

## ROUND ROBIN – ROUND 12

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### TOSS-UP

1) Earth & Space – *Multiple Choice* The formation of volcanos on Mars is thought to be most mechanically similar to that of which of the following volcanos on Earth?

- W) Mount Fuji
- X) Mount St. Helens
- Y) Mauna Loa
- Z) Parícutin [*pah-REE-coo-TEEN*]

ANSWER: Y) MAUNA LOA

### BONUS

1) Earth & Space – *Short Answer* Identify all of the following three types of climates that would be considered part of Koppen Group C: 1) Tropical wet; 2) Mediterranean; 3) Subtropical steppe.

ANSWER: 2

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### TOSS-UP

2) Chemistry – *Short Answer* What principle can be used to predict the direction of changes in the equilibrium point of a reaction based on changes in reactant and product concentrations?

ANSWER: LE CHATELIER'S PRINCIPLE

### BONUS

2) Chemistry – *Short Answer* Place the following three compounds in order of increasing boiling point: 1) Methanol; 2) Ethane; 3) Butanoic [*b-yoo-tan-OH-ik*] acid.

ANSWER: 2, 1, 3

## **TOSS-UP**

3) Energy – *Multiple Choice* Researchers at Argonne National Lab are exploring the possibility of using neutrino detectors to search for dark matter. Which of the following similarities between neutrinos and theoretical dark matter particles explains why the detectors could be repurposed?

- W) Current cosmological models suggest that dark matter consists entirely of neutrinos
- X) Both particles are very heavy
- Y) Both particles are extremely rare in the universe
- Z) Both particles interact very weakly with normal matter

ANSWER: Z) BOTH PARTICLES INTERACT VERY WEAKLY WITH NORMAL MATTER

## **BONUS**

3) Energy – *Multiple Choice* Scientists at Lawrence Berkeley National Lab have made inorganic crystals of germanium sulfide that are arranged in a helical stack of thin sheets. They determined the structure of these crystals using X-ray crystallography. How did these scientists generate the requisite high-energy X-rays?

- W) Rapidly decelerating neutral particles
- X) Spallation of heavy elements
- Y) Rapidly oscillating electric dipoles in an ultra-high-frequency antenna
- Z) Centrifugal acceleration of charged particles

ANSWER: Z) CENTRIFUGAL ACCELERATION OF CHARGED PARTICLES

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## **TOSS-UP**

4) Physics – *Multiple Choice* MRI imaging primarily depends on the interaction of magnetic fields and which of the following atomic properties?

- W) Molecular electric dipole moment
- X) Electron anomalous moment
- Y) Electron orbital magnetic moment
- Z) Nuclear magnetic moment

ANSWER: Z) NUCLEAR MAGNETIC MOMENT

## **BONUS**

4) Physics – *Short Answer* In meters per second squared with two significant figures, what is the acceleration due to gravity on the surface of a spherical planet with the same mass as Earth but three times the radius?

ANSWER: 1.1

### **TOSS-UP**

5) Math – *Multiple Choice* Which of the following is logically equivalent to the statement “not A or not B”?

- W) A and B
- X) A if and only if B
- Y) A implies not B
- Z) Not A implies not B

ANSWER: Y) A IMPLIES NOT B

### **BONUS**

5) Math – *Short Answer* What is the sum of the first 5 terms in the increasing geometric sequence with first term 5 and third term 80?

ANSWER: 1705

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### **TOSS-UP**

6) Biology – *Short Answer* In the process of autophagy [*auto-fay-jee*], a cell can recycle its own contents by merging vesicles containing damaged parts with what organelles?

ANSWER: LYSOSOMES

### **BONUS**

6) Biology – *Short Answer* Identify all of the following three types of blood cells that contain nuclei:

1) Platelets; 2) Erythrocytes [*eh-RITH-roh-site*]; 3) Monocytes.

ANSWER: 3

### **TOSS-UP**

7) Earth & Space – *Short Answer* What is the term for stellar objects that are typically less than 0.08 stellar masses and, as a result, failed to start nuclear fusion?

ANSWER: BROWN DWARFS

### **BONUS**

7) Earth & Space – *Short Answer* The Kirkwood gaps are caused by orbital resonance with what planet?

ANSWER: JUPITER

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### **TOSS-UP**

8) Physics – *Short Answer* The statement that the electric flux through a closed surface is only dependent on the charge it encloses is a statement of which of Maxwell's equations?

ANSWER: GAUSS'S LAW

### **BONUS**

8) Physics – *Short Answer* Consider an extrasolar “rogue” planet approaching our solar system. Identify all of the following three statements that are true of their gravitational interaction: 1) If the total energy is greater than zero, the planet will enter a stable orbit about the Sun; 2) If the total energy is less than zero, the planet will enter a stable orbit about the Sun; 3) If the total energy is equal to zero, the path of the planet will form a parabola [*pah-RAB-ah-la*].

ANSWER: 2, 3

## **TOSS-UP**

9) Biology – *Short Answer* The spinal cord is enclosed by three layers of membranes collectively called what?

ANSWER: MENINGES (DO NOT ACCEPT: DURA, PIA, ARACHNOID MATTER)

## **BONUS**

9) Biology – *Multiple Choice* Which of the following amino acids would be most likely found in the intramembrane domain of a surface receptor protein?

- W) Cysteine *[SIS-tuh-een]*
- X) Glutamic *[gloo-TAM-ik]* acid
- Y) Lysine *[LYE-seen]*
- Z) Phenylalanine *[fennil-AL-ah-neen]*

ANSWER: Z) PHENYLALANINE

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## **TOSS-UP**

10) Math – *Short Answer* What is the product of the three different prime factors of 168?

ANSWER: 42

## **BONUS**

10) Math – *Multiple Choice* A regular 36-sided polygon is inscribed in a circle with radius 8. Which of the following is the length of one of its sides?

- W) 8 cosine 10 degrees
- X) 8 sine 10 degrees
- Y) 16 cosine 5 degrees
- Z) 16 sine 5 degrees

ANSWER: Z) 16 SINE 5 DEGREES

### **TOSS-UP**

11) Energy – *Short Answer* Researchers at the Joint Genome Institute are studying plants that perform CAM photosynthesis. This pathway is characterized by the storage of carbon dioxide as what acid during the night?

ANSWER: MALATE (ACCEPT: MALIC ACID)

### **BONUS**

11) Energy – *Short Answer* Scientists at the Joint Genome Institute are studying terpenes, which are plant metabolites synthesized from what monomer?

ANSWER: ISOPENTENYL PYROPHOSPHATE (ACCEPT: IDP, IPP, ISOPENTENYL DIPHOSPHATE)

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### **TOSS-UP**

12) Chemistry – *Multiple Choice* Which of the following molecules contains the most electron-rich carbon center?

- W) Methanol
- X) Methane
- Y) Formaldehyde
- Z) Carbon monoxide

ANSWER: X) METHANE

### **BONUS**

12) Chemistry – *Short Answer* Order the following three salts in order of increasing melting point:  
1) NaCl; 2) NaBr; 3) MgF<sub>2</sub>.

ANSWER: 2, 1, 3

### **TOSS-UP**

13) Biology – *Short Answer* In the Krebs cycle, citrate is generated by the combination of acetyl-CoA [*ah-see-til-koh-AY*] with what four-carbon molecule?

ANSWER: OXALOACETATE (ACCEPT: OXALOACETIC ACID, OXALACETIC ACID)

### **BONUS**

13) Biology – *Short Answer* Identify all of the following three phyla [*FYE-lah*] that are composed of deuterostomes [*DOO-tur-ah-stomes*]: 1) Cnidaria [*nye-DARE-ee-ah*];  
2) Arthropoda [*ahr-THRAW-pod-ah*]; 3) Echinodermata [*eh-kye-noh-der-MAH-tah*].

ANSWER: 3

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### **TOSS-UP**

14) Math – *Short Answer* What is the dot product of the vectors  $3\mathbf{i} - 5\mathbf{j} + 7\mathbf{k}$  and  $4\mathbf{i} + \mathbf{j}$ ?

ANSWER: 7

### **BONUS**

14) Math – *Short Answer* Given that log base 10 of 2 is 0.301 and log base 10 of 3 is 0.477, and giving your answer to three decimal places, what is log base 10 of 75?

ANSWER: 1.875

## TOSS-UP

15) Energy – *Multiple Choice* Scientists at Lawrence Berkeley National Lab are functionalizing peptoid nanosheets with sugars. They do this via an azide-alkyne **[AL-kine]** cycloaddition, which is most similar in mechanism to which of the following reactions?

- W) SN1
- X) SN2
- Y) Grignard **[GRIN-yerd]**
- Z) Diels **[deals]**-Alder

ANSWER: Z) DIELS-ALDER

## BONUS

15) Energy – *Multiple Choice* Scientists from Lawrence Berkeley National Lab are studying volatile organic compounds, or VOCs, released from the upper canopy in the Amazon Rainforest as part of the "Go Amazon" project. Understanding VOC production by trees involves understanding the variables that control it. Which variable is NOT important to the study?

- W) Air temperature
- X) Species of tree
- Y) Tree age
- Z) Atmospheric CO<sub>2</sub>

ANSWER: Y) TREE AGE

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## TOSS-UP

16) Physics – *Short Answer* What type of semiconductor is formed if a silicon crystal is doped with phosphorus?

ANSWER: N (ACCEPT: N-TYPE)

## BONUS

16) Physics – *Short Answer* A particle in one dimension is undergoing a force  $F$  of  $x = x^2$ , where  $x$  represents its position. As this particle travels from  $x = 0$  to  $x = 6$ , what is the work, in joules, that the force does on the particle?

ANSWER: 72

### **TOSS-UP**

17) Earth & Space – *Short Answer* What is the term for the temperature at which the relative humidity of air becomes 100%?

ANSWER: DEW POINT (ACCEPT: FROST POINT)

### **BONUS**

17) Earth & Space – *Short Answer* Identify all of the following three Earth layers that are brittle:

- 1) Crust; 2) Lithosphere [*LITH-oh-sfeer*]; 3) Upper mantle.

ANSWER: ALL

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### **TOSS-UP**

18) Chemistry – *Short Answer* Dinitrogen pentoxide decomposes to form oxygen gas and nitrogen dioxide. If this reaction is first order with respect to dinitrogen pentoxide, by what number would the rate of the reaction be multiplied if the concentration of dinitrogen pentoxide is doubled?

ANSWER: 2

### **BONUS**

18) Chemistry – *Short Answer* Consider four rigid vessels, each of which contains 1 mole of a pure gas at standard temperature and pressure. Rank the following four gases in increasing order of mass density under these conditions: 1) Oxygen; 2) Nitrogen; 3) Helium; 4) Krypton.

ANSWER: 3, 2, 1, 4

### **TOSS-UP**

19) Math – *Short Answer* Point  $P$  is one of the vertices of a 40-sided convex polygon. How many diagonals of the polygon have point  $P$  as an endpoint?

ANSWER: 37

### **BONUS**

19) Math – *Short Answer* In a group of 1000 home owners, 400 of them have home security systems, 300 of them are dog owners, and 200 of them have both a dog and a home security system. If a home chosen at random does not contain a home security system, what is the probability that it also does not contain a dog?

ANSWER: 5/6

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### **TOSS-UP**

20) Earth & Space – *Short Answer* The Chandrasekhar [*chan-drah-SAY-kar*] limit concerns the maximal mass of what type of stellar remnant?

ANSWER: WHITE DWARF

### **BONUS**

20) Earth & Space – *Short Answer* Sometimes called the Local Supercluster, by what other name is the supercluster containing the Milky Way known?

ANSWER: VIRGO SUPERCLUSTER (ACCEPT: LANIAKEA SUPERCLUSTER)

### **TOSS-UP**

21) Physics – *Short Answer* What is the most massive elementary particle emitted when carbon-10 undergoes its most likely radioactive decay?

ANSWER: POSITRON

### **BONUS**

21) Physics – *Short Answer* Two events are separated by a space-like interval. According to special relativity, identify all of the following three observations for which there exists an inertial reference frame where it is possible: 1) They occur at the same position; 2) They occur at the same time; 3) They occur at both the same time and place.

ANSWER: 2

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### **TOSS-UP**

22) Chemistry – *Multiple Choice* Which of the following substances can spontaneously reduce chromium (III) *[three]* to chromium metal?

- W) Iodine
- X) Silver
- Y) Manganese
- Z) Iron

ANSWER: Y) MANGANESE

### **BONUS**

22) Chemistry – *Short Answer* Identify all of the following three compounds that are Arrhenius *[ah-REE-nee-us]* bases: 1) Ammonia; 2) Fluoride; 3) Iodide.

ANSWER: NONE OF THEM

## **TOSS-UP**

23) Biology – *Short Answer* The ventricles of the brain are lined with ependymal [*eh-PEN-dih-mul*] cells, which are responsible for circulation of what fluid?

ANSWER: CEREBROSPINAL FLUID (ACCEPT: CSF)

## **BONUS**

23) Biology – *Short Answer* Identify all of the following three processes that occur in marine fish, in contrast to freshwater fish: 1) Excretion of salt from the gills; 2) Loss of water from body surfaces due to osmosis; 3) Excretion of large amounts of dilute urine.

ANSWER: 1, 2