

ROUND 13A

TOSS-UP

1) Biology – *Short Answer* What hormone targets the kidneys and stimulates reabsorption of water from urine?

ANSWER: ADH (ACCEPT: ANTIDIURETIC HORMONE, VASOPRESSIN)

BONUS

1) Biology – *Short Answer* What thyroid hormone plays a role in inhibiting calcium loss from bones?

ANSWER: CALCITONIN

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### TOSS-UP

2) Physics – *Short Answer* Identify all of the following 3 changes that would increase the magnetic field outside an ideal solenoid of infinite length: 1) Increasing current strength; 2) Increasing turn density; 3) Adding an iron core.

ANSWER: NONE

### BONUS

2) Physics – *Short Answer* What mineral is commonly used in watch crystals and radio transmitters due to its piezoelectric properties?

ANSWER: QUARTZ

### TOSS-UP

3) Chemistry – *Multiple Choice* Which of the following statements is TRUE concerning SN<sub>2</sub> reactions?

- W) Pentavalent [*penta-vay-lent*] transition state
- X) Pentavalent intermediate
- Y) Trivalent [*try-vay-lent*] transition state
- Z) Trivalent intermediate

ANSWER: W) PENTAVALENT TRANSITION STATE

### BONUS

3) Chemistry – *Short Answer* Identify all of the following three statements concerning crystal structures that are true:

- 1) The FCC lattice fills volume more efficiently than the BCC lattice;
- 2) The number of atoms in a BCC unit cell is 4;
- 3) The coordination number of an FCC lattice is 12.

ANSWER: 1 AND 3

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TOSS-UP

4) Energy – *Multiple Choice* Which of the following solar cell systems has the highest efficiency?

- W) Silicon
- X) Gallium [*GAL-ee-um*] Arsenide [*AHR-sin-ide*]
- Y) Thin Film Photovoltaic [*photo-vawl-TAY-ik*]
- Z) Polymeric [*paw-lih-MARE-ik*] Photovoltaic

ANSWER: X) GALLIUM ARSENIDE

BONUS

4) Energy – *Multiple Choice* Which of the following materials would most likely be used as a catalyst for fuel cells?

- W) Titanium
- X) Silver
- Y) Carbon
- Z) Palladium [*puh-LAID-ee-um*]

ANSWER: Z) PALLADIUM

TOSS-UP

5) Math – *Multiple Choice* Given that the function f of x has a zero at $x = 6$, at what x -value must $2 + f$ of x have a zero?

- W) 3
- X) 4
- Y) 8
- Z) It need not have a zero

ANSWER: Z) IT NEED NOT HAVE A ZERO

BONUS

5) Math – *Short Answer* What is the real quadratic polynomial with least possible positive integer leading coefficient that has $7 - 8i$ as a zero?

ANSWER: $x^2 - 14x + 113$

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### TOSS-UP

6) Earth and Space – *Multiple Choice* What type of feature is the Moon's Rupes Recta?

- W) Fault
- X) Ridge
- Y) Bay
- Z) Valley

ANSWER: W) FAULT

### BONUS

6) Earth and Space – *Multiple Choice* When corals bleach due to warming seas they expel what symbiotic organisms, leaving them vulnerable to starvation and disease?

- W) Chlorella
- X) Diatoms
- Y) Zooxanthellae
- Z) Spirogyra

ANSWER: Y) ZOOXANTHELLAE

### TOSS-UP

7) Biology – *Short Answer* What is the adjective for the type of nephron [**NEF-ron**] that possesses long loops of Henle [**HEN-lee**] in order to promote water reabsorption?

ANSWER: JUXTAMEDULLARY

### BONUS

7) Biology – *Short Answer* Rank the following four plasma proteins in terms of increasing mass:

- 1) Fibrinogen [**fye-BRIN-oh-jen**]; 2) Transferrin [**trans-FEH-rin**]; 3) Albumin [**al-BYOO-min**];  
4) Immunoglobulin G [**immune-oh-GLOB-yuh-lin G**].

ANSWER: 3, 2, 4, 1

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TOSS-UP

8) Physics – *Short Answer* Modulo a dimensionless constant, the Heisenberg uncertainty principle relates the products of momentum and positional uncertainties to what constant?

ANSWER: PLANCK'S CONSTANT (ACCEPT: REDUCED PLANCK'S)

BONUS

8) Physics – *Short Answer* In the Grand Unified Theory, which of its three unified forces separates from the other two earliest on?

ANSWER: STRONG (ACCEPT: STRONG NUCLEAR)

TOSS-UP

9) Energy – *Short Answer* Rank the following three substances in order of increasing energy density: 1) Bituminous coal; 2) Gasoline; 3) TNT.

ANSWER: 3, 1, 2

BONUS

9) Energy – *Multiple Choice* Metal-organic frameworks, or MOFs, are a subject of research at Lawrence Berkeley National Lab. Which of the following is a potential use of MOFs?

- W) Tools for quantum computing
- X) Developing more accurate predictions via density functional theory
- Y) Efficient storage of gases
- Z) Homogeneous catalysts

ANSWER: Y) EFFICIENT STORAGE OF GASES

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### TOSS-UP

10) Math – *Short Answer* What is the greatest integer that is less than or equal to the log base 6 of 975?

ANSWER: 3

### BONUS

10) Math – *Short Answer* To the nearest degree, what is the measure of each interior angle of a regular 65-sided polygon?

ANSWER: 174

### TOSS-UP

11) Earth and Space – *Multiple Choice* Which of these is true regarding the Sargasso sea?

W) It has relatively low biological productivity

X) It is adjacent to the Bay of Bengal

Y) It is primarily a hypoxic dead zone

Z) It has the saltiest ocean water

ANSWER: W) IT HAS RELATIVELY LOW BIOLOGICAL PRODUCTIVITY

### BONUS

11) Earth and Space – *Short Answer* Rank the following three stars in order of increasing surface temperature:

1) Arcturus; 2) Betelgeuse; 3) The Sun.

ANSWER: 2, 1, 3 (ACCEPT: BETELGEUSE, ARCTURUS, THE SUN)

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TOSS-UP

12) Chemistry – *Multiple Choice* Which of the following compounds would have the largest retention factor in a TLC experiment with a silica stationary phase and hexane mobile phase?

W) Benzene

X) Benzoic acid [*ben-ZOH-ik*]

Y) Phenylacetone [*fennel-ASS-eh-tone*]

Z) Benzyl [*BEN-zil*] methyl ether

ANSWER: X) BENZOIC ACID

BONUS

12) Chemistry – *Short Answer* Arrange the following three hydrogens in a proton-NMR spectrum in terms of increasing chemical shift: 1) Hydrogens in benzene; 2) Aldehyde hydrogen in acetaldehyde [*asset-AL-de-hide*];

3) Hydroxyl [*high-DROX-il*] group in methanol.

ANSWER: 3, 1, 2

TOSS-UP

13) Math – *Short Answer* If the definite integral from 1 to 6 of f of x dx = 21, then what is the definite integral from 1 to 6 of open parenthesis f of x minus 3 close parenthesis dx ?

ANSWER: 6

BONUS

13) Math – *Short Answer* What is the sum of the squares of the first 20 positive integers?

ANSWER: 2870

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### TOSS-UP

14) Physics – *Multiple Choice* In inductors, the back EMF generated most directly depends on which of the following properties of the circuit?

- W) Voltage
- X) Time derivative of voltage
- Y) Current
- Z) Time derivative of current

ANSWER: Z) TIME DERIVATIVE OF CURRENT

### BONUS

14) Physics – *Short Answer* In an electromagnetic motor, what conductive component generates an electromotive force?

ANSWER: ARMATURE (ACCEPT: ROTATING COIL)

### TOSS-UP

15) Biology – *Multiple Choice* Which of the following scientific names correctly describes a family of plants?

W) Quercus rubra

X) Liliaceae [*lilly-AY-see-eye*]

Y) Poales [*Poh-AY-leez*]

Z) Magnoliophyta [*mag-NO-lee-oh-FYE-tah*]

ANSWER: X) LILIACEAE

### BONUS

15) Biology – *Short Answer* Identify all of the following three statements that are true of second messengers:

1) Phospholipase [*faws-fo-LYE-pace*] C catalyzes the release of IP<sub>3</sub>; 2) Cells store calcium in the nucleus;

3) Calmodulin [*kal-MOD-u-lin*] binds to cyclic GMP.

ANSWER: 1

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TOSS-UP

16) Chemistry – *Short Answer* What is the empirical formula for the acid anhydride of phosphoric [*faws-FOR-ik*] acid?

ANSWER: P₂O₅

BONUS

16) Chemistry – *Short Answer* Identify all of the following four compounds in which London dispersion forces dominate intermolecular interactions: 1) Dichloromethane; 2) Neon; 3) Ammonia; 4) Hydrogen.

ANSWER: 2 AND 4

TOSS-UP

17) Energy – *Multiple Choice* DOE scientists at SLAC [*slack*] have been using the Linac Coherent Light Source to study SNARE proteins in the brain. Which of the following processes are SNARE proteins involved with?

- W) Vesicle docking
- X) Actin polymerization [*pawl-ih-mer-eh-ZAY-shun*]
- Y) Intracellular trafficking
- Z) Hormonal signalling

ANSWER: W) VESICLE DOCKING

BONUS

17) Energy – *Multiple Choice* Researchers at Lawrence Berkeley National Lab are currently working on optimizing plants to produce less lignin. For which of the following are these genetically modified plants likely to be used?

- W) Construction materials
- X) Ethanol production
- Y) Insulation
- Z) Food

ANSWER: X) ETHANOL PRODUCTION

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### TOSS-UP

18) Earth and Space – *Multiple Choice* Which of the following is closest to the percentage of the Earth's total surface water contained in ice caps, glaciers, and permanent snow?

- W) 2
- X) 13
- Y) 25
- Z) 45

ANSWER: W) 2

### BONUS

18) Earth and Space – *Multiple Choice* The orbital period of Pluto is 248 years. For what percentage of Pluto's orbital period is it closer to the Sun than Neptune is?

- W) 8
- X) 24
- Y) 37
- Z) 48

ANSWER: W) 8

### TOSS-UP

19) Chemistry – *Short Answer* What is the major acidic species that forms when an acid is dissolved in water?

ANSWER: HYDRONIUM (ACCEPT:  $\text{H}_3\text{O}^+$ )

### BONUS

19) Chemistry – *Short Answer* Identify all of the following three compounds that have a higher lattice energy than sodium fluoride: 1) Sodium chloride; 2) Aluminum fluoride; 3) Sodium oxide.

ANSWER: 2 AND 3

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TOSS-UP

20) Biology – *Short Answer* Which animal phylum **[FYE-lum]** contains the most extant species?

ANSWER: ARTHROPODA

BONUS

20) Biology – *Short Answer* Identify all of the following three nucleobases that are purines **[PURE-eeenz]**: 1) Guanine **[GWAH-neen]**; 2) Uracil **[YUR-ah-sil]**; 3) Thymine **[THIGH-meen]**.

ANSWER: 1 (ACCEPT: GUANINE)

TOSS-UP

21) Physics – *Short Answer* What is the name for the device Michelson and Morley used to disprove the existence of luminiferous aether?

ANSWER: INTERFEROMETER

BONUS

21) Physics – *Short Answer* A hydrogen atom is in its 4th excited state. What is the value of its principal quantum number n ?

ANSWER: 5

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**TOSS-UP**

22) Earth and Space – *Short Answer* What is the general term for the formation of mountains?

ANSWER: OROGENY

**BONUS**

22) Earth and Space – *Short Answer* What soil horizon is composed primarily of decaying organic matter?

ANSWER: O HORIZON

### TOSS-UP

23) Math – *Short Answer* The point (5, 6) is reflected across the  $y$ -axis and the resulting point is then translated 4 units down. What are the coordinates of the final image point?

ANSWER: (-5, 2)

### BONUS

23) Math – *Short Answer* At what  $x$ -value does the maximum value of the function  $f$  of  $x = 2x^3 - 3x^2 - 12x - 6$  occur on the closed interval from  $-4$  to  $4$ ?

ANSWER: 4