

## ROUND 14A

### TOSS-UP

1) Physics – *Short Answer* What physical phenomenon is exploited when tuning the frequency of a radio antenna in order to amplify reception of the signal and is characterized by the tendency of a system to oscillate with greater amplitude at certain frequencies than others?

ANSWER: RESONANCE

### BONUS

1) Physics – *Short Answer* A charged particle is moving in the x-direction when a uniform magnetic field is applied in the y-direction. What shape will the path traced out by the particle's motion be?

ANSWER: CIRCLE (DO NOT ACCEPT: HELICAL)

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### TOSS-UP

2) Math – *Short Answer* Jora models a series of 28 six-sided dice rolls as a binomial distribution based on whether a roll is 6 or not. If she repeated this series of dice rolls multiple times, what is the average number of times that the dice will land on six?

ANSWER: 14/3 ACCEPT: FOUR AND TWO THIRDS

### BONUS

2) Math – *Short Answer* Given the three vectors,  $\mathbf{a} = 2i + j$ ,  $\mathbf{b} = -i + 3j + 4k$ , and  $\mathbf{c} = -2j + k$ , find  $\mathbf{a} \cdot (2\mathbf{b} + 4\mathbf{c})$ .

ANSWER: -6

### TOSS-UP

3) Energy – *Multiple Choice* Gallium arsenide would most likely be found in which of the following?

- W) Nuclear fission reactor
- X) Semiconductor photovoltaic
- Y) Magnetic containment chamber
- Z) Penning trap

ANSWER: X) SEMICONDUCTOR PHOTOVOLTAIC

### BONUS

3) Energy – *Multiple Choice* Which of the following is not true regarding electrochemical cells?

- W) Concentration cells have a standard cell potential of zero
- X) In a Daniell cell, copper is oxidized
- Y) The equilibrium reduction potential of a half cell is related to the standard electrode potential via the Nernst equation
- Z) Electrochemical cells using water as a solvent are usually limited to a cell potential of approximately 2.5 volts

ANSWER: X) IN A DANIELL CELL, COPPER IS OXIDIZED

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### TOSS-UP

4) Earth and Space – *Multiple Choice* In about twelve thousand years, the star Vega will be the North Star, not Polaris, due to which of the following:

- W) Jupiter's gravity
- X) Earth's tilted axis
- Y) Earth's axial precession
- Z) Earth's nutation

ANSWER: Y) EARTH'S AXIAL PRECESSION

### BONUS

4) Earth and Space – *Multiple Choice* Which of the following is true of the eyewall replacement cycles of a hurricane?

- W) Maximum sustained wind speeds tend to increase in the eyewall
- X) A smaller eye expands outward and replaces a larger eye
- Y) The core of strongest wind tends to become more compact
- Z) Eyewall replacement cycles are common when a hurricane reaches a Category 5 status

ANSWER: Z) EYEWALL REPLACEMENT CYCLES ARE COMMON WHEN A HURRICANE REACHES A CATEGORY 5 STATUS

### TOSS-UP

5) Biology – *Short Answer* In the late 1800s, Martinus Beijerinck investigated what specific infectious agent, which he discovered could not be cultured on nutrient media in test tubes or petri dishes?

ANSWER: TOBACCO MOSAIC VIRUS

### BONUS

5) Biology – *Short Answer* What nerve is known as the “wandering” nerve, as it travels down into the chest and abdomen from the throat and larynx, where it helps control the cardiovascular and gastrointestinal systems?

ANSWER: VAGUS NERVE

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### TOSS-UP

6) Chemistry – *Short Answer* What process, that uses a platinum-rhodium alloy as a catalyst, uses ammonia from the Haber process as a reactant to form nitric oxide, which is then oxidized and dissolved in water to form nitric acid?

ANSWER: OSTWALD PROCESS

### BONUS

6) Chemistry – *Multiple Choice* For the reaction  $N_2 + 3H_2$  in equilibrium with  $2NH_3$ , with a negative change in enthalpy, which of the following events is least likely to occur when the temperature of the reaction is increased?

- W) The gas particles will speed up
- X) The reaction will produce more ammonia
- Y) The reaction will reverse
- Z) The entropy of the system will increase

ANSWER: X) THE REACTION WILL PRODUCE MORE AMMONIA

**TOSS-UP**

7) Physics – *Short Answer* The Heisenberg Uncertainty principle states that the product of the standard deviation of position and the standard deviation of momentum must be less than one half of the reduced form of what constant?

ANSWER: PLANCK'S CONSTANT

**BONUS**

7) Physics – *Short Answer* A generator making alternating current has a peak voltage of 40 volts and a peak current of 2.5 amperes. To the nearest whole number, what are the root mean square quantities of the current and voltage?

ANSWER: 2 AMPERES, 28 VOLTS



**TOSS-UP**

8) Math – *Short Answer* What is the equation of the plane, parallel to one of the coordinate planes, that passes through the two points (4,7,-2) and (3,7,12)?

ANSWER:  $y = 7$

**BONUS**

8) Math – *Short Answer* If all A are B and some C are A, identify all of the following three conclusions that necessarily follow: 1) All A are C; 2) Some B are C; 3) Some A are not C.

ANSWER: 2

### TOSS-UP

9) Biology – *Short Answer* What group of light-absorbing compounds, including chlorophyll b and carotenoids, are found in photosynthetic organisms and work with chlorophyll a to expand the action spectrum of the organism?

ANSWER: ACCESSORY PIGMENTS

### BONUS

9) Biology – *Short Answer* Identify all of the following three statements that are true regarding fats: 1) Fats are a more efficient form of energy storage than proteins; 2) Fats play a role in cell structure; 3) Fats are a less efficient form of energy storage than carbohydrates.

ANSWER: 1 AND 2

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### TOSS-UP

10) Physics – *Short Answer* Identify all of the following three statements that are true regarding electromagnetism: 1) Dipoles experience a net force in a uniform electric field; 2) At a distance infinity, dipoles are equivalent to a neutral particle; 3) Dipoles experience a net force in a nonuniform electric field.

ANSWER: 2 AND 3

### BONUS

10) Physics – *Short Answer* What scientist first discovered that a moving charge induces a magnetic field?

ANSWER: HANS CHRISTIAN OERSTED (ACCEPT: OERSTED)

### TOSS-UP

11) Energy – *Multiple Choice* Which of the following statements is not true regarding lighting and lighting technology?

- W) Organic LED displays require backlights
- X) Incandescent lights emit most of their energy as heat
- Y) LED lights are based on a pn-junction diode
- Z) Halogen light bulbs use tungsten filaments just like incandescent bulbs do

ANSWER: W) ORGANIC LED DISPLAYS REQUIRE BACKLIGHTS

### BONUS

11) Energy – *Short Answer* Identify all of the following three statements that are true regarding endothermic reactions: 1) The reactants have higher chemical energy than the products; 2) Heat is absorbed during the reaction; 3) They feel cold to the touch after they have occurred.

ANSWER: 2, 3



### TOSS-UP

12) Chemistry – *Multiple Choice* Which of the following compounds is both a hydrogen bond donor and a hydrogen bond acceptor?

- W) Ammonia
- X) Hydrogen chloride
- Y) Acetone
- Z) Triethylamine

ANSWER: W) AMMONIA

### BONUS

12) Chemistry – *Short Answer* One mole of the following three compounds is added to 1 liter of water in order to reduce its freezing point. Rank them, from the smallest freezing point reduction to the greatest: 1) Sucrose; 2) Ammonium chloride; 3) Calcium chloride.

ANSWER: 1, 2, 3

### TOSS-UP

13) Earth and Space – *Short Answer* What term refers to the outer limit of the Sun's electromagnetic influence?

ANSWER: HELIOPAUSE

### BONUS

13) Earth and Space – *Multiple Choice* Which of the following is true about spiral galaxies?

- W) Their spiral arms are dark due to the presence of cool, red stars
- X) They are the rarest type of galaxy in the observable universe
- Y) They originate from supernova explosions
- Z) Spiral galaxies with patchy arms are called flocculent spirals

ANSWER: Z) SPIRAL GALAXIES WITH PATCHY ARMS ARE CALLED FLOCCULENT SPIRALS

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### TOSS-UP

14) Biology – *Multiple Choice* Which of the following characteristics of plants is absent in charophyte algae?

- W) Presence of chlorophyll b
- X) Cellulose in the cell walls
- Y) Sexual reproduction
- Z) Alternation of multicellular generations

ANSWER: Z) ALTERNATION OF MULTICELLULAR GENERATIONS

### BONUS

14) Biology – *Multiple Choice* Which of the following compounds would one use to detect the presence of protein in a polyacrylamide gel?

- W) Ethidium bromide [*eth-ih-dee-um broh-myde*]
- X) Coomassie Blue [*coo-mah-see*]
- Y) Rhodamine 2 [*row-duh-meen*]
- Z) Fluorescein [*flow-ruh-seen*]

ANSWER: X) COOMASSIE BLUE

### TOSS-UP

15) Chemistry – *Short Answer* Identify all of the following three compounds that are network solids: 1) Silicon dioxide; 2) Silicon carbide [*car-byde*]; 3) Boron nitride.

ANSWER: 1, 2, 3

### BONUS

15) Chemistry – *Multiple Choice* For which of the following gas-phase reactions are the equilibrium constants  $K_c$  and  $K_p$  equivalent to one another?

- W) Ozone is produced from diatomic oxygen
- X) Carbon dioxide and hydrogen are produced from carbon monoxide and steam
- Y) Ammonia is produced from hydrogen and nitrogen
- Z) Gaseous methanol is produced from carbon monoxide and hydrogen

ANSWER: X) CARBON DIOXIDE AND HYDROGEN ARE PRODUCED FROM CARBON MONOXIDE AND STEAM



### TOSS-UP

16) Math – *Short Answer* If  $x$  is a positive number such that 6 is the geometric mean between  $x + 3$  and  $x - 3$ , what is the value of  $x$ ?

Answer: 3 times the square root of 5

### BONUS

16) Math – *Short Answer* If  $A$  is an acute angle and  $\sin A \text{ times } \cos A = 60/169$ , find the numerical value of  $\sin A + \cos A$ .

ANSWER: 17/13

### TOSS-UP

17) Earth and Space – *Multiple Choice* Type Ia supernovae are said to be standardizable candles because their intrinsic luminosity can be determined after taking what other factor into account?

- W) H alpha line width
- X) Si II line width
- Y) Decay time
- Z) Lyman alpha line width

Answer: Y) DECAY TIME

### BONUS

17) Earth and Space – *Multiple Choice* Cloud seeding with silver iodide is based upon what process?

- W) Haber process
- X) Sublimation
- Y) Bergeron process
- Z) Chemical vapor deposition

ANSWER: Y) BERGERON PROCESS

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### TOSS-UP

18) Energy – *Short Answer* Identify all of the following three statements that are true regarding the use of cellulosic ethanol as fuel: 1) Cellulosic ethanol has a more abundant stock of raw materials compared to corn ethanol; 2) Cellulosic ethanol has higher greenhouse emissions than corn ethanol; 3) Cellulosic ethanol can be produced via cellulolysis or gasification.

ANSWER: 1 AND 3

### BONUS

18) Energy – *Short Answer* Identify all of the following three statements that are true regarding binding energy: 1) The mass of a carbon-12 nucleus is equal to the sum of the masses of 6 unbound protons and 6 unbound neutrons; 2) Mass defect arises due to the equivalence of mass and energy; 3) Iron-56 has the lowest mass per nucleon of any nucleus.

ANSWER: 2, 3

### TOSS-UP

19) Biology – *Short Answer* The deficiency of magnesium causes what disorder in plants, characterized by the leaves turning pale yellow?

ANSWER: CHLOROSIS

### BONUS

19) Biology – *Multiple Choice* Atropine is a powerful toxin that is gathered from which of the following groups of plants?

- W) Nightshades
- X) Orchids
- Y) Horsetails
- Z) Yews

ANSWER: W) NIGHTSHADES

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### TOSS-UP

20) Physics – *Short Answer* Name the phenomenon in which a liquid, in near contact with a mass significantly hotter than the liquid's boiling point, produces an insulating vapor layer keeping that liquid from boiling rapidly?

ANSWER: LEIDENFROST EFFECT

### BONUS

20) Physics – *Short Answer* A supercomputer sends information throughout its parts using light pulses in optical fibers. If the CPU needs to obtain information from the memory in 2.5 nanoseconds and it takes the memory 0.5 nanoseconds to process and fetch the request, assuming that the refractive index for the optical fibers is 3.0, what is the maximum distance, in centimeters, the CPU can be from the memory unit?

ANSWER: 10

### TOSS-UP

21) Chemistry – *Multiple Choice* Which of the following statements concerning amino acids is NOT true?

- W) Glycine is an achiral amino acid
- X) Phenylalanine has a nonpolar side chain
- Y) Some amino acids contain sulfur
- Z) All amino acids are net neutral at a pH of 7

ANSWER: Z) ALL AMINO ACIDS ARE NET NEUTRAL AT A pH OF 7

### BONUS

21) Chemistry – *Short Answer* Identify all of the following three species that would be able to oxidize copper from the +1 to +2 oxidation state: 1) Potassium dichromate; 2) Sodium borohydride; 3) Silver nitrate.

ANSWER: 1 AND 3

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### TOSS-UP

22) Earth and Space – *Short Answer* What is the nearest triple system?

ANSWER: ALPHA CENTAURI

### BONUS

22) Earth and Space – *Short Answer* The Columbia River Basalts are thought to be related to what major magma source found east of the basalt deposits?

ANSWER: YELLOWSTONE HOTSPOT

### TOSS-UP

23) Math – *Short Answer* A circular cone-shaped reservoir holds 3 gallons of water. How many gallons does a circular cylindrical reservoir hold if it has the same base and height as the conical reservoir?

ANSWER: 9

### BONUS

23) Math – *Short Answer* In a three-dimensional coordinate system, the point  $(1, 2, 3)$  is reflected in the  $xy$ -plane, then the result is rotated by 180 degrees about the  $x$ -axis, and finally that image is translated by 5 units in the positive  $y$  direction. What are the final coordinates of the final image?

ANSWER:  $(1, 3, 3)$