

CK ROUND 1

TOSS-UP

1) Chemistry – *Short Answer* Calcium carbide reacts with water to form calcium hydroxide and what gas?

ANSWER: ACETYLENE (ACCEPT: ETHYNE; C_2H_2)

BONUS

1) Chemistry – *Multiple Choice* An alkyne is treated with sodium metal in a solution of liquid ammonia. Which of the following products is most likely to form?

- W) Alkane
- X) Alcohol
- Y) Cis-alkene
- Z) Trans-alkene

ANSWER: Z) TRANS-ALKENE

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### TOSS-UP

2) Physics – *Multiple Choice* A 1000-kilogram car is traveling on a frictionless road at 20 meters per second to the right when it collides perfectly inelastically with a 2000-kilogram truck traveling 30 meters per second to the left. Which of the following statements is true regarding the collision?

- W) Only momentum was conserved
- X) Only kinetic energy was conserved
- Y) Both kinetic energy and momentum were conserved
- Z) Neither momentum nor kinetic energy were conserved

ANSWER: W) ONLY MOMENTUM WAS CONSERVED

### BONUS

2) Physics – *Short Answer* Identify all of the following three changes that would increase the period of a pendulum's swing: 1) Increasing the length of the string; 2) Decreasing the mass of the bob; 3) Releasing the pendulum from a higher point.

ANSWER: 1 ONLY

**TOSS-UP**

3) Biology – *Short Answer* Adenylyl cyclase is an integral membrane protein activated by G-proteins to catalyze the formation of what molecule?

ANSWER: cAMP (ACCEPT: CYCLIC AMP)

**BONUS**

3) Biology – *Short Answer* Identify all of the following three cells types that are considered leukocytes: 1) Macrophages; 2) Lymphocytes; 3) Erythrocytes.

ANSWER: 1 AND 2



**TOSS-UP**

4) Math – *Short Answer* What is the  $x$ -intercept of the line with equation  $3y - 2x = 8$ ?

ANSWER:  $(-4, 0)$

**BONUS**

4) Math – *Short Answer* What is the volume in of a right circular cone with a diameter of 6 and a slant height of 5?

ANSWER:  $12\pi$

### TOSS-UP

5) Earth and Space – *Multiple Choice* Which of the following locations could be a site of intraplate volcanism?

- W) Yellowstone
- X) Hawaii
- Y) East African rift
- Z) Andes Mountains

ANSWER: W) YELLOWSTONE

### BONUS

5) Earth and Space – *Short Answer* What is the name for the region on an H-R diagram where Cepheid and other variable stars are located due to their tendency to pulsate?

ANSWER: INSTABILITY STRIP



### TOSS-UP

6) Chemistry – *Multiple Choice* Which of the following is FALSE regarding black bodies?

- W) The energy of radiation emitted by a black body is quantized
- X) All black bodies preferentially absorb low-wavelength radiation
- Y) The intensity of radiation emitted from a black body is proportional to the fourth power of its temperature
- Z) Increasing the temperature of a black body shifts its maximum intensity to lower wavelengths

ANSWER: X) ALL BLACK BODIES PREFERENTIALLY ABSORB LOW-WAVELENGTH RADIATION

### BONUS

6) Chemistry – *Short Answer* Both  $\text{AlCl}_3$  and  $\text{ICl}_3$  dimerize to form  $\text{Al}_2\text{Cl}_6$  and  $\text{I}_2\text{Cl}_6$ , respectively. Identify all of the following three ways in which these latter structures differ: 1) Hybridization of central atoms; 2) Geometry of molecule; 3) Connectivity of atoms.

ANSWER: 1 AND 2

### TOSS-UP

7) Math – *Short Answer* If  $f(x) = 3x^2 - 2x + 5$ , what is  $f$  prime of 3?

ANSWER: 16

### BONUS

7) Math – *Short Answer* A fair coin is flipped five times. What is the probability that it does not land on heads once after all five tosses?

ANSWER: 1/32



### TOSS-UP

8) Biology – *Multiple Choice* What is the name given to the tall vertical root found in vascular plants that is responsible for anchoring plants in the soil?

- W) Primary root
- X) Lateral root
- Y) Rhizome
- Z) Taproot

ANSWER: Z) TAPROOT

### BONUS

8) Biology – *Short Answer* Identify all of the following three features that appear at some stage during the embryonic development of all chordates: 1) Dorsal nerve cord; 2) Post-anal tail; 3) Vertebral column.

ANSWER: 1 AND 2

### TOSS-UP

9) Earth and Space – *Short Answer* When high-energy particles from the solar wind hit the Earth's atmosphere, they can become captured by the Earth's magnetic field. This results in the formation of what zones?

ANSWER: VAN ALLEN BELTS

### BONUS

9) Earth and Space – *Multiple Choice* When moist air has an environmental lapse rate between 5 and 10 degrees Celsius per 1,000 meters, it is said to exhibit which of the following?

- W) Absolute stability
- X) Absolute instability
- Y) Conditional instability
- Z) Temperature inversion

ANSWER: Y) CONDITIONAL INSTABILITY



### TOSS-UP

10) Physics – *Multiple Choice* What quantity is defined as the measure of how resistant to compression a substance is?

- W) Young's modulus
- X) Bulk modulus
- Y) Shear modulus
- Z) Reynold's number

ANSWER: X) BULK MODULUS

### BONUS

10) Physics – *Short Answer* What thermodynamic state function is defined as the maximum useful work that can be obtained from a system under conditions of constant temperature and volume?

ANSWER: HELMHOLTZ FREE ENERGY

### TOSS-UP

11) Biology – *Multiple Choice* Which of the following are homologous genes resulting from gene duplication?

- W) Paralogous genes
- X) Orthologous genes
- Y) Divergent genes
- Z) Xenologous genes

ANSWER: W) PARALOGOUS GENES

### BONUS

11) Biology – *Short Answer* Identify all of the following three types of cell junctions that are present in animal cells: 1) Desmosomes; 2) Gap junctions; 3) Plasmodesmata.

ANSWER: 1 AND 2



### TOSS-UP

12) Physics – *Short Answer* What is the time constant, in seconds, of an RC circuit consisting of two 3-ohm resistors in series with a 6-millifarad capacitor?

ANSWER: 0.036

### BONUS

12) Physics – *Short Answer* Spin magnetic dipole moments of electrons are roughly equal to what physical constant?

ANSWER: BOHR MAGNETON

### TOSS-UP

13) Chemistry – *Multiple Choice* Which of the following bonds has the smallest bond dissociation energy?

- W) H-F
- X) H-Cl
- Y) H-Br
- Z) H-I

ANSWER: Z) H-I

### BONUS

13) Chemistry – *Short Answer* What is the change in the oxidation number of manganese when it is reduced to  $\text{Mn}^{2+}$  from permanganate in acidic solution?

ANSWER: -5



### TOSS-UP

14) Math – *Short Answer* How many points of intersection are there between the curves of  $y = x^2$  and  $y = e$  to the  $x$ ?

ANSWER: 1

### BONUS

14) Math – *Short Answer* The radius of a sphere is increased by a factor of 3. If the surface area of the new sphere is now  $108\pi$ , what was the original volume of the sphere?

ANSWER:  $36\pi$

### TOSS-UP

15) Earth and Space – *Multiple Choice* Danish geologist Nicolaus Steno is credited with recognizing that the oldest strata form at the bottom of a sequence of sedimentary rocks. What is the name given to his discovery?

- W) Principle of original horizontality
- X) Principle of cross-cutting relationships
- Y) Law of superposition
- Z) Law of disconformity

ANSWER: Y) LAW OF SUPERPOSITION

### BONUS

15) Earth and Space – *Short Answer* Main-sequence stars with masses greater than 1.1 times that of our Sun possess a high enough temperature to fuse hydrogen into helium using what process?

ANSWER: CNO CYCLE



### TOSS-UP

16) Chemistry – *Short Answer* Order the following three functional groups in order of increasing pKa: 1) Carboxylic acid; 2) Ketone; 3) Alcohol.

ANSWER: 1, 3, 2

### BONUS

16) Chemistry – *Multiple Choice* Which of the following statements is true regarding azeotropes?

- W) Positive azeotropes boil at lower temperatures than either of their constituents
- X) Positive azeotropes result from more favorable intermolecular interactions
- Y) Azeotropes can be separated using fractional distillation
- Z) A 96% ethanol and 4% water solution forms a negative azeotrope

ANSWER: W) POSITIVE AZEOTROPES BOIL AT LOWER TEMPERATURES THAN EITHER OF THEIR CONSTITUENTS



### TOSS-UP

17) Physics – *Short Answer* Identify all of the following three waves that are considered longitudinal: 1) Electromagnetic waves; 2) Sound waves; 3) Seismic P-waves.

ANSWER: 2 AND 3

### BONUS

17) Physics – *Multiple Choice* Regions in a crystal where the alignment of atomic dipoles is uniform are called which of the following?

- W) Magnetic zones
- X) Magnetic domains
- Y) Curie regions
- Z) Gaussian belts

ANSWER: X) MAGNETIC DOMAINS

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### TOSS-UP

18) Biology – *Multiple Choice* Which of the following types of microscopy uses ultra-thin specimens to study the internal structure of cells?

- W) Scanning electron microscopy
- X) Transmission electron microscopy
- Y) Fluorescence microscopy
- Z) Super-resolution microscopy

ANSWER: X) TRANSMISSION ELECTRON MICROSCOPY

### BONUS

18) Biology – *Multiple Choice* Sickle cell disease is caused when a single glutamic acid in hemoglobin is substituted by which of the following?

- W) Lysine
- X) Aspartic acid
- Y) Valine
- Z) Glycine

ANSWER: Y) VALINE

**TOSS-UP**

19) Math – *Short Answer* What is the greatest prime factor of 140?

ANSWER: 7

**BONUS**

19) Math – *Short Answer* What is the magnitude of the vector  $-2\mathbf{i} + 5\mathbf{j} + \mathbf{k}$ ?

ANSWER:  $\sqrt{30}$



**TOSS-UP**

20) Earth and Space – *Multiple Choice* Assuming all other properties remain constant, when the radius of a star is halved, its total luminosity decreases by which of the following factors?

- W) 2
- X) 4
- Y) 8
- Z) 16

ANSWER: W) 4

**BONUS**

20) Earth and Space – *Multiple Choice* A magnitude 4.6 earthquake releases approximately how much more energy than a magnitude 2.6 earthquake?

- W) 30
- X) 130
- Y) 510
- Z) 1000

ANSWER: Z) 1000