

## ROUND 8A

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### TOSS-UP

1) MATH *Multiple Choice* Which of the following best describes the system of linear equations:  
 $y - 2x = -2$ ,  $y + x = 4$  [***y minus two x equals negative two and y plus x equals four***]?

- W) Consistent, Dependent
- X) Consistent, Independent
- Y) Inconsistent, Dependent
- Z) Inconsistent, Independent

ANSWER: X) CONSISTENT, INDEPENDENT

### BONUS

1) MATH *Short Answer* What is the largest possible sum of the digits on a 12-hour digital clock that displays the hours and minutes?

ANSWER: 23

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### TOSS-UP

2) BIOLOGY *Multiple Choice* Which of the following instruments would be used to sterilize glassware for use in a biology lab?

- W) Microtome
- X) Autoclave
- Y) Spectrometer
- Z) Thermocycler

ANSWER: X) AUTOCLAVE

### BONUS

2) BIOLOGY *Multiple Choice* In dragons, the alleles [***uh-LEELS***] for yellow flame color and blue flame color are incompletely dominant. If a homozygous [***hoh-muh-ZY-guhs***] yellow-flame dragon mates with a homozygous blue-flame dragon, all of the brood will have green flame. Which of the following choices represents an expected probability for a brood produced by two green-flame dragons?

- W) 75% green flame
- X) 75% blue flame
- Y) 25% yellow flame
- Z) 25% green flame

ANSWER: Y) 25% YELLOW FLAME

### TOSS-UP

3) CHEMISTRY *Multiple Choice* Which of the following molecules is NOT an exception to the octet rule?

W)  $\text{BF}_3$  [**B-F three**]

X)  $\text{NH}_3$  [**N-H three**]

Y)  $\text{SF}_4$  [**S-F four**]

Z) NO [**N-O**]

ANSWER: X)  $\text{NH}_3$

### BONUS

3) CHEMISTRY *Short Answer* In nickel-cadmium batteries, the cadmium electrode undergoes what process?

ANSWER: OXIDATION

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### TOSS-UP

4) PHYSICS *Short Answer* Millikan's oil-drop experiment was used to calculate what physical value?

ANSWER: CHARGE OF THE ELECTRON (ACCEPT: CHARGE-TO-MASS RATIO)

### BONUS

4) PHYSICS *Multiple Choice* Which of the following statements is NOT true regarding a system undergoing rotation?

W) Torque is the physical quantity describing a force causing rotation about an axis

X) Moment of inertia describes the tendency of an object to resist changes in angular momentum

Y) Torque is required to tilt the axis of rotation

Z) Conservation of angular momentum explains why pulsars will never stop spinning

ANSWER: Z) CONSERVATION OF ANGULAR MOMENTUM EXPLAINS WHY PULSARS WILL NEVER STOP SPINNING

**TOSS-UP**

5) EARTH AND SPACE *Short Answer* The Sun's energy is generated from the fusion of what element to form what other element?

ANSWER: HYDROGEN TO FORM HELIUM

**BONUS**

5) EARTH AND SPACE *Multiple Choice* What is the principle characteristic of rocks that originate from volcanoes?

- W) Light in color
- X) Fine-grained structure
- Y) Presence of shale
- Z) Coarse-grained structure

ANSWER: X) FINE-GRAINED STRUCTURE

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**TOSS-UP**

6) BIOLOGY *Short Answer* The Bowman's capsule and the glomerulus [*gloh-MER-yuh-luhs*] compose what part of the mammalian kidney?

ANSWER: MALPIGHIAN BODY (ACCEPT: MALPIGHIAN CORPUSCLE, RENAL CORPUSCLE, RENAL CORTEX; DO NOT ACCEPT: MALPIGHIAN)

**BONUS**

6) BIOLOGY *Multiple Choice* Which of the following proteins makes up intermediate filaments in the cytoskeleton?

- W) Actin
- X) Myosin [*MY-uh-sin*]
- Y) Tubulin
- Z) Keratin

ANSWER: Z) KERATIN

### TOSS-UP

7) Energy *Multiple Choice* Which of the following is true regarding capacity factor for an electric power producer?

- W) Can be any number
- X) Always greater than 1
- Y) Always between 1 and 0
- Z) Always below 0

ANSWER: Y) ALWAYS BETWEEN 1 AND 0

### BONUS

7) Energy *Short Answer* Specific gravity is commonly measured in what units?

ANSWER: NONE, IT IS DIMENSIONLESS

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### TOSS-UP

8) CHEMISTRY *Multiple Choice* If  $\ell = 3$ , what are the minimum and maximum allowed values of the magnetic quantum number ( $m_\ell$ ) [**M-L**], respectively?

- W) 1, infinity
- X) 0, 2
- Y) -3, 3
- Z)  $-\frac{1}{2}$ ,  $\frac{1}{2}$

ANSWER: Y) -3, 3

### BONUS

8) CHEMISTRY *Short Answer* Identify all of the following three thermodynamic state functions that would increase as a result of water boiling at 100 degrees Celsius at atmospheric pressure:

1) Gibbs free energy; 2) enthalpy; 3) entropy.

ANSWER: 2 AND 3 (ACCEPT: ENTHALPY AND ENTROPY)

### TOSS-UP

9) PHYSICS *Multiple Choice* An object is placed 20 centimeters in front of a thin convex lens of focal length 10 centimeters. What must be the image distance in centimeters?

- W) 2
- X) 5
- Y) 10
- Z) 20

ANSWER: Z) 20

### BONUS

9) PHYSICS *Short Answer* Two people slide a 22 kilogram box across a frictionless floor a distance of 8 meters. Person 1 applies a force of 10 newtons to the box, while Person 2 applies a force of 12 newtons to the box in the same direction as Person 1. What is the velocity of the box, in meters per second, when it reaches the end of the 8 meters?

ANSWER: 4

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### TOSS-UP

10) BIOLOGY *Multiple Choice* You are surfing at the beach and see a shark nearby, activating your vertebrate stress response. Levels of which of the following would decrease during this response?

- W) Cortisol
- X) Glucagon [**GLOO-kuh-gon**]
- Y) Insulin
- Z) Epinephrine [**e-puh-NE-frin**]

ANSWER: Y) INSULIN

### BONUS

10) BIOLOGY *Multiple Choice* If your parietal [**puh-RAY-i-tl**] cells were to stop functioning, which of the following would you need to stop consuming?

- W) Soda pop
- X) Steak
- Y) Bread
- Z) Salad greens

ANSWER: X) STEAK

### TOSS-UP

11) EARTH AND SPACE *Short Answer* Carbon dioxide was released into the atmosphere by volcanic activity and the resulting increase in carbon dioxide levels raised world temperatures by 6 degrees Celsius. The resulting phenomenon, known as The Great Dying, occurred between what two eras?

ANSWER: PALEOZOIC AND MESOZOIC

### BONUS

11) EARTH AND SPACE *Multiple Choice* The red shift in the spectral lines reaching us from other galaxies implies that these galaxies are which of the following?

- W) In rapid rotation
- X) Moving farther apart from one another
- Y) Predominantly of red giants
- Z) Moving closer to one another

ANSWER: X) MOVING FARTHER APART FROM ONE ANOTHER

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### TOSS-UP

12) CHEMISTRY *Multiple Choice* With respect to magnesium and oxygen, respectively, how do the radii of the constituent ions compare to the corresponding neutral atoms?

- W) Larger and larger
- X) Larger and smaller
- Y) Smaller and larger
- Z) Smaller and smaller

ANSWER: Y) SMALLER AND LARGER

### BONUS

12) CHEMISTRY *Short Answer* Given that the pKa [**P-K-A**] of acetic acid is 4.8, find the pH to one decimal place of a solution of acetic acid that contains a 10:1 [**ten to one**] ratio of acetic acid to acetate.

ANSWER: 3.8

**TOSS-UP**

13) MATH *Short Answer* If  $\frac{1}{x} - \frac{1}{y} = \frac{1}{z}$ , [**one over x minus one over y equals one over z**] what does z equal in terms of x and y?

ANSWER:  $\frac{xy}{y-x}$

**BONUS**

13) MATH *Short Answer* Find the inverse of the function  $f(x) = 2/(x - 1)$  [**f of x equals two divided by quantity x minus one**].

ANSWER:  $f^{-1}(x) = (2 + x)/x$  (ACCEPT:  $(2+x)/x, 1 + 2/x$ )

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**TOSS-UP**

14) ENERGY *Multiple Choice* Carnot efficiency is limited by what physical quantity?

- W) Pressure
- X) Entropy
- Y) Flow rate
- Z) Temperature

ANSWER: Z) TEMPERATURE

**BONUS**

14) ENERGY *Short Answer* What type of biofuel is produced by the anaerobic digestion or fermentation of biodegradable materials, primarily producing methane and carbon dioxide?

ANSWER: BIOGAS

### TOSS-UP

15) BIOLOGY *Multiple Choice* Which of the following fish groups is most likely to utilize tidal ventilation when feeding?

- W) Shark
- X) Tuna
- Y) Lamprey
- Z) Eel

ANSWER: Y) LAMPREY

### BONUS

15) BIOLOGY *Multiple Choice* Duchenne [**duh-SHEEN**] muscular dystrophy is the result of a recessive disease allele [**uh-LEEL**] for a gene on the X-chromosome. Which of the following is true regarding inheritance of the disease?

- W) Females have twice the chance of developing it, because they have two X chromosomes
- X) Mothers with the disease allele can pass it with equal probability to sons or daughters
- Y) Inbreeding has no effect on the likelihood of inheriting this disease
- Z) An affected son is always produced if his father has the disease allele

ANSWER: X) MOTHERS WITH THE DISEASE ALLELE CAN PASS IT WITH EQUAL PROBABILITY TO SONS OR DAUGHTERS

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### TOSS-UP

16) CHEMISTRY *Short Answer* In sulfur dioxide, what is the VSEPR [**ves-per**] theory prediction for the bond angle between sulfur-oxygen bonds?

ANSWER: 120

### BONUS

16) CHEMISTRY *Short Answer* A reaction is dependent upon the concentrations of L, M, and N. You find that keeping the other reactants constant and doubling L quadruples the reaction rate; halving M has no effect on the reaction rate; halving N reduces the reaction rate to 1/8 of its original value. Provide the reaction orders for L, M, and N, as well as the overall order for the reaction.

ANSWER: L: 2; M: 0; N: 3 Overall Order: 5



### TOSS-UP

17) MATH *Short Answer* How many points of intersection do the lines  $2x - 3y = 5$  and  $x = 1.5y + 2$  [*two x minus three y equals five and x equals one point five y plus two*] have?

ANSWER: ZERO

### BONUS

17) MATH *Multiple Choice* In a class of 20 students taking an exam, 10% got 70 points, 25% got 80 points, 20% got 85 points, 15% got 90 points, and the rest got 95 points. What is the mean score?

- W) 80
- X) 82
- Y) 84
- Z) 86

ANSWER: Z) 86

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### TOSS-UP

18) PHYSICS *Short Answer* A horizontally polarized electromagnetic wave is travelling in the positive  $x$  direction. When the electric field is pointing in the negative  $z$  direction, what direction is the magnetic field pointing?

ANSWER: POSITIVE Y DIRECTION

### BONUS

18) PHYSICS *Short Answer* Identify all of the following 3 changes that would be observed if you were a stationary observer watching a spaceship pass by travelling at 99% of the speed of light:  
1) The ship would appear longer; 2) A clock on the ship appears to run slower than your wristwatch; 3) As the ship travels away from you, it appears to be bluer.

ANSWER: 2 (ACCEPT: A CLOCK ON THE SHIP APPEARS TO RUN SLOWER THAN YOUR WRISTWATCH)

### TOSS-UP

19) EARTH AND SPACE *Multiple Choice* Present evidence suggests that, by mass, most of the matter in the universe is in the form of what material?

- W) Cosmic rays
- X) Dark matter
- Y) Luminous matter
- Z) Black holes

ANSWER: X) DARK MATTER

### BONUS

19) EARTH AND SPACE *Short Answer* Indirect evidence for the existence of gravitational waves has been found by observing the orbital decay of the Hulse-Taylor binary. A pair of what object makes up the binary?

ANSWER: NEUTRON STARS (ACCEPT: PULSARS)

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### TOSS-UP

20) CHEMISTRY *Multiple Choice* Which of the following statements about Fischer projections is false?

- W) The structure may be rotated by 90 degrees or 180 degrees
- X) Four bonds to a chiral [**KY-ruh**] carbon make a cross with the carbon at the intersection of horizontal and vertical lines
- Y) Two horizontal bonds are directed toward the viewer
- Z) Two vertical bonds are directed behind the stereogenic carbon

ANSWER: W) THE STRUCTURE MAY BE ROTATED BY 90 DEGREES OR 180 DEGREES

### BONUS

20) CHEMISTRY *Short Answer* Identify, respectively, the type of strain, if any, for both the antiperiplanar and synclinal [**sin-KLYN-I**] conformations of butane.

ANSWER: ANTIPERIPLANAR = NONE; SYNCLINAL = STERIC

### TOSS-UP

21) BIOLOGY *Multiple Choice* Which of the following trace nutrients is most important for proper function of cytochrome c [**SY-tuh-kroh** C]?

- W) Magnesium
- X) Copper
- Y) Iron
- Z) Chromium

ANSWER: Y) IRON

### BONUS

21) BIOLOGY *Multiple Choice* Which of the following mammalian groups does NOT have a placenta?

- W) Marsupials [**mahr-SOO-pee-uhs**]
- X) Monotremes [**MON-uh-treems**]
- Y) Cetacea [**si-TAY-shuh**]
- Z) Chiroptera [**kee-ROHP-tuh-ruh**]

ANSWER: X) MONOTREMES

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### TOSS-UP

22) ENERGY *Multiple Choice* Assuming that one maintained a calorie deficit of 500 calories per day, approximately how long would it take to burn one pound of fat?

- W) 1 day
- X) 1 week
- Y) 1 month
- Z) 1 year

ANSWER: X) 1 WEEK

### BONUS

22) ENERGY *Multiple Choice* What is permeability as it applies to magnetic materials?

- W) Degree of magnetization that a material obtains in response to an applied magnetic field
- X) Ability of a magnetic material to move gases through the material
- Y) Amount of magnetic field needed to be applied to saturate the material
- Z) Ability of a magnetic material to pass a current

ANSWER: W) DEGREE OF MAGNETIZATION THAT A MATERIAL OBTAINS IN RESPONSE TO AN APPLIED MAGNETIC FIELD

### TOSS-UP

23) EARTH AND SPACE *Multiple Choice* Which of the following is primarily responsible for the production of spectral absorption lines in the Sun?

- W) Cool gas in the photosphere
- X) Cool gas in the chromosphere
- Y) Hot gas in the photosphere
- Z) Hot gas in the chromosphere

ANSWER: W) COOL GAS IN THE PHOTOSPHERE

### BONUS

23) EARTH AND SPACE *Multiple Choice* Southeasterly tradewinds in the Indian Ocean, near the tropical convergence zone, become which of the following type of winds due to the Coriolis Effect?

- W) Southwest
- X) Southeast
- Y) Northwest
- Z) Northeast

ANSWER: W) SOUTHWEST