

ROUND 10A

TOSS-UP

1) Chemistry – *Short Answer* What is the hybridization of the central iodine atom in iodine pentafluoride?

ANSWER: sp^3d^2 [*s-p-3-d-2*]

BONUS

1) Chemistry – *Short Answer* What class of organic molecules has the formula R-COOH and can react with alcohols to produce esters?

ANSWER: CARBOXYLIC ACID

~~~~~

### TOSS-UP

2) Earth and Space – *Multiple Choice* Which of the following planets is mostly composed of hydrogen, helium, and methane?

- W) Uranus
- X) Mercury
- Y) Mars
- Z) Venus

ANSWER: W) URANUS

### BONUS

2) Earth and Space – *Multiple Choice* Which of the following provides the most accurate description of carrying capacity?

- W) Population below the carrying capacity will increase primary succession
- X) Population above the carrying capacity cannot be sustained indefinitely
- Y) Population above the carrying capacity will always run out of space
- Z) Population above the carrying capacity will always result in excessive CO<sub>2</sub> levels

ANSWER: X) POPULATION ABOVE THE CARRYING CAPACITY CANNOT BE SUSTAINED INDEFINITELY

### TOSS-UP

3) Energy – *Multiple Choice* What is the primary advantage of using cellulosic feedstocks over crops like corn to produce ethanol?

- W) The enzymes that produce cellulosic ethanol are cheap and plentiful
- X) There are more cellulosic ethanol plants than corn ethanol plants
- Y) Waste products can be used as cellulosic feedstocks
- Z) Cellulosic ethanol production does not require government subsidies to be economically competitive

ANSWER: Y) WASTE PRODUCTS CAN BE USED AS CELLULOSIC FEEDSTOCKS

### BONUS

3) Energy – *Multiple Choice* Which of the following countries generates the highest percentage of its electricity from nuclear power?

- W) Japan
- X) France
- Y) United States
- Z) Russia

ANSWER: X) FRANCE



### TOSS-UP

4) Physics – *Short Answer* A certain planet has four times the mass of Earth, but the acceleration due to gravity on the planet's surface is the same as that of Earth. What is the ratio of the planet's radius to the Earth's radius?

ANSWER: 2 (ACCEPT: 2:1)

### BONUS

4) Physics – *Short Answer* A ball of mass  $M$  and speed  $V$  collides with a ball of mass  $2M$  moving toward the first ball with a speed of  $\frac{1}{2}V$ . If the two balls stick together, what will their speed after the collision be?

ANSWER: 0

### TOSS-UP

5) Biology – *Short Answer* Recombinant DNA can be introduced to eukaryotic cells by briefly shocking them. What is this technique called?

ANSWER: ELECTROPORATION (DO NOT ACCEPT: TRANSFECTION, TRANSFORMATION)

### BONUS

5) Biology – *Multiple Choice* Which of the following statements is true regarding fungal mutualism?

W) Most endophytes are basidiomycetes [*buh-sid-ee-oh-mye-seets*]

X) Many species of ants culture fungi inside of their bodies

Y) Lichens are capable of nitrogen fixation

Z) Plants can generally grow normally without endophytes

ANSWER: Y) LICHENS ARE CAPABLE OF NITROGEN FIXATION

~~~~~

TOSS-UP

6) Math – *Short Answer* For a normal distribution with mean of 94 and standard deviation of 4, for a score of 88, what is the corresponding Z-score?

ANSWER: -1.5 (ACCEPT $-3/2$ or $-1\frac{1}{2}$)

BONUS

6) Math – *Multiple Choice* For the arithmetic series with first three terms 3, 5, and 7, what is the sum of the first 10 terms of the series?

W) 100

X) 120

Y) 140

Z) 160

ANSWER: X) 120

TOSS-UP

7) Chemistry – *Multiple Choice* A catalyst speeds up a chemical reaction by:

- W) Shifting the equilibrium
- X) Increasing the activation energy
- Y) Decreasing the reaction enthalpy
- Z) Providing an alternate reaction pathway

ANSWER: Z) PROVIDING AN ALTERNATE REACTION PATHWAY

BONUS

7) Chemistry – *Multiple Choice* Which of the following chlorides is least soluble?

- W) Barium chloride
- X) Cesium chloride
- Y) Lead(II) chloride
- Z) Nickel(II) chloride

ANSWER: Y) LEAD(II) CHLORIDE

~~~~~

### TOSS-UP

8) Energy – *Multiple Choice* Two resistors, R1 and R2, are identical, but the potential difference across R1 is half the potential difference across R2. What is the ratio of the current in R1 to the current in R2?

- W) 1/2
- X) 1/4
- Y) 2
- Z) 4

ANSWER: W) 1/2

### BONUS

8) Energy – *Multiple Choice* What major mode of heat transfer is primarily responsible for the circulation of atmospheric cells, such as the Hadley cell?

- W) Radiation
- X) Conduction
- Y) Convection
- Z) Diffusion

ANSWER: Y) CONVECTION

### TOSS-UP

9) Earth and Space – *Short Answer* What types of streams, usually found in deserts, only carry water in response to specific episodes of rainfall?

ANSWER: EPHEMERAL STREAMS

### BONUS

9) Earth and Space – *Short Answer* Identify all of the following three geological features that are formed by the wind: 1) Yardangs; 2) Roche moutonnee [*moot-an-ay*]; 3) Blowouts.

ANSWER: 1 AND 3



### TOSS-UP

10) Physics – *Short Answer* A neutron, an electron, a proton, and an alpha particle are all traveling at the same speed. Which of these particles has the shortest de Broglie wavelength?

ANSWER: ALPHA PARTICLE

### BONUS

10) Physics – *Short Answer* Identify all of the following 3 statements that are true of equipotential surfaces: 1) Field lines and equipotential surfaces are always mutually perpendicular; 2) When all charges are at rest, the surface of a conductor is always an equipotential surface; 3) The work done to move a charge from any point on an equipotential surface to any other point on the equipotential surface is zero.

ANSWER: 1, 2, 3

### TOSS-UP

11) Biology – *Multiple Choice* There are three checkpoints during normal cell division. In what stages in the life of a cell are these checkpoints found?

- W) Growth phase I, Growth Phase II, and mitosis
- X) Growth phase I, S phase, and mitosis
- Y) S phase, telophase, and anaphase
- Z) S phase, growth phase II, and mitosis

ANSWER: W) GROWTH PHASE I, GROWTH PHASE II, AND MITOSIS

### BONUS

11) Biology – *Multiple Choice* Which of the following is not true regarding arthropods?

- W) Arthropods have an open circulatory system
- X) Molting occurs because arthropods cannot grow without shedding their exoskeleton
- Y) Book lungs are found in arachnids
- Z) Cheliceriformes [*kuh-liss-er-uh-forms*] are characterized by 5 pairs of legs and two pairs of antennae

ANSWER: Z) CHELICERIFORMES ARE CHARACTERIZED BY 5 PAIRS OF LEGS AND TWO PAIRS OF ANTENNAE

~~~~~

TOSS-UP

12) Math – *Multiple Choice* Divide a unit segment into 3 congruent segments and remove the middle segment. Do this process a second time on each of the remaining two segments. If this process is carried out a total of n times, what is the sum of the lengths of the remaining segments?

- W) One-third to the n th power
- X) One minus one-third to the n th power
- Y) Two-thirds to the n th power
- Z) One minus two-thirds to the n th power

ANSWER: Y) TWO-THIRDS TO THE n th POWER

BONUS

12) Math – *Short Answer* If $a_1 = 4$ and $a_n = 2a_{n-1} + 5$, what is the value of a_4 ?

ANSWER: 67

TOSS-UP

13) Chemistry – *Short Answer* For an electron in a 3d subshell, what is the smallest value the magnetic quantum number can take?

ANSWER: -2

BONUS

13) Chemistry – *Short Answer* Identify all of the following three reactions that would result in a precipitate. 1) Addition of iron(III) nitrate to sodium sulfate; 2) Addition of aluminum nitrate and zinc sulfate; 3) Addition of iron(III) nitrate to sodium hydroxide.

ANSWER: 3

~~~~~

### TOSS-UP

14) Energy – *Multiple Choice* What is the approximate wavelength range of light that is used in night vision goggles, guided missiles, and some remote controls?

- W) 10 nanometers – 380 nanometers
- X) 380 nanometers – 700 nanometers
- Y) 700 nanometers – 1 millimeter
- Z) 1 millimeter – 1 meter

ANSWER: Y) 700 NANOMETERS – 1 MILLIMETER

### BONUS

14) Energy – *Multiple Choice* What signs for change in enthalpy and entropy guarantee that a process will be spontaneous at any temperature?

- W) Negative enthalpy, positive entropy
- X) Negative enthalpy, negative entropy
- Y) Positive enthalpy, negative entropy
- Z) Positive enthalpy, positive entropy

ANSWER: W) NEGATIVE ENTHALPY, POSITIVE ENTROPY

### TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following is true regarding all members of our solar system?

- W) They have always existed
- X) They were formed thousands of years ago from elements that have always existed
- Y) They were formed millions of years ago, when the elements and each body were created at the same time
- Z) They were formed billions of years ago from elements that were created in many previously existing stars

ANSWER: Z) THEY WERE FORMED BILLIONS OF YEARS AGO FROM ELEMENTS THAT WERE CREATED IN MANY PREVIOUSLY EXISTING STARS

### BONUS

15) Earth and Space – *Multiple Choice* Areas of low pressure exist over the equatorial regions due to which of the following?

- W) Temperature
- X) Salinity
- Y) Coriolis forces
- Z) Circulation

ANSWER: W) TEMPERATURE

~~~~~

TOSS-UP

16) Physics – *Short Answer* Identify all of the following three types of collisions that conserve kinetic energy: 1) Elastic collision; 2) Partial inelastic collision; 3) Completely inelastic collision.

ANSWER: 1

BONUS

16) Physics – *Short Answer* A 2.0 meter long, 100 kilogram horizontal uniform steel beam is supported 0.6 meters from the right end. To the nearest whole newton-meter, what is the gravitational torque about the support?

ANSWER: 392

TOSS-UP

17) Biology – *Multiple Choice* Which of the following cleavage patterns is characteristic of deuterostomes [*doo-tuhr-oh-stohms*]?

- W) Spiral cleavage
- X) Determinate cleavage
- Y) Bilateral cleavage
- Z) Radial cleavage

ANSWER: Z) RADIAL CLEAVAGE

BONUS

17) Biology – *Multiple Choice* Which of the following enzymes would be required for the formation of cDNA, a genetic transcript from eukaryotic cells that has had the introns removed?

- W) Excinuclease [*ex-ih-noo-lee-ayse*]
- X) AP Endonuclease
- Y) Reverse transcriptase
- Z) DNase I

ANSWER: Y) REVERSE TRANSCRIPTASE

~~~~~

### TOSS-UP

18) Math – *Multiple Choice* Which of the following best describes the following system of two linear equations:  $y - 2x = -2$ ,  $y + x = 4$ ?

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

ANSWER: Y) CONSISTENT, INDEPENDENT

### BONUS

18) Math – *Multiple Choice* Telesha and Chrissy each have a bag that contains one ball of each of the colors blue, green, red, purple, and pink. If Telesha takes one ball at random out of her bag and places it in Chrissy's bag and then Chrissy takes one ball at random out of her bag and places it in Telesha's bag, what is the probability that the two bags have the same contents?

- W) 1/10
- X) 1/6
- Y) 1/5
- Z) 1/3

ANSWER: Z) 1/3

### TOSS-UP

19) Chemistry – *Multiple Choice* Macrophages use NADPH oxidase to generate what chemical, which is then used to destroy invading bacteria?

- W) Hypochlorite ions
- X) Superoxide ions
- Y) Hydroxide ions
- Z) Chloric acid

ANSWER: X) SUPEROXIDE IONS

### BONUS

19) Chemistry – *Short Answer* Assume that heptane boils at a temperature of 97 degrees Celsius and has a molar enthalpy of vaporization of 37 kilojoules per mole. What is the delta G, to two significant figures and in joules, for the vaporization of one mole of heptane at 100 degrees Celsius?

ANSWER: -300 (DO NOT ACCEPT: 300)

~~~~~

TOSS-UP

20) Earth and Space – *Multiple Choice* Which of the following minerals is the most economically important ore for mining and extraction of the element mercury?

- W) Calcite
- X) Cinnabar
- Y) Chabazite
- Z) Cristobalite

ANSWER: X) CINNABAR

BONUS

20) Earth and Space – *Multiple Choice* How fast, in miles per hour, can a tsunami travel over the open ocean?

- W) 20
- X) 100
- Y) 500
- Z) 1000

ANSWER: Y) 500

TOSS-UP

21) Physics – *Multiple Choice* The gravitational potential energy of an object is often approximated as mgh , for which m is its mass, h is the height above the Earth's surface, and g is the acceleration due to gravity. What assumption is required in order to approximate g as a constant?

- W) Wind resistance is negligible
- X) The object has no rotational inertia
- Y) m is very small compared to the mass of the Earth
- Z) h is very small compared to the radius of the Earth

ANSWER: Z) h is very small compared to the radius of the Earth

BONUS

21) Physics – *Short Answer* How many total degrees of freedom does a diatomic gas have?

ANSWER: SIX



TOSS-UP

22) Biology – *Short Answer* Identify all of the following three choices that represent correct reasons why the eradication of polio is possible: 1) Humans are the only reservoir of polio; 2) Transmission of the polio virus is very difficult; 3) Vaccination generates herd immunity.

ANSWER: 1 AND 3

BONUS

22) Biology – *Short Answer* Identify all of the following three species that are part of the phylum Mollusca: 1) Blue-ringed octopus; 2) Giant clam; 3) Oyster.

ANSWER: 1, 2, 3

TOSS-UP

23) Math – *Short Answer* Evaluate the following definite integral: the integral from 0 to $\pi/2$ of $\sin x \cos x$ dx .

ANSWER: $\frac{1}{2}$ (ACCEPT: 0.5)

BONUS

23) Math – *Short Answer* The sums of three whole numbers taken in pairs are 11, 13, and 16. What is the product of these three numbers?

ANSWER: 252