

ROUND 7A

TOSS-UP

1) Physics – *Short Answer* Two billiard balls of equal mass are travelling collinearly in opposite directions. One has a velocity of 5 meters per second, the other has a velocity of 3 meters per second. They collide completely inelastically. In meters per second, what is their final speed?

ANSWER: ONE

BONUS

1) Physics – *Short Answer* A 3-volt battery is connected to two 4-ohm resistors that are connected in parallel. What is the power, in watts, dissipated by this circuit?

ANSWER: 4.5 (ACCEPT: 4 ½, 9/2)

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### TOSS-UP

2) Biology – *Multiple Choice* Sap that is used in making maple syrup is transported by what organ?

- W) Epidermis
- X) Xylem
- Y) Phloem
- Z) Pith

ANSWER: X) XYLEM

### BONUS

2) Biology – *Short Answer* The sliding filament theory of muscle contraction primarily involves what two proteins?

ANSWER: ACTIN AND MYOSIN

### TOSS-UP

3) Energy – *Multiple Choice* Which of the following forms of energy has the lowest average cost of operation and maintenance?

- W) Solar
- X) Wind
- Y) Geothermal
- Z) Hydro

ANSWER: W) SOLAR

### BONUS

3) Energy – *Multiple Choice* One of the largest solar power plants in the U.S. is at Ivanpah [*EYE-van-pah*] in southern California. It converts solar energy into electricity via what mechanism?

- W) Molten salt contacting thermoelectrics
- X) Direct photovoltaic [*photo-vawl-TAY-ik*] panels
- Y) Photoelectrolysis to produce hydrogen gas
- Z) Superheated steam through a turbine

ANSWER: Z) SUPERHEATED STEAM THROUGH A TURBINE

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TOSS-UP

4) Chemistry – *Multiple Choice* What element has the highest ionization energy?

- W) Hydrogen
- X) Helium
- Y) Lithium
- Z) Beryllium

ANSWER: X) HELIUM

BONUS

4) Chemistry – *Multiple Choice* Which of the following compounds has the highest polarity?

- W) Carbon tetrachloride
- X) Dimethyl [*dye-meth-il*] ether [*EE-thur*]
- Y) Boron trifluoride [*tri-FLOOR-ide*]
- Z) Trinitrotoluene [*try-nitro-TAWL-yoo-een*]

ANSWER: X) DIMETHYL ETHER

TOSS-UP

5) Earth and Space – *Multiple Choice* What is the term for a fluidized mixture of solid to semi-solid fragments and hot expanding gases that flows under gravity down the flanks of a volcano during an eruption?

- W) Pyroclastic surge
- X) Lahar
- Y) Pyroclastic flow
- Z) Lava flow

ANSWER: Y) PYROCLASTIC FLOW

BONUS

5) Earth and Space – *Short Answer* Identify all of the following three locations where continental ice sheets can be currently found: 1) Greenland; 2) North America; 3) Antarctica.

ANSWER: 1 AND 3

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### TOSS-UP

6) Math – *Multiple Choice* Two coplanar circles have a common chord. Which of the following best describes the quadrilateral that has as opposite vertices the centers of the two circles and the endpoints of the common chord?

- W) Kite
- X) Parallelogram
- Y) Rhombus
- Z) Square

ANSWER: W) KITE

### BONUS

6) Math – *Short Answer* A particle's position  $x$  at time  $t$  is defined by the equation  $x$  of  $t = 2t^3 - 21t^2 + 60t - 36$ . At what time or times  $t$  is the particle at rest?

ANSWER: 2 AND 5

**TOSS-UP**

7) Chemistry – *Short Answer* Rank the following three ions in terms of increasing radius:

1) Na+ [*N A plus*]; 2) Be<sup>2+</sup> [*B E plus two*]; 3) Li+ [*L I plus*].

ANSWER: 2, 3, 1

**BONUS**

7) Chemistry – *Short Answer* What allotrope of phosphorus, which can be prepared by heating white phosphorus to 300 degrees Celsius in the absence of air, is composed of amorphous interlocking P<sub>4</sub> tetrahedra?

ANSWER: RED PHOSPHORUS (ACCEPT: RED)



**TOSS-UP**

8) Physics – *Short Answer* Most room-temperature permanent magnets are magnets due to what phenomenon that is commonly seen in iron, nickel, and cobalt?

ANSWER: FERROMAGNETISM

**BONUS**

8) Physics – *Short Answer* An atom of uranium-235 at rest undergoes spontaneous nuclear fission to form krypton-94 and barium-141. If the barium atom moves away at 4 kilometers per second, what is the speed, to the nearest kilometer per second, of the krypton atom?

ANSWER: 6

**TOSS-UP**

9) Earth and Space – *Multiple Choice* The La Brea Tar Pits of Los Angeles, California, are famous for the quantity and diversity of fossils of extinct Pleistocene animals. Which of the following is closest to the number of years ago that these pits formed?

- W) 40,000
- X) 400,000
- Y) 4,000,000
- Z) 40,000,000

ANSWER: W) 40,000

**BONUS**

9) Earth and Space – *Short Answer* Identify all of the following three statements that are true regarding the waves produced by earthquakes: 1) S waves are transverse waves; 2) S waves only travel through solids; 3) S waves travel faster than P waves.

ANSWER: 1 AND 2

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TOSS-UP

10) Biology – *Multiple Choice* Apical dominance in plants means that:

- W) The apical bud stimulates vertical growth
- X) The apical bud inhibits auxin production
- Y) The apical bud stimulates floral development
- Z) The apical bud inhibits the growth of lateral buds

ANSWER: Z) THE APICAL BUD INHIBITS THE GROWTH OF LATERAL BUDS

BONUS

10) Biology – *Short Answer* Identify all of the following three structures that possess a double membrane: 1) Lysosome [*LYE-soh-sohm*]; 2) Nucleus; 3) Ribosome [*RYE-beh-sohme*].

ANSWER: 2 (ACCEPT: NUCLEUS)

TOSS-UP

11) Energy – *Multiple Choice* Immediately after being removed from a fission reactor, spent fuel rods will be placed where?

- W) Underground
- X) Underwater
- Y) Reprocessing plants
- Z) MOX factories

ANSWER: X) UNDERWATER

BONUS

11) Energy – *Multiple Choice* What are the primary mobile charge carriers in the sulfonated fluoropolymer [*floor-oh-PAWL-ih-mur*] ion-exchange membranes used in commercial fuel cells?

- W) Hydroxide ions
- X) Sodium cations [*CAT-eye-onz*]
- Y) Water
- Z) Protons

ANSWER: Z) PROTONS

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### TOSS-UP

12) Math – *Short Answer* A prism with 7 faces has how many edges?

ANSWER: 15

### BONUS

12) Math – *Short Answer* Evaluate the summation, from  $n = 0$  to infinity, of the fraction with numerator 12 and denominator  $4^n$ .

Answer: 16

**TOSS-UP**

13) Earth and Space – *Multiple Choice* Greenhouse gases build up in the atmosphere of Earth and limit the amount of heat escaping back into space. Which of the following is not a greenhouse gas for Earth?

- W) Carbon dioxide
- X) Argon
- Y) Nitrous oxide
- Z) Methane

ANSWER: X) ARGON

**BONUS**

13) Earth and Space – *Multiple Choice* What coordinate is the celestial-sphere equivalent of latitude?

- W) Declination
- X) Right-ascension
- Y) Altitude
- Z) Zenith angle

ANSWER: W) DECLINATION

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TOSS-UP

14) Math – *Short Answer* What is the log base 3 of 243?

ANSWER: 5

BONUS

14) Math – *Short Answer* What is the integer part of the geometric mean of 6 and 80?

ANSWER: 21

TOSS-UP

15) Chemistry – *Multiple Choice* Which of the following statements best explains why chloroacetic [*kloro-ah-SEE-tik*] acid is a stronger acid than acetic [*ah-SEE-tik*] acid?

- W) Resonance delocalization of the conjugate base chloroacetate
- X) Withdrawal of electron density by chlorine
- Y) Donation of electron density by chlorine
- Z) Greater electronegativity of chlorine than oxygen

ANSWER: X) WITHDRAWAL OF ELECTRON DENSITY BY CHLORINE

BONUS

15) Chemistry – *Short Answer* What is the name for the wavelength at which a sample's absorbance does not change during a reaction?

ANSWER: ISOSBESTIC POINT

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### TOSS-UP

16) Energy – *Short Answer* Moderators in nuclear reactors are used because of their ability to absorb energy from what particles?

ANSWER: NEUTRONS (ACCEPT: FAST NEUTRONS)

### BONUS

16) Energy – *Short Answer* DOE researchers recently published about the development of a complex oxide alloy that, rather than being primarily stabilized by chemical bonding, is stabilized by what state function?

ANSWER: ENTROPY

**TOSS-UP**

17) Physics – *Multiple Choice* Capillary action refers to which of the following?

- W) The tendency for objects to flee the center of circular motion
- X) The change in frequency of a wave depending on the relative motion of the source
- Y) The property by which liquids can flow against gravity
- Z) The tendency for fluids to dissipate energy as heat

ANSWER: Y) THE PROPERTY BY WHICH LIQUIDS CAN FLOW AGAINST GRAVITY

**BONUS**

17) Physics – *Short Answer* What is the name of the law of electromagnetism that states that the force exerted on each other by two charged particles is inversely proportional to the square of the distance between them?

ANSWER: COULOMB'S LAW

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TOSS-UP

18) Biology – *Short Answer* Calcium ions activate muscle contraction because they move what protein from thin filaments?

ANSWER: TROPOMYOSIN

BONUS

18) Biology – *Multiple Choice* Ferredoxin is an electron-transfer protein that contains which of the following?

- W) Heme [*heem*] group
- X) Iron-sulfur cluster
- Y) Zinc finger
- Z) Leucine [*LOO-seen*] zipper

ANSWER: X) IRON-SULFUR CLUSTER

TOSS-UP

19) Math – *Short Answer* What is the slope of the line with equation $3x - 8y = -24$?

ANSWER: $3/8$ (ACCEPT: 0.375)

BONUS

19) Math – *Short Answer* A class of 16 students selects a different student of the month each month during March, April, and May. In how many different ways can the 3 honored students be selected?

ANSWER: 3360

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**TOSS-UP**

20) Biology – *Short Answer* What two blood-sugar-relevant hormones are secreted by the islets [*EYE-lets*] of Langerhans [*LAYN-gur-honz*]?

ANSWER: GLUCAGON AND INSULIN

**BONUS**

20) Biology – *Short Answer* What acid is produced by parietal [*pah-RYE-eh-ul*] cells?

ANSWER: HYDROCHLORIC ACID (ACCEPT: HCl)

**TOSS-UP**

21) Chemistry – *Short Answer* For the tri-iodide ion, what is the hybridization of the central iodine atom?

ANSWER: DSP3 (ACCEPT: SP3D)

**BONUS**

21) Chemistry – *Short Answer* Identify all of the following three compounds with dsp3 hybridized central atoms:

1) Silicon tetrafluoride [*tetrah-FLOOR-ide*]; 2) Sulfur hexafluoride [*hex-ah-FLOOR-ide*]; 3) Sulfur tetrafluoride.

ANSWER: 3

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TOSS-UP

22) Earth and Space – *Short Answer* What type of tide is caused when the gravitational forces of the Sun and Moon coincide?

ANSWER: SPRING TIDES

BONUS

22) Earth and Space – *Short Answer* Pahoehoe and a'a are lava flows associated with what type of magma?

ANSWER: BASALTIC (ACCEPT: MAFIC)

TOSS-UP

23) Physics – *Short Answer* A 1000-kilogram car traveling at 15 meters per second takes a turn on a flat surface with a radius of 50 meters. In kilo-newtons, what is the force of friction on the car?

ANSWER: 4.5

BONUS

23) Physics – *Short Answer* A 50-kilogram superhero is standing on a frictionless surface. He fires a 100-gram arrow horizontally at a speed of 200 meters per second at a target. In meters per second, what is his speed afterwards?

ANSWER: 0.4