space – *Multiple Choice* Which of the following types of olivine has the highest iron content?

- W) Forsterite
- X) Fayalite
- Y) Monticellite
- Z) Tephroite

ANSWER: X) FAYALITE

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TOSS-UP

16) Chemistry – *Multiple Choice* For a given redox [*REE-dox*] reaction, which of the following pairs of thermodynamic statements is NOT possible?

- W) K-equilibrium greater than 1 and ΔH greater than zero
- X) E-cell greater than zero and ΔG greater than zero
- Y) ΔH greater than zero and ΔG greater than zero
- Z) K-equilibrium greater than 1 and E-cell greater than zero

ANSWER: X) E-CELL GREATER THAN ZERO AND ΔG GREATER THAN ZERO

BONUS

16) Chemistry – *Short Answer* How many total nodes exist within the highest energy pi molecular orbital for 1,3-butadiene [*One three byoo-tah-DYE-eeen*]?

ANSWER: 4

TOSS-UP

17) Physics – *Multiple Choice* What thermodynamic cycle describes a jet turbine?

W) Rankine

X) Carnot

Y) Brayton

Z) Otto

ANSWER: Y) BRAYTON

BONUS

17) Physics – *Short Answer* Identify all of the following three statements that are true of the physics of the Big Bang:

1) The Big Bang is consistent with the observations made by Hubble; 2) The Big Bang produced mostly oxygen and carbon; 3) The leftover energy from the Big Bang is no longer detectable.

ANSWER: 1

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### TOSS-UP

18) Math – *Short Answer* What is  $\frac{4}{9}$  divided by  $\frac{8}{15}$ ?

ANSWER:  $\frac{5}{6}$

### BONUS

18) Math – *Short Answer* What are the radius and the coordinates of the center of the circle with equation  $x^2 - 14x + y^2 + 8y + 41 = 0$ ?

ANSWER: RADIUS =  $2\sqrt{6}$ , CENTER = (7, -4)

**TOSS-UP**

19) Chemistry – *Short Answer* Identify all of the following three compounds that can crystallize as network solids:  
1) Carbon dioxide; 2) Silicon dioxide; 3) Silicon carbide.

ANSWER: 2 AND 3

**BONUS**

19) Chemistry – *Short Answer* Rank the following three reactions in terms of increasing delta H, from most negative to most positive: 1) Combustion of one mole of formaldehyde; 2) Combustion of one mole of methanol; 3) Combustion of one mole of methane.

ANSWER: 3, 2, 1

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TOSS-UP

20) Physics – *Short Answer* What is the term for the quasiparticles present in p-type semiconductors that represent the absence of electrons?

ANSWER: HOLES (ACCEPT: ELECTRON HOLES)

BONUS

20) Physics – *Short Answer* What is the wavelength, as a fraction of the length of the box, of the third excited state of a one-particle one-dimensional particle in a box?

ANSWER: 1/2

TOSS-UP

21) Earth and Space – *Short Answer* What is the general term for the data-gathering technique by which the measurements of several smaller telescopes are superimposed to create a higher-resolution and more detailed image?

ANSWER: INTERFEROMETRY

BONUS

21) Earth and Space – *Short Answer* Fossils of Mesosaurus were instrumental in providing evidence for what theory?

ANSWER: CONTINENTAL DRIFT

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**TOSS-UP**

22) Math – *Short Answer* Name one of the linear factors of  $x^2 + 14x - 72$ .

ANSWER:  $x - 4$  OR  $x + 18$  (must give at least one)

**BONUS**

22) Math – *Short Answer* What is the sum of the distinct prime factors of 348?

ANSWER: 34

**TOSS-UP**

23) Biology – *Short Answer* In the sarcomere, what protein is found as filaments twisted into a double helix?

ANSWER: ACTIN

**BONUS**

23) Biology – *Short Answer* Identify all of the following three types of muscle that can contract strongly even when stretched : 1) Cardiac; 2) Skeletal; 3) Smooth.

ANSWER: 3