

ROUND 8A

TOSS-UP

1) Biology – *Multiple Choice* Meiosis I differs from mitosis in that:

- W) Meiosis I separates sister chromatids whereas mitosis does not
- X) Meiosis I introduces genetic diversity via crossing over whereas mitosis does not
- Y) Meiosis I lines up homologous chromosomes at the equator whereas mitosis does not
- Z) Meiosis I is much shorter than mitosis

Answer: X) MEIOSIS I INTRODUCES GENETIC DIVERSITY VIA CROSSING OVER WHEREAS MITOSIS DOES NOT

BONUS

1) Biology – *Short Answer* Identify all of the following three organelles that are surrounded by a double membrane: 1) Nucleus; 2) Lysosome; 3) Ribosome.

ANSWER: 1

TOSS-UP

2) Energy – *Multiple Choice* Which of the following countries uses the highest percentage of wind power per annum to generate electricity?

- W) France
- X) Australia
- Y) Denmark
- Z) Iceland

ANSWER: Y) DENMARK

BONUS

2) Energy – *Multiple Choice* Which of the following materials could be used as a moderator in a nuclear reactor?

- W) Uranium
- X) Graphite
- Y) Zirconium
- Z) Cesium

ANSWER: X) GRAPHITE

TOSS-UP

3) Math – *Short Answer* How many faces does a regular icosahedron have?

ANSWER: 20

BONUS

3) Math – *Short Answer* You have a sample of 30 values that correspond to the amount of money you spent on gas each month. You notice that the highest value was mistakenly recorded with an extra zero, but after correcting it, it remains the highest value. Identify all of the following three values that change after the correction: 1) Mean; 2) Median; 3) Range

ANSWER: 1, 3

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### TOSS-UP

4) Chemistry – *Short Answer* Argon gas has a total of 3 degrees of freedom. How many of these degrees of freedom are rotation and vibrational, respectively?

ANSWER: ZERO AND ZERO

### BONUS

4) Chemistry – *Multiple Choice* Which of the following molecules has a tetrahedral molecular geometry?

- W) Sulfur tetrafluoride
- X) Xenon tetrafluoride
- Y) Carbon tetrafluoride
- Z) Bromine tetrafluoride anion

ANSWER: Y) CARBON TETRAFLUORIDE

### TOSS-UP

5) Earth and Space – *Multiple Choice* Which of the following is a warm core, low pressure system?

- W) Anticyclone
- X) Hurricane
- Y) Nor'easter
- Z) Mid-latitude cyclone

ANSWER: X) HURRICANE

### BONUS

5) Earth and Space – *Multiple Choice* A total solar eclipse can occur only during what phase of the moon?

- W) Full moon
- X) New moon
- Y) First quarter
- Z) Last quarter

ANSWER: X) NEW MOON



### TOSS-UP

6) Physics – *Short Answer* How much energy, in joules, does a circuit containing a 1.5 volt battery and a 2 ohm resistor dissipate over 8 seconds?

ANSWER: 9

### BONUS

6) Physics – *Short Answer* A spring with spring constant  $k = 200$  newtons per meter with a 0.5 kilogram mass attached is released from rest at 0.02 meters from its equilibrium point. What is the magnitude, in meters per second, of the maximum velocity attained by the mass?

ANSWER: 0.4

### TOSS-UP

7) Energy – *Multiple Choice* Which of the following is least likely to improve the rate of an endothermic reaction involving two gas species reacting on the wall of a vessel?

- W) Coating the wall with a catalyst
- X) Increasing the volume
- Y) Increasing the reactant partial pressure
- Z) Increasing the temperature

ANSWER: X) INCREASING THE VOLUME

### BONUS

7) Energy – *Short Answer* A gas expands by 1.2 liters at a constant pressure of 2.5 bar. During the expansion, 500 joules of heat is added. Given that 1 bar =  $10^5$  pascals, find the change, in joules, in the internal energy of the gas.

ANSWER: 200 (ANSWER MUST BE POSITIVE)

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TOSS-UP

8) Biology – *Multiple Choice* At which of the following pH values would pepsin likely be most active?

- W) 2
- X) 4
- Y) 6
- Z) 8

ANSWER: W) 2

BONUS

8) Biology – *Short Answer* What group of monoamine hormones is derived from tyrosine?

ANSWER: CATECHOLAMINE

TOSS-UP

9) Math – *Multiple Choice* What type of conic section is represented by the following equation:
 $0 = x^2 + 2x - y^2 + 6y - 14$?

- W) ellipse
- X) circle
- Y) hyperbola
- Z) parabola

Answer: Y) HYPERBOLA

BONUS

9) Math – *Short Answer* If the equations $2x + 8 = 4$ and $ax - 30 = -22$ both have the same solution for x , what is the value of a ?

ANSWER: -4

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### TOSS-UP

10) Chemistry – *Short Answer* Reaction A has the same change in Gibbs free energy per mole of reactants as reaction B. If 2 moles of electrons are transferred per mole of reactants in reaction A, and 3 moles of electrons are transferred per mole of reactants in reaction B, what is the ratio of the redox potential for reaction A to that of B?

ANSWER: 3/2 (ACCEPT: 1.5)

### BONUS

10) Chemistry – *Multiple Choice* Which of the following amino acids is present in collagen and is often called an imino acid?

- W) Cysteine [*sis-teen*]
- X) Serine
- Y) Glutamic acid
- Z) Proline

ANSWER: Z) PROLINE

### TOSS-UP

11) Earth and Space – *Multiple Choice* The rate at which temperature decreases with increasing altitude is known as the:

- W) Temperature slope
- X) Lapse rate
- Y) Temperature sounding
- Z) Thermocline

ANSWER: X) LAPSE RATE

### BONUS

11) Earth and Space – *Multiple Choice* A backdoor cold front is most likely to occur in which of the following states?

- W) Florida
- X) California
- Y) Maine
- Z) Michigan

ANSWER: Y) MAINE

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TOSS-UP

12) Physics – *Short Answer* Identify all of the following three particles that would be deflected while traveling in a magnetic field: 1) Positron; 2) Neutrino; 3) Neutron.

ANSWER: 1

BONUS

12) Physics – *Multiple Choice* An object sits in front of a spherical mirror with a focal length of 20 centimeters. The image produced by the mirror is upright and has a height one-third that of the original object. Which of the following is true?

- W) The image is real and the mirror is convex
- X) The image is real and the mirror is concave
- Y) The image is virtual and the mirror is convex
- Z) The image is virtual and the mirror is concave

ANSWER: Y) THE IMAGE IS VIRTUAL AND THE MIRROR IS CONVEX

TOSS-UP

13) Biology – *Multiple Choice* Which of the following are examples of asexual reproduction?

- W) Fragmentation, budding, and binary fission
- X) Parthenocarpic [*pahr-then-oh-car-pic*] fruit development and budding
- Y) Binary fission and zygote formation
- Z) Fragmentation and sporogenesis

ANSWER: W) FRAGMENTATION, BUDDING, AND BINARY FISSION

BONUS

13) Biology – *Multiple Choice* Conifers often have needlelike leaves, which are an adaptation to arid conditions. The slopes of mountains, however, often have dense conifer populations and experience a large amount of rainfall each year. Which of the following correctly explains why trees with adaptations to arid climates flourish near mountains?

- W) Albedo near mountains is high, desiccating normal leaves
- X) Most soil water is frozen, rendering it unavailable to the tree
- Y) The high winds near mountains increase the rate of desiccation
- Z) The soil around mountains drains poorly

ANSWER: X) MOST SOIL WATER IS FROZEN, RENDERING IT UNAVAILABLE TO THE TREE

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### TOSS-UP

14) Chemistry – *Short Answer* What scientist is credited with discovering electrons and calculating their mass to charge ratio?

ANSWER: J.J. THOMSON

### BONUS

14) Chemistry – *Short Answer* When computing freezing point depression and boiling point elevation most directly, what measure of solute concentration should be used, which has units of moles per kilogram?

ANSWER: MOLALITY

### TOSS-UP

15) Math – *Multiple Choice* A continuous function  $f$  has domain the closed interval from 1 to 25 and range the closed interval from 3 to 30. If  $f$  prime of  $x$  is less than 0 for all  $x$  in the closed interval from 1 to 25, what is  $f(25)$ ?

- W) 1
- X) 3
- Y) 25
- Z) 30

ANSWER: X) 3

### BONUS

15) Math – *Multiple Choice* The two legs of a right triangle have lengths of 6 and 2 times the square root of 3. How long is the altitude to the hypotenuse?

- W) 2
- X) 3
- Y) 4
- Z) 5

ANSWER: X) 3

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TOSS-UP

16) Earth and Space – *Multiple Choice* A chinook wind causes which of the following?

- W) Cooling and moistening of air
- X) Cooling and drying of air
- Y) Warming and moistening of air
- Z) Warming and drying of air

ANSWER: Z) WARMING AND DRYING OF AIR

BONUS

16) Earth and Space – *Multiple Choice* Compared with Earth, Mars has:

- W) A denser atmosphere
- X) A shorter year
- Y) More surface water
- Z) Lower average surface temperature

ANSWER: Z) LOWER AVERAGE SURFACE TEMPERATURE

TOSS-UP

17) Physics – *Short Answer* What is the law that describes the relationship between the magnetic field contribution and its source current element?

ANSWER: BIOT-SAVART LAW

BONUS

17) Physics – *Short Answer* The daylight color of the sky is most directly caused by which type of scattering?

ANSWER: ELASTIC (ACCEPT: RAYLEIGH)

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### TOSS-UP

18) Chemistry – *Multiple Choice* Which of the following quantities increases with the addition of a catalyst?

- W) Gibbs free energy
- X) Activation energy
- Y) Reaction rate
- Z) Equilibrium constant

ANSWER: Y) REACTION RATE

### BONUS

18) Chemistry – *Multiple Choice* Which of the following occurs when a dilute solution of ammonia is added to a solution containing iron(III) ions?

- W)  $\text{Fe}(\text{NH}_2)_3$  precipitates
- X)  $\text{Fe}(\text{OH})_3$  precipitates
- Y) The solution turns from yellow to blue
- Z) Hydrogen gas is given off

ANSWER: X)  $\text{Fe}(\text{OH})_3$  PRECIPITATES

### TOSS-UP

19) Energy – *Short Answer* What term describes the random motion of particles suspended in a fluid resulting from collisions with individual fluid atoms or molecules?

ANSWER: BROWNIAN MOTION (ALSO ACCEPT “PEDESIS”)

### BONUS

19) Energy – *Multiple Choice* Which of the following is a disadvantage of using LEDs over incandescent light sources?

- W) Shorter lifespan
- X) Larger size
- Y) Higher energy consumption
- Z) Temperature dependence of performance quality

ANSWER: Z) TEMPERATURE DEPENDENCE OF PERFORMANCE QUALITY

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TOSS-UP

20) Math – *Short Answer* You have some number of marbles of several different sizes and colors. For any set of 5 marbles, at least two of them will be the same size and at least two of them will be the same color. What is the maximum possible number of size-color combinations?

ANSWER: 16

BONUS

20) Math – *Short Answer* Determine all values in the closed interval from zero to 2 times the square root of 3 that are prescribed by Rolle’s [*Rolls*] Theorem for $f(x) = x^3 - 12x$.

ANSWER: 2

TOSS-UP

21) Physics – *Multiple Choice* Which of the following statements most accurately describes Einstein's first postulate of special relativity?

- W) The speed of light in a vacuum is the same in all inertial reference frames
- X) The laws of physics are the same in all inertial reference frames
- Y) It is impossible for an observer to travel at the speed of light in a vacuum
- Z) An observer cannot discern between inertial acceleration and acceleration due to gravity

ANSWER: X) THE LAWS OF PHYSICS ARE THE SAME IN ALL INERTIAL REFERENCE FRAMES

BONUS

21) Physics – *Short Answer* What phenomenon occurs in solid materials that results in a burst of light when the material is crushed or scratched?

ANSWER: TRIBOLUMINESCENCE

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### TOSS-UP

22) Biology – *Multiple Choice* Which of the following methods was used to determine the 3D structure of hemoglobin?

- W) Circular dichroism [*dye-croh-ism*]
- X) X-ray crystallography
- Y) Protein NMR
- Z) Electrolysis

ANSWER: X) X-RAY CRYSTALLOGRAPHY

### BONUS

22) Biology – *Short Answer* What common second messenger is released after epinephrine binds to liver GPCRs and was the subject of the 1994 Nobel Prize?

ANSWER: CYCLIC AMP (ACCEPT: cAMP)

### TOSS-UP

23) Earth and Space – *Multiple Choice* A line of brown semicircles on a weather map indicates:

- W) A warm front
- X) A cold front
- Y) A dry line
- Z) Smog

ANSWER: Y) A DRY LINE

### BONUS

23) Earth and Space – *Short Answer* What structural modification did the United States introduce to enable atmospheric pollutants such as nitrogen and sulfur oxides to be dispersed at higher altitudes?

ANSWER: SMOKESTACKS