

ROUND 2A

TOSS-UP

1) Math – *Short Answer* While waiting at a train crossing, Gayle decided to time how long it took for a 1-mile long train to pass her directly. If it took exactly 75 seconds for the train to pass, at how many miles per hour was the train traveling?

ANSWER: 48

BONUS

1) Math – *Multiple Choice* What is the inverse function of $y = \frac{1}{x+3}$?

W) $y = \frac{1-3x}{x}$ divided by x

X) $y = x - 3$

Y) $y = 3 - 1/x$

Z) $y = 3x - 1$

Answer: W) $y = \frac{1-3x}{x}$

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### TOSS-UP

2) Physics – *Short Answer* What is the equivalent capacitance in microfarads of four capacitors  $C_1 = 3$  microfarads,  $C_2 = 5$  microfarads,  $C_3 = 6$  microfarads, and  $C_4 = 8$  microfarads that are connected in parallel?

ANSWER: 22

### BONUS

2) Physics – *Multiple Choice* Which of the following statements is true regarding entropy?

W) The first law of thermodynamics defines entropy

X) Entropy is a function of state and obeys Hess's Law

Y) Completely reversible processes increase entropy

Z) Entropy can only be defined macroscopically

ANSWER: X) ENTROPY IS A FUNCTION OF STATE AND OBEYS HESS'S LAW

### TOSS-UP

3) Earth and Space – *Short Answer* What term is used to describe the formation of mountains?

ANSWER: OROGENY

### BONUS

3) Earth and Space – *Multiple Choice* What two layers of the atmosphere have the least influence over weather?

- W) Troposphere and tropopause
- X) Mesosphere and thermosphere
- Y) Stratosphere and troposphere
- Z) Stratosphere and thermosphere

ANSWER: X) MESOSPHERE AND THERMOSPHERE

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### TOSS-UP

4) Chemistry – *Short Answer* In the Arrhenius equation, the exponential term is multiplied by a quantity, A, originally introduced as a fudge factor. What is the name of this term?

ANSWER: FREQUENCY FACTOR (Accept: PREEXPONENTIAL FACTOR)

### BONUS

4) Chemistry – *Short Answer* A sealed vessel contains 8 grams of oxygen gas and 12 grams of methane. If no other gases are present and the total pressure is 800 torr, what is the partial pressure, in torr, of oxygen?

ANSWER: 200

### TOSS-UP

5) Biology – *Short Answer* The nervous system consists of neurons and what other type of cell that is responsible for nourishing neurons?

ANSWER: GLIAL [*GLEE-AL*] CELL (ACCEPT: GLIA)

### BONUS

5) Biology – *Short Answer* What type of population selection would occur in an environment that is very close to its carrying capacity?

ANSWER: K-SELECTION

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TOSS-UP

6) Energy – *Short Answer* What thermodynamic potential, symbolized by the letter U, is the sum of the heat added to a system and the work done on a system by its surroundings?

ANSWER: INTERNAL ENERGY

BONUS

6) Energy – *Multiple Choice* Why is it not a good idea to use pure vegetable oil in a conventional diesel engine?

- W) Straight vegetable oil will not work in a diesel engine
- X) Straight vegetable oil produces more emissions than regular diesel
- Y) Straight vegetable oil will damage the diesel engine over time
- Z) Straight vegetable oil does not allow diesel engines to work at high speeds

ANSWER: Y) STRAIGHT VEGETABLE OIL WILL DAMAGE THE DIESEL ENGINE OVER TIME

TOSS-UP

7) Math – *Short Answer* Identify all of the following four operations that are NOT closed over the set of all positive real numbers: 1) addition; 2) subtraction; 3) multiplication; 4) division.

Answer: 2

BONUS

7) Math – *Multiple Choice* Which of the following ratios represents the ratio of the diagonal of a cube to a diagonal of one of the faces of cube?

W) 2 to the square root of 3

X) the square root of 3 to the square root of 2

Y) the square root of 3 to 1

Z) the square root of 6 to the square root of 3

ANSWER: X) THE SQUARE ROOT OF 3 TO THE SQUARE ROOT OF 2

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### TOSS-UP

8) Physics – *Short Answer* What is the resistance, in ohms, of a resistor that has a 20 milliampere current when connected across the terminals of a 1.5 volt battery?

ANSWER: 75

### BONUS

8) Physics – *Short Answer* A 2 kilogram box is sliding across a frictionless surface at 4 meters per second to the north. A 6 newton force directed to the south acts on the box for 2 seconds. What is the final speed, in meters per second, and direction of the box?

ANSWER: 2; SOUTH

### TOSS-UP

9) Earth and Space – *Multiple Choice* Which of the following clouds develops at the highest altitude?

- W) Cirrocumulus
- X) Nimbostratus
- Y) Stratocumulus
- Z) Stratus

ANSWER: W) CIRROCUMULUS

### BONUS

9) Earth and Space – *Multiple Choice* The Galápagos Islands consist of a single active volcano among volcanic islands whose ages increase westward. Based on this knowledge, what geologic scenario is creating the islands?

- W) Subduction
- X) Hot spot
- Y) Sea floor spreading
- Z) Continental rifting

ANSWER: X) HOT SPOT

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TOSS-UP

10) Chemistry – *Short Answer* What term can apply to the compounds 1-octanol and sodium dodecyl-sulfate [*doh-dek-ihl sulfate*], as well as transmembrane proteins, phospholipids, and surfactants, characterizing molecules that contain both fat-soluble and water-soluble components?

ANSWER: AMPHIPATHIC (ACCEPT: AMPHIPHILIC)

BONUS

10) Chemistry – *Short Answer* A gas phase reaction is conducted in a cylinder with a moveable piston. If the reaction releases 320 joules of heat and does 150 joules of PV work, what is the change in internal energy, in joules, for this reaction?

ANSWER: -470

TOSS-UP

11) Biology – *Short Answer* Some herbivores, such as rabbits and horses, possess the ability to digest cellulose with the aid of bacteria located in a pouch at the beginning of the large intestine. What is the name of this pouch?

ANSWER: CECUM

BONUS

11) Biology – *Short Answer* What structures, composed of nine sets of triplet microtubules arranged in a ring, play a role in eukaryotic cell division, but are not present in plant cells?

ANSWER: CENTRIOLES

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### TOSS-UP

12) Math – *Multiple Choice* A right triangle with one angle of  $45^\circ$  is inscribed in a circle of radius 10. What is the area of the triangle?

W) 50

X) 50 times the square root of 2

Y) 100

Z) 100 times the square root of 2

Answer: Y) 100

### BONUS

12) Math – *Short Answer* For real numbers  $a$  and  $b$ , define the binary operation “star” by  $a$  “star”  $b$  is equal to open parenthesis  $a + b$  close parenthesis times open parenthesis  $a - b$  close parenthesis. What is 3 “star” open parenthesis 4 “star” 5 close parenthesis?

ANSWER: -72

### TOSS-UP

13) Physics – *Short Answer* In the excitation of metal ions by light, light of a high enough frequency can cause the excited electrons to be ejected from the metal. What is the name of this effect?

ANSWER: PHOTOELECTRIC EFFECT

### BONUS

13) PHYSICS – *Short Answer* An 80 kilogram hockey player is skating towards the blue line at a speed of 4.5 meters/second. He briefly looks away and accidentally collides with a 100 kilogram teammate head on who was standing in place. At what speed, in meters per second, do the two players slide across the ice if they get tangled up with each other after the collision?

ANSWER: 2

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TOSS-UP

14) Earth and Space – *Short Answer* What term is used to describe breaks in strata that represent periods during which deposition of sediments ceased and erosion removed previously formed rocks?

ANSWER: UNCONFORMITY

BONUS

14) Earth and Space – *Multiple Choice* By which of the following mechanisms do pulsar magnetic fields emit gamma rays?

- W) Nuclear fission
- X) Compton scattering
- Y) Cyclotron radiation
- Z) Synchrotron radiation

ANSWER: Z) SYNCHROTRON RADIATION

TOSS-UP

15) Energy – *Short Answer* What type of rechargeable battery, often used in cell phones and laptop computers, includes a lithium-cobalt oxide cathode and a carbon anode?

ANSWER: LITHIUM-ION BATTERY

BONUS

15) Energy – *Short Answer* An LED has a forward voltage drop of 3.1 volts. How many LEDs can be driven in series by a 12 volt power source?

ANSWER: 3

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### TOSS-UP

16) Chemistry – *Multiple Choice* Which of the following best describes the kinetics of radioactive decay?

- W) It is a zeroth order process
- X) It is a first order process
- Y) It is a second order process
- Z) It is a third order process

ANSWER: X) IT IS A FIRST ORDER PROCESS

### BONUS

16) Chemistry – *Short Answer* Rank the following four atoms from the smallest atomic radius to the largest atomic radius: 1) Oxygen; 2) Fluorine; 3) Sulfur; 4) Chlorine.

ANSWER: 2, 1, 4, 3 (ACCEPT: FLOURINE, OXYGEN, CHLORINE, SULFUR)



### TOSS-UP

17) Math – *Short Answer* Consider a bag of five marbles, 3 red and 2 white. You draw marbles from the bag until you draw the last white marble, at which point you stop. What is the probability you stop drawing after the 2<sup>nd</sup> marble is selected?

ANSWER: 1/10 (ACCEPT: 0.1 OR 10%)

### BONUS

17) Math – *Short Answer* Four coplanar circles of radius  $r$  have their centers arranged to form the vertices of a square of side length  $2r$ . What is the area of the region enclosed in the square, but not enclosed in any of the four circles?

ANSWER:  $4r^2 - \pi r^2$  (ACCEPT:  $r^2(4 - \pi)$ )

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TOSS-UP

18) Biology – *Short Answer* Penicillin inhibits the cross-linking of which structural molecule in bacteria?

ANSWER: PEPTIDOGLYCAN

BONUS

18) Biology – *Short Answer* Cholesterol and testosterone are examples of what type of lipid that contains four cycloalkane [*sigh-kloh-al-cane*] rings and is vital to homeostasis?

ANSWER: STEROID

TOSS-UP

19) Physics – *Short Answer* What subatomic particle was discovered by J.J. Thomson in a series of experiments involving cathode rays?

ANSWER: Electrons

BONUS

19) Physics – *Short Answer* Identify all of the following three statements that are true regarding pendulums: 1) Changing the length of the string affects the period; 2) For small swings, pendulums can be approximated as simple harmonic oscillators; 3) Pendulums were used as the first evidence regarding the rotation of the Earth that didn't require celestial observations.

ANSWER: 1, 2, AND 3

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### TOSS-UP

20) Energy – *Short Answer* What is the term used to describe for an HVAC device that transfers energy in the opposite direction of its natural flow to warm a location rather than generating heat directly?

ANSWER: HEAT PUMP

### BONUS

20) Energy – *Multiple Choice* Which of the following types of electromagnetic radiation possesses the greatest amount of energy per photon?

- W) Microwave
- X) Ultraviolet
- Y) Infrared
- Z) X-Ray

ANSWER: Z) X-RAY

**TOSS-UP**

21) Biology – *Short Answer* Roundworms are part of what invertebrate phylum?

ANSWER: NEMATODA

**BONUS**

21) Biology – *Short Answer* Fish extrude nitrogenous waste in what toxic form?

ANSWER: AMMONIA



**TOSS-UP**

22) Earth and Space – *Short Answer* What term describes the change of direction in a wave as it enters shallower water?

ANSWER: REFRACTION

**BONUS**

22) Earth and Space – *Short Answer* On what tectonic plate does most of the North American continent rest?

ANSWER: NORTH AMERICAN PLATE

### TOSS-UP

23) Chemistry – *Short Answer* What reaction, that can be catalyzed by Adams's catalyst, Wilkinson's catalyst, Raney nickel, or alloys of platinum and rhodium, is responsible for forming alkanes from alkenes?

ANSWER: HYDROGENATION

### BONUS

23) Chemistry – *Short Answer* A metal, M, adopts the +3 oxidation state. What is the chemical formula of the most stable ionic compound that forms between M and oxygen?

ANSWER:  $M_2O_3$