

ROUND 1

TOSS-UP

1) Physics – *Multiple Choice* A famous principle of fluid mechanics, traditionally attributed as the explanation behind lift on an airplane wing, is named after what scientist?

- W) Bernoulli
- X) Pascal
- Y) Rayleigh
- Z) Reynolds

ANSWER: W) BERNOULLI

BONUS

1) Physics – *Short Answer* A metal disk has a moment of inertia of 5.0×10^{-3} kilogram meters squared. If the disk is rotating with 9 joules [*jools*] of kinetic energy, what is the angular speed, in radians per second, of a point on its rim?

ANSWER: 60

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### TOSS-UP

2) Math – *Short Answer* A geometric sequence has third term 1 and fourth term  $-3$ . What is its first term?

ANSWER:  $1/9$

### BONUS

2) Math – *Short Answer* If theta equals the arcsine of 0.8, what is the sum of the cotangent of theta and the cosecant of theta?

ANSWER: 2

### TOSS-UP

3) Biology – *Multiple Choice* Steroids can be classified as which of the following types of biomacromolecule?

- W) Carbohydrate
- X) Protein
- Y) Lipid
- Z) Nucleic Acid

ANSWER: Y) LIPID

### BONUS

3) Biology – *Short Answer* In the mitochondrial electron transport chain during oxidative phosphorylation [*faws-four-il-AY-shun*], what molecule is the final electron acceptor?

ANSWER: OXYGEN (ACCEPT: O<sub>2</sub>)

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TOSS-UP

4) Energy – *Multiple Choice* What gas is produced by bacterial decay in landfills?

- W) Neon
- X) Oxygen
- Y) Carbon monoxide
- Z) Methane

ANSWER: Z) METHANE

BONUS

4) Energy – *Multiple Choice* Researchers at Argonne National Lab used high-energy x-rays to confirm a model of quantum magnetism. Which of the following facilities did they use?

- W) Electron Microscopy Center
- X) Center for Nanoscale Materials
- Y) Advanced Photon Source
- Z) Tandem Linear Accelerator

ANSWER: Y) ADVANCED PHOTON SOURCE

TOSS-UP

5) Earth and Space – *Multiple Choice* What type of lava can be expected to erupt from a shield volcano, like Kilauea?

- W) Andesite
- X) Basalt
- Y) Dacite
- Z) Rhyolite

ANSWER: X) BASALT

BONUS

5) Earth and Space – *Short Answer* What is the name for a large depression that forms when the vent of a volcano collapses into a drained magma chamber?

ANSWER: CALDERA

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### TOSS-UP

6) Physics – *Multiple Choice* Which of the following is equivalent to 10 centimeters?

- W)  $10^8$  nanometers
- X)  $10^3$  millimeters
- Y)  $10^7$  micrometers
- Z)  $10^2$  decimeters

ANSWER: W)  $10^8$  NANOMETERS

### BONUS

6) Physics – *Multiple Choice* Which of the following will increase the entropy [*EN-troh-pee*] of a system?

- W) Decreasing the temperature
- X) Changing the phase from a liquid to a solid
- Y) Increasing the volume
- Z) Decreasing the number of molecules

ANSWER: Y) INCREASING THE VOLUME

### TOSS-UP

7) Biology – *Multiple Choice* Which of the following best describes why a complete lack of cholesterol is dangerous for cells?

- W) Cholesterol maintains membrane fluidity
- X) Cholesterol is necessary for all signal transduction
- Y) Cholesterol is required for ATP production
- Z) Cholesterol protects against DNA degradation

ANSWER: W) CHOLESTEROL MAINTAINS MEMBRANE FLUIDITY

### BONUS

7) Biology – *Multiple Choice* Which of the following is definitely known about Australopithecines [*aw-stral-oh-PITH-eh-seens*]?

- W) They had human-sized brains
- X) They walked upright
- Y) They were 2 meters tall, on average
- Z) They were herbivores

ANSWER: X) THEY WALKED UPRIGHT

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TOSS-UP

8) Chemistry – *Short Answer* What type of covalent bond, found in amine [*ah-MEEN*] oxides, is formed by two electrons from the same atom?

ANSWER: DATIVE (ACCEPT: DIPOLAR OR COORDINATE)

BONUS

8) Chemistry – *Short Answer* Identify all of the following three statements that are TRUE of acetic acid:

- 1) It exists predominantly in its monomeric form when dissolved in benzene;
- 2) It exists predominantly in its monomeric form when dissolved in water;
- 3) It exists predominantly in its monomeric form in the gas phase.

ANSWER: 2

TOSS-UP

9) Physics – *Short Answer* What is the adjective for a process that occurs at constant pressure?

ANSWER: ISOBARIC

BONUS

9) Physics – *Multiple Choice* Tim blows into a hollow cylinder that is open on both ends. It emits a sound at its fundamental frequency, a middle A which is 440 Hertz. Which of the following is closest to the length, in centimeters, of the cylinder?

- W) 20
- X) 40
- Y) 60
- Z) 80

ANSWER: X) 40

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**TOSS-UP**

10) Math – *Multiple Choice* Which of the following numbers has a remainder of 1 when it is divided by 7?

- W) 62
- X) 82
- Y) 99
- Z) 103

ANSWER: Y) 99

**BONUS**

10) Math – *Short Answer* The graph of  $f(x)$  = the fraction with numerator  $x^2 - 5x + 6$  and denominator  $x^2 - 9$  has a removable discontinuity at  $x = a$  for some real number  $a$ . What is the limit as  $x$  approaches  $a$  of  $f(x)$ ?

ANSWER: 1/6

**TOSS-UP**

11) Energy – *Multiple Choice* Iridates and cuprates [*KYU-prayts*] are being studied at Argonne National Lab because of their potential uses as what?

- W) Heavy-ion particle beam fuel
- X) Ultra-strong alloys
- Y) Megatesla [*mega-tes-la*] magnets
- Z) High temperature superconductors

ANSWER: Z) HIGH TEMPERATURE SUPERCONDUCTORS

**BONUS**

11) Energy – *Multiple Choice* DOE researchers are studying how hemorrhagic [*heh-more-AJ-ik*] fevers suppress the immune system. Which of the following viruses is being studied?

- W) Influenza virus
- X) Polio virus
- Y) Ebola virus
- Z) Virga virus

ANSWER: Y) EBOLA VIRUS

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TOSS-UP

12) Earth and Space – *Multiple Choice* What is the name for the type of mass wasting in which perpendicular forces due to freeze-thaw processes in the ground cause soil to lift upwards?

- W) Frost Heave
- X) Debris Slump
- Y) Earth Slide
- Z) Soil Sturzstrom

ANSWER: W) FROST HEAVE

BONUS

12) Earth and Space – *Short Answer* Which of the seven spectral classes includes our Sun?

ANSWER: G

TOSS-UP

13) Energy – *Short Answer* Scientists at Oak Ridge National Lab are using the Titan supercomputer in order to study actinide [**AK-tin-ide**] chemistry at a molecular level. Identify all of the following three elements that are being studied:

1) Uranium; 2) Thorium [**THOR-ee-um**]; 3) Neptunium [**nep-TOO-nee-um**].

ANSWER: 1, 2, 3 (ACCEPT: ALL OF THEM)

BONUS

13) Energy – *Short Answer* DOE researchers, as part of the Daya [**DIE-ah**] Bay Collaboration, use sophisticated experiments to observe the reactions going on in nuclear reactors. Other than a proton and an electron, what particle that is produced by beta minus decay are they observing?

ANSWER: ANTINEUTRINO

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**TOSS-UP**

14) Earth and Space – *Multiple Choice* Walden Pond in Massachusetts is a famous example of a kettle lake. What created Walden pond?

- W) Earthquake
- X) Glacial activity
- Y) A meander cut off to form a lake
- Z) Volcanic activity

ANSWER: X) GLACIAL ACTIVITY

**BONUS**

14) Earth and Space – *Multiple Choice* During what eon did visible life start to appear and resulted in abundant fossils?

- W) Hadean
- X) Archaean
- Y) Proterozoic
- Z) Phanerozoic

ANSWER: Z) PHANEROZOIC

**TOSS-UP**

15) Math – *Multiple Choice* Which of the following best describes the relationship between the lines with equations  $5x + 7y = 35$  and  $28x - 20y = 35$ ?

- W) Parallel
- X) Perpendicular
- Y) Intersecting but not perpendicular
- Z) Coincident

ANSWER: X) PERPENDICULAR

**BONUS**

15) Math – *Short Answer* A regular hexagon is inscribed in a circle of diameter 16. What is the area of the hexagon?

ANSWER:  $96\sqrt{3}$

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TOSS-UP

16) Physics – *Short Answer* The liquefaction of what gas was recognized in the 1913 Nobel Prize?

ANSWER: HELIUM

BONUS

16) Physics – *Short Answer* A 2-liter container is filled with 3 moles of an ideal gas at 150 kelvins. What is the pressure of the gas, in atmospheres, to two significant figures?

ANSWER: 18

TOSS-UP

17) Chemistry – *Multiple Choice* Consider the covalent bonding in the molecule acetylene [*ah-SET-ihl-een*], and assume that the carbon-carbon axis is the x-axis. What two orbitals on each carbon atom participate in pi bonding?

- W) 1s and 2s
- X) $2p_x$ and $2p_y$
- Y) 2s and $2p_x$
- Z) $2p_y$ and $2p_z$

ANSWER: Z) $2P_Y$ AND $2P_Z$

BONUS

17) Chemistry – *Short Answer* Rank the following three barium salts in terms of increasing water solubility:

1) Barium chlorate; 2) Barium sulfate; 3) Barium hydroxide.

ANSWER: 2, 3, 1

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### TOSS-UP

18) Biology – *Short Answer* Fish and reptiles are classified under what phylum?

ANSWER: CHORDATA

### BONUS

18) Biology – *Multiple Choice* Which of the following muscles adducts and rotates the scapula and tilts the chin?

- W) Latissimus [*lah-TIH-sih-mus*] dorsi
- X) Rhomboideus [*rom-BOY-dee-us*] major
- Y) Subscapularis [*sub-scap-yoo-LAIR-us*]
- Z) Trapezius [*trah-PEE-zee-us*]

ANSWER: Z) TRAPEZIUS

**TOSS-UP**

19) Physics – *Short Answer* Identify all of the following 3 forms of heat transfer for which the rate of heat transfer is independent of the temperature gradient: 1) Conduction; 2) Convection; 3) Radiation.

ANSWER: NONE

**BONUS**

19) Physics – *Short Answer* A pool of water and the surrounding air are at thermal equilibrium. Identify all of the following 3 molecular-level properties that are statistically equal between the two substances:  
1) Internal energy; 2) Kinetic energy; 3) Velocity.

ANSWER: NONE

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TOSS-UP

20) Biology – *Short Answer* Dental cavities in humans are primarily caused by what genus [*JEE-nus*] of bacteria?

ANSWER: STREPTOCOCCUS

BONUS

20) Biology – *Short Answer* What structure does Paramecium [*para-MEE-see-um*] use for motility?

ANSWER: CILIUM (ACCEPT: CILIA)

TOSS-UP

21) Earth and Space – *Short Answer* After a long period of deflation by the wind, a desert will be reduced to a layer of cobble that is resistant to further deflation. What is the term for this layer of cobble?

ANSWER: DESERT PAVEMENT

BONUS

21) Earth and Space – *Multiple Choice* Which of the following best describes the origin of Long Island in New York?

- W) It arose from the sea due to hotspot activity
- X) It was formed when an earthquake drove a sea mount above water
- Y) It marks a location where an ocean rift lies
- Z) It formed from glacial till during the last Ice Age

ANSWER: Z) IT FORMED FROM GLACIAL TILL DURING THE LAST ICE AGE

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### TOSS-UP

22) Chemistry – *Short Answer* Identify all of the following three elements that, when inserted into a silicon crystal lattice, would result in a p-type, doped semiconductor: 1) Carbon; 2) Boron; 3) Nitrogen.

ANSWER: 2 (ACCEPT: BORON)

### BONUS

22) Chemistry – *Short Answer* Identify all of the following three statements that are true of benzene:  
1) It is nonpolar; 2) It is aromatic; 3) It is miscible [*MIH-sih-bul*] with water.

ANSWER: 1 AND 2

### TOSS-UP

23) Math – *Short Answer* The mean of a set of 5 numbers is 5. Four of the numbers are 1, 2, 5, and 8. What is the fifth number?

ANSWER: 9

### BONUS

23) Math – *Short Answer* A task takes a single computer processor 10 days to complete. For this task, each successive processor added in parallel reduces the computation time needed by 50%. How many processors would need to be used for this task so that it could be completed in under one hour?

ANSWER: 9