

ROUND 5A

TOSS-UP

1) Physics – *Multiple Choice* What is the arc length, in miles, traveled by a rocket along a circular path whose angle measures 0.2 radians with a radius of 80 miles?

- W) 16
- X) 40
- Y) 80
- Z) 400

ANSWER: W) 16

BONUS

1) Physics – *Short Answer* What is the name for the amount of time it takes for a wave to complete a single cycle?

ANSWER: PERIOD

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### TOSS-UP

2) Earth and Space – *Multiple Choice* Which of the following planets has rings?

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

ANSWER: Y) NEPTUNE

### BONUS

2) Earth and Space – *Short Answer* Put the following four minerals in order from softest to hardest on the Mohs scale: 1) Apatite; 2) Fluorite; 3) Quartz; 4) Corundum.

ANSWER: 2, 1, 3, 4 (ACCEPT: FLUORITE, APATITE, QUARTZ, CORUNDUM)

### TOSS-UP

3) Energy – *Short Answer* What type of renewable fuel source consists of long alkyl chain esters produced from biolipids?

ANSWER: BIODIESEL

### BONUS

3) Energy – *Short Answer* What is the total R-value of a wall with 2 inches of fiberglass batting, with R = 3 per inch, and 4 inches of brick, with R = 0.2 per inch?

ANSWER: 6.8

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TOSS-UP

4) Chemistry – *Short Answer* What is the name of the oxyanion [*ox-ee-AN-eye-on*] of bromine in which bromine has a +7 oxidation state and formula BrO_4^- [*B-R-oh-4-negative*]?

ANSWER: PERBROMATE (ACCEPT: PERBROMATE ION)

BONUS

4) Chemistry – *Multiple Choice* The functional groups forming a peptide bond do NOT contain which of the following atoms?

- W) Hydrogen
- X) Nitrogen
- Y) Oxygen
- Z) Phosphorus

ANSWER: Z) PHOSPHORUS

TOSS-UP

5) Biology – *Multiple Choice* Maple syrup is extracted from maple trees by tapping what part of the plant?

- W) Xylem [**ZYE-lum**]
- X) Phloem [**FLOW-em**]
- Y) Cambium [**KAM-bee-um**]
- Z) Bark

ANSWER: W) XYLEM

BONUS

5) Biology – *Multiple Choice* Which of the following types of cells could one find surrounding a stomatal pore?

- W) Guard cells
- X) Mesophyll [**MEH-zoh-fill**] cells
- Y) Palisade cells
- Z) Trace cells

ANSWER: W) GUARD CELLS



TOSS-UP

6) Math – *Short Answer* The ratio of the measures of the three angles in a triangle is 2:3:4. What are the degree measures of the three angles?

ANSWER: 40, 60, 80

BONUS

6) Math – *Short Answer* What mathematical rule can be applied to give information about the number of positive or negative real roots of a polynomial based on the number of sign changes in the polynomial's coefficients?

ANSWER: DESCARTES' RULE OF SIGNS

TOSS-UP

7) Chemistry – *Short Answer* What alcohol reactant is needed to perform a Fischer esterification on a carboxylic acid to yield a methyl ester?

ANSWER: METHANOL

BONUS

7) Chemistry – *Short Answer* Rank the following three acid solutions from lowest pH to highest pH:

1) 1.0 normal sulfuric acid; 2) 1.0 molal sulfuric acid; 3) 1.0 molar sulfuric acid.

ANSWER: 3, 2, 1

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**TOSS-UP**

8) Energy – *Short Answer* What operating situation, characterized by a circuit with very little to no electrical impedance, can cause lithium ion batteries to generate a lot of heat, sometimes causing fires?

ANSWER: SHORT CIRCUIT

**BONUS**

8) Energy – *Multiple Choice* Which of the following best explains why power transmission lines use high voltage?

- W) Substation equipment used to transmit power at high voltage is cheaper than equipment for low voltage
- X) Power loss decreases as the square of the voltage increases
- Y) Power loss decreases linearly as the voltage increases
- Z) It is safer to transmit power at high rather than low voltage

ANSWER: X) POWER LOSS DECREASES AS THE SQUARE OF THE VOLTAGE INCREASES

**TOSS-UP**

9) Physics – *Short Answer* Identify all of the following four forces that are real in inertial reference frames: 1) Centrifugal; 2) Centripetal; 3) Lorentz; 4) Coriolis.

ANSWER: 2, 3 (ACCEPT: CENTRIPETAL, LORENTZ)

**BONUS**

9) Physics – *Short Answer* An alpha particle of velocity 600 kilometers per second is fired directly at a helium-4 nucleus at rest. The two collide completely elastically. What is the final velocity, in kilometers per second, of the target helium nucleus?

ANSWER: 600



**TOSS-UP**

10) Earth and Space – *Short Answer* What volcano hosts the world's primary benchmark site for atmospheric carbon dioxide measurements and the observatory that produced the original Keeling curve?

ANSWER: MAUNA LOA

**BONUS**

10) Earth and Space – *Multiple Choice* Which of the following best explains how and why galaxies in the universe are moving relative to each other?

- W) Most galaxies are moving away from each other because space is expanding
- X) All galaxies are moving toward each other because space is contracting
- Y) Most galaxies are moving away from each other because space is contracting
- Z) All galaxies are moving toward each other because space is expanding

ANSWER: W) MOST GALAXIES ARE MOVING AWAY FROM EACH OTHER BECAUSE SPACE IS EXPANDING

**TOSS-UP**

11) Biology – *Multiple Choice* Which of the following vitamins is NOT synthesized by plants or animals?

- W) B12
- X) B6
- Y) B2
- Z) C

ANSWER: W) B12

**BONUS**

11) Biology – *Multiple Choice* Which of the following is thought to have been the beneficial effect of two entire genome duplication events in the vertebrate lineage?

- W) More copies of each gene per cell were insurance against DNA damage from increased solar radiation
- X) Polyploid animals were more likely to have one good copy of each gene
- Y) One copy of a duplicated gene was free to take on new functions
- Z) Four copies of each gene meant stronger gene responses

ANSWER: Y) ONE COPY OF A DUPLICATED GENE WAS FREE TO TAKE ON NEW FUNCTIONS



**TOSS-UP**

12) Math – *Multiple Choice* With respect to  $x$ , which of the following has  $-3x^2$  as an antiderivative?

- W)  $-6x$
- X)  $6x$
- Y)  $-x^3$
- Z)  $x^3$

ANSWER: W)  $-6x$

**BONUS**

12) Math – *Short Answer* Identify the center and radius of the sphere with equation  $36 = \text{open parenthesis } x - 2 \text{ close parenthesis squared} + \text{open parenthesis } y - 7 \text{ close parenthesis squared} + \text{open parenthesis } z + 1 \text{ close parenthesis squared}$ .

ANSWER: CENTER (2, 7, -1); RADIUS 6

### TOSS-UP

13) Chemistry – *Multiple Choice* Nitrogen monoxide is an example of which of the following?

- W) An expanded octet
- X) A resonance molecule
- Y) A dimerizing molecule
- Z) A free radical

ANSWER: Z) A FREE RADICAL

### BONUS

13) Chemistry – *Multiple Choice*  $M^{2+}$  is a metal ion with a ground state electron configuration of  $[\text{Ar}]3d^84s^0$  [*argon-3-d-8-4-s-0*]. What is the identity of M?

- W) Molybdenum [*muh-LIB-den-um*]
- X) Nickel
- Y) Niobium
- Z) Magnesium

ANSWER: X) NICKEL

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TOSS-UP

14) Energy – *Multiple Choice* One 42-gallon barrel of crude oil produces approximately how many US gallons of gasoline?

- W) 10
- X) 20
- Y) 30
- Z) 40

ANSWER: X) 20

BONUS

14) Energy – *Multiple Choice* During fission in a nuclear reactor, non-fission neutron capture by uranium yields heavy elements like americium and plutonium. What are these elements called?

- W) Pnictogens [*NIK-teh-jins*]
- X) Chalcogens [*CHAWK-eh-jins*]
- Y) Lanthanides [*LAN-tha-nides*]
- Z) Actinides [*AK-tin-ides*]

ANSWER: Z) ACTINIDES

TOSS-UP

15) Math – *Short Answer* What are the prime factors of 105?

ANSWER: 3, 5, and 7

BONUS

15) Math – *Multiple Choice* If $f(x)$ = the square root of open parenthesis $x + 3$ close parenthesis and $g(x)$ = the square root of open parenthesis $x - 3$ close parenthesis, what is the domain of the function $f(x)$ divided by $g(x)$?

- W) $x > 3$
- X) $x \geq 3$
- Y) $x \geq -3$
- Z) $-3 < x < 3$

Answer: W) $x > 3$



TOSS-UP

16) Earth and Space – *Multiple Choice* If a slow-moving warm front is followed by a fast-moving cold front, the cold front will sometimes overtake the warm front. When the cold air lifts the warm air entirely aloft, what atmospheric phenomenon results?

- W) Stationary front
- X) Occluded front
- Y) Marine front
- Z) Polar front

ANSWER: X) OCCLUDED FRONT

BONUS

16) Earth and Space – *Short Answer* Identify all of the following three constellations and asterisms that would be visible in the December night sky over the North Pole: 1) Cassiopeia; 2) Crux; 3) The Big Dipper.

ANSWER: 1 AND 3 (CASSIOPEIA AND THE BIG DIPPER)

TOSS-UP

17) Biology – *Short Answer* What form of active transport involves moving two or more different molecules across a membrane in the same direction, coupling the favorable transport of one molecule to the unfavorable transport of the other?

ANSWER: SYMPORT

BONUS

17) Biology – *Multiple Choice* Mycobacterium [**MY-koh-bacterium**] is a genus of slow-growing and difficult-to-eradicate bacteria responsible for what two human diseases?

W) Mononucleosis and pertussis [**per-TUH-sis**]

X) Shigella [**shih-GEHL-ah**] and malaria

Y) Gingivitis and impetigo [**im-puh-tie-goh**]

Z) Leprosy and tuberculosis

ANSWER: Z) LEPROSY AND TUBERCULOSIS

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### TOSS-UP

18) Physics – *Short Answer* Identify all of the following three statements that are always true about resistors in parallel: 1) The equivalent resistance is greater than any individual resistance; 2) The voltage across each resistor is the same; 3) The current through each resistor is the same.

ANSWER: 2

### BONUS

18) Physics – *Short Answer* An object is thrown with a horizontal velocity of 20 meters per second from a height of 125 meters above level ground. If air resistance is negligible, to the nearest whole number, how many seconds does it take the object to fall to the ground?

ANSWER: 5

**TOSS-UP**

19) Chemistry – *Multiple Choice* What is the coordination number of a body-centered cubic lattice?

- W) 2
- X) 4
- Y) 6
- Z) 8

ANSWER: Z) 8

**BONUS**

19) Chemistry – *Short Answer* What quantum number determines if an orbital is s, p, d, or f?

ANSWER: AZIMUTHAL (ACCEPT: ANGULAR MOMENTUM OR L)

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TOSS-UP

20) Biology – *Multiple Choice* Bacteria are able to become resistant to antibiotics by increasing their genetic variability through all of the following mechanisms EXCEPT:

- W) Conjugation
- X) Transduction
- Y) Binary fission
- Z) Transformation

ANSWER: Y) BINARY FISSION

BONUS

20) Biology – *Short Answer* In humans, the mucosa of the stomach produces intrinsic factor, which is required for absorption of what vitamin?

ANSWER: B12 (ACCEPT: COBALAMIN)

TOSS-UP

21) Physics – *Short Answer* In volts per meter, what is the electric field at the center of a hollow metallic sphere with a radius of 10 centimeters when the center of the sphere is 3 meters from a particle with a charge of 5 coulombs?

ANSWER: 0

BONUS

21) Physics – *Short Answer* A model train is towing 3 rail cars full of marbles, with a total kinetic energy of 100 joules. If the locomotive detaches the rail cars, the total mass of the train is reduced by 50%. If the locomotive then suddenly doubles its speed, what will be its resulting kinetic energy, in joules?

ANSWER: 200



TOSS-UP

22) Math – *Short Answer* How many exterior angles does a parallelogram have?

ANSWER: 8

BONUS

22) Math – *Short Answer* What is the sum from $n = 1$ to 4 of $2n^2$?

ANSWER: 60

TOSS-UP

23) Earth and Space – *Short Answer* At what type of plate boundary is there no destruction or creation of lithosphere due to the relative motion being in the horizontal direction?

ANSWER: TRANSFORM (ACCEPT: CONSERVATIVE; DO NOT ACCEPT: STRIKE-SLIP, WHICH IS A CLASSIFICATION FOR FAULTS RATHER THAN PLATE BOUNDARIES)

BONUS

23) Earth and Space – *Short Answer* A stream is referred to as a “gaining stream” when its surface is below what groundwater feature?

ANSWER: WATER TABLE