

ROUND 5A

TOSS-UP

1) Biology – *Multiple Choice* A deficiency of what trace element can result in goiter?

- W) Sodium
- X) Chlorine
- Y) Potassium
- Z) Iodine

ANSWER: Z) IODINE

BONUS

1) Biology – *Multiple Choice* Which of the following is NOT a symptom or sign of a person suffering from diabetes mellitus ?

- W) Increase in protein breakdown
- X) Presence of sugar in urine
- Y) Decrease in the amount of urine production
- Z) Increased levels of blood glucose

ANSWER: Y) DECREASE IN THE AMOUNT OF URINE PRODUCTION

~~~~~

### TOSS-UP

2) Math – *Multiple Choice* The natural log of which of the following is irrational?

- W) 1
- X)  $\sqrt{e}$
- Y)  $e$
- Z) 10

ANSWER: Z) 10

### BONUS

2) Math – *Short Answer* If two sides of a right triangle have lengths 13 and 7, then, rounded to the nearest whole numbers, what are the possible lengths of the third side?

ANSWER: 11 and 15

**TOSS-UP**

3) Energy – *Multiple Choice* Which of the following energy sources produces the least carbon dioxide per unit of energy?

- W) Oil
- X) Coal
- Y) Natural gas
- Z) Nuclear

ANSWER: Z) NUCLEAR

**BONUS**

3) Energy – *Multiple Choice* Fuel cell vehicles are commercially available in the U.S. How is the hydrogen fuel stored on these vehicles?

- W) As a gas at 8000 psi
- X) As a liquid under cryogenic conditions
- Y) Absorbed in metal hydrides
- Z) Adsorbed in ceramic zeolites

ANSWER: W) AS A GAS AT 8000 PSI

~~~~~  
TOSS-UP

4) Chemistry – *Multiple Choice* Which of the following atoms is commonly found in a +3 oxidation state?

- W) Calcium
- X) Nickel
- Y) Iron
- Z) Zirconium

ANSWER: Y) IRON

BONUS

4) Chemistry – *Short Answer* Identify all of the following properties that are examples of state functions:

1) Volume; 2) Temperature; 3) Entropy [*EN-troh-pee*].

ANSWER: 1, 2, 3 (ACCEPT: ALL OF THEM)

TOSS-UP

5) Earth and Space – *Multiple Choice* What type of earthquake wave is associated with ground roll?

- W) Love wave
- X) P-wave
- Y) Rayleigh wave
- Z) S-wave

ANSWER: Y) RAYLEIGH WAVE

BONUS

5) Earth and Space – *Short Answer* Galena is an ore of what element?

ANSWER: LEAD

~~~~~  
**TOSS-UP**

6) Physics – *Multiple Choice* If a constant force is applied to an object, which of the following quantities must also be constant?

- W) Position
- X) Acceleration
- Y) Velocity
- Z) Speed

ANSWER: X) ACCELERATION

**BONUS**

6) Physics – *Short Answer* A Carnot engine is operating between a hot reservoir at 125 degrees Celsius and a cold reservoir at 25 degrees Celsius. If the engine extracts 600 joules [*joules*] from the hot reservoir, to two significant figures and in joules [*joules*], how much heat is discarded as waste per cycle?

ANSWER: 450

**TOSS-UP**

7) Math – *Short Answer* What is the  $x$ -coordinate of the vertex of the parabola with equation  $y = 6x^2 + 4x - 7$ ?

Answer:  $-1/3$

**BONUS**

7) Math – *Short Answer* During football season, a player catches passes for 687 yards and averages 14.6 yards per catch, rounded to the nearest tenth. How many catches did the player make?

ANSWER: 47

~~~~~  
TOSS-UP

8) Physics – *Short Answer* A circuit contains a 6-volt battery and a 2-ohm resistor. What is the power, in watts, of this circuit?

ANSWER: 18

BONUS

8) Physics – *Multiple Choice* If an electron in a hydrogen atom decays to emit a photon, which of the following transitions emits the longest wavelength photon?

- W) First excited state to ground state
- X) Second excited state to ground state
- Y) Second excited state to first excited state
- Z) Third excited state to first excited state

ANSWER: Y) SECOND EXCITED STATE TO FIRST EXCITED STATE

TOSS-UP

9) Earth and Space – *Multiple Choice* What is found in clouds that can acquire opposite charges, creating the potential for lightning?

- W) Entrained mist
- X) Liquid water
- Y) Dust grains
- Z) Ice crystals

ANSWER: Z) ICE CRYSTALS

BONUS

9) Earth and Space – *Short Answer* With what type of plate boundary is the Mariana Trench associated?

ANSWER: CONVERGENT

~~~~~  
**TOSS-UP**

10) Biology – *Multiple Choice* Which of the following is the adjective for a leaf arrangement in which two leaves are present at each node?

- W) Opposite
- X) Alternate
- Y) Whorled
- Z) Sessile

ANSWER: W) OPPOSITE

**BONUS**

10) Biology – *Short Answer* What is the highest level of protein structure found in hemoglobin?

ANSWER: QUATERNARY

**TOSS-UP**

11) Chemistry – *Short Answer* What is the shape of an isolated complex in which a metal ion is bonded to six ligands [*LIH-gunz*]?

ANSWER: OCTAHEDRAL

**BONUS**

11) Chemistry – *Short Answer* Rank the boiling points of the following three hydrocarbons, from lowest to highest:  
1) Isobutane; 2) Butane; 3) Pentane.

ANSWER: 1, 2, 3

~~~~~  
TOSS-UP

12) Energy – *Multiple Choice* DOE scientists have recently been studying the material properties of graphene. Which of the following pairs of characteristics did they discover regarding graphene?

- W) High strength, high toughness
- X) High strength, low toughness
- Y) Low strength, high toughness
- Z) Low strength, low toughness

ANSWER: X) HIGH STRENGTH, LOW TOUGHNESS

BONUS

12) Energy – *Multiple Choice* Which of the following is derived from kerosene?

- W) Gasoline
- X) Paraffin wax
- Y) Jet fuel
- Z) Propane

ANSWER: Y) JET FUEL

TOSS-UP

13) Chemistry – *Multiple Choice* Consider an ideal gas initially occupying a volume of 5 liters and at a pressure of 5 atmospheres, that undergoes an adiabatic [*ad-ee-ah-BAT-ik*] expansion to a final pressure of 1 atmosphere. Which of the following is TRUE concerning the final volume of the gas?

- W) It is greater than 25 liters
- X) It is equal to 25 liters
- Y) It is between 5 liters and 25 liters
- Z) It is equal to 5 liters

ANSWER: Y) IT IS BETWEEN 5 LITERS AND 25 LITERS

BONUS

13) Chemistry – *Short Answer* What class of microporous aluminosilicates [*ah-lumin-oh-SILL-ih-kets*] is used to soften hard water by removing metal ions such as iron and replacing them with sodium?

ANSWER: ZEOLITES

~~~~~

### TOSS-UP

14) Energy – *Multiple Choice* 97% of US gasoline sold today contains what percentage of ethanol?

- W) 0
- X) 10
- Y) 15
- Z) 85

ANSWER: X) 10

### BONUS

14) Energy – *Short Answer* In the United States, what is the maximum percentage of ethanol upon which a "flex-fuel" vehicle is designed to run?

ANSWER: 85

### TOSS-UP

15) Physics – *Multiple Choice* For which of the following is Erwin Schrodinger most famous?

- W) Describing how wavefunctions change over time
- X) Discovering that electrons occupy energy levels in atoms
- Y) Discovering that atoms contain a positively charged nucleus
- Z) Discovering nuclear fission

ANSWER: W) DESCRIBING HOW WAVEFUNCTIONS CHANGE OVER TIME

### BONUS

15) Physics – *Short Answer* Identify all of the following three statements that are true of semiconductors: 1) Silicon dioxide is a semiconductor; 2) Silicon is commonly used as a semiconductor; 3) LEDs can be made of semiconductors.

ANSWER: 2 AND 3

~~~~~

TOSS-UP

16) Earth and Space – *Multiple Choice* In what cloud type does hail generally form?

- W) Cirrocumulus
- X) Cirrostratus
- Y) Altocumulus
- Z) Cumulonimbus

ANSWER: Z) CUMULONIMBUS

BONUS

16) Earth and Space – *Multiple Choice* You find a chunk of granite that you conclude, via radiometric dating, is 3.2 billion years old. The granite also contains inclusions of quartzite. Which of the following is a reasonable conclusion based on this data?

- W) The quartzite likely formed less than 3.2 billion years ago
- X) Because the quartzite is contained in the granite, it also formed 3.2 billion years ago
- Y) The quartzite likely formed more than 3.2 billion years ago
- Z) The sandstone from which the quartzite came is likely older than 3.2 billion years, but the quartzite itself is younger than that

ANSWER: Y) THE QUARTZITE LIKELY FORMED MORE THAN 3.2 BILLION YEARS AGO

TOSS-UP

17) Biology – *Short Answer* What is the name of the muscle attachment point that remains relatively stationary during contraction?

ANSWER: ORIGIN

BONUS

17) Biology – *Multiple Choice* When viewed under a microscope, a eukaryotic [*YOU-care-ee-AW-tic*] cell has visible chromosomes. In what phase of the cell cycle is the cell?

W) M

X) S

Y) G1 [*G one*]

Z) G-zero [*g-zero*]

ANSWER: W) M

~~~~~  
**TOSS-UP**

18) Math – *Short Answer* What is 145 squared?

ANSWER: 21,025

**BONUS**

18) Math – *Short Answer* For what values of  $x$  does the function  $f$  of  $x =$  the fraction with numerator  $x^2 - 25$  and denominator  $3x^2 - 16x + 5$  have a vertical asymptote?

ANSWER:  $1/3$

**TOSS-UP**

19) Physics – *Short Answer* A hydraulic press has two ends that are level but have different areas. Identify all of the following 4 quantities that may have differing magnitudes at the two ends: 1) Force; 2) Work; 3) Displacement; 4) Pressure.

ANSWER: 1 AND 3

**BONUS**

19) Physics – *Short Answer* Identify all of the following 3 classes of levers that are capable of producing a mechanical advantage greater than unity: 1) Class 1; 2) Class 2; 3) Class 3.

ANSWER: 1 AND 2

~~~~~  
TOSS-UP

20) Earth and Space – *Short Answer* What causes the trees in Alaskan forests to start tilting in many different directions, creating an area called a drunken forest?

ANSWER: THAWING SOIL (ACCEPT: ANY VARIANT OF THAWING OR MELTING GROUND SURFACE)

BONUS

20) Earth and Space – *Multiple Choice* What type of faulting is defined by strike-slip offset along an essentially vertical fault plane?

- W) Normal
- X) Reverse
- Y) Thrust
- Z) Transcurrent

ANSWER: Z) TRANSCURRENT

TOSS-UP

21) Chemistry – *Short Answer* Identify all of the following three solutions that would be acidic: 1) A solution of iron(III) atoms hexacoordinated by water molecules; 2) A solution of ammonium sulfate; 3) A solution of sodium cyanide.

ANSWER: 1 AND 2

BONUS

21) Chemistry – *Short Answer* The compound sulfurous [*sul-FYUR-us*] acid has a first pKa of approximately 1.8 and a second pKa of approximately 7.2. To one decimal place, what is the pH of a solution of 0.1 molar sodium bisulfite?

ANSWER: 4.5

~~~~~  
**TOSS-UP**

22) Math – *Short Answer* 3 is one-third percent of what number?

ANSWER: 900

**BONUS**

22) Math – *Short Answer* For real numbers  $a$  and  $b$ , define the binary operation “star” by  $a$  “star”  $b$  is equal to one less than the average of  $a$  and  $b$ . What is 3 “star” open parenthesis 4 “star” 5 close parenthesis?

ANSWER: 9/4 (ACCEPT: 2¼ , 2.25)

**TOSS-UP**

23) Biology – *Short Answer* The hamstrings allow flexion of what joint?

ANSWER: KNEE

**BONUS**

23) Biology – *Short Answer* In humans, what group of muscles produce extension of the knee joint, such as during jumping?

ANSWER: QUADRICEPS