

ROUND 3A

TOSS-UP

1) Math – *Short Answer* What is the greatest common factor of 18 and 142?

ANSWER: 2

BONUS

1) Math – *Multiple Choice* Which of the following points does the line $2x - 3y = -12$ NOT pass through?

W) $(-2, 8/3)$

X) $(1, -14/3)$

Y) $(3, 6)$

Z) $(7, 26/3)$

ANSWER: X) $(1, -14/3)$

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### TOSS-UP

2) Energy – *Multiple Choice* Which of the following countries was NOT a major petroleum exporter to the United States in 2015?

W) Canada

X) Saudi Arabia

Y) Iran

Z) Venezuela

ANSWER: Y) IRAN

### BONUS

2) Energy – *Short Answer* Sustainable biofuel in Brazil is mostly produced from what plant?

ANSWER: SUGARCANE

### TOSS-UP

3) Chemistry – *Multiple Choice* If an acid is added to an unbuffered, neutral aqueous solution, which of the following is true?

- W) The hydroxide ion concentration increases
- X) The hydronium ion concentration decreases
- Y) The hydroxide ion concentration decreases
- Z) The concentrations of the hydronium and hydroxide ion concentrations remain unchanged

ANSWER: Y) THE HYDROXIDE ION CONCENTRATION DECREASES

### BONUS

3) Chemistry – *Multiple Choice* A student performs combustion analysis on a compound composed of carbon, hydrogen, oxygen, and possibly nitrogen - with molecular mass 56 grams per mole. One mole of the compound reacts with 3 moles of oxygen gas to generate 2 moles of carbon dioxide, 1 mole of water, and an unknown product. How many nitrogen atoms are in the chemical formula?

- W) Zero
- X) One
- Y) Two
- Z) Three

ANSWER: X) ONE

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TOSS-UP

4) Physics – *Multiple Choice* In millimeters, what must the focal length of the objective lens of a telescope be in order to produce a magnification of 300 when used with a 3-millimeter eye piece?

- W) 100
- X) 300
- Y) 900
- Z) 1200

ANSWER: Y) 900

BONUS

4) Physics – *Short Answer* What technique uses Bragg's law to identify and characterize crystal structures?

ANSWER: DIFFRACTION (ACCEPT: X-RAY DIFFRACTION, XRD, X-RAY CRYSTALLOGRAPHY)

TOSS-UP

5) Biology – *Short Answer* How many chromosomes does a human gamete contain?

ANSWER: 23

BONUS

5) Biology – *Multiple Choice* Which of the following describes the relationship between glucose and fructose?

- W) Structural isomers
- X) Diastereomers [*dye-ah-STARE-ee-oh-mers*]
- Y) Epimers
- Z) Enantiomers [*en-AN-tee-oh-mirz*]

ANSWER: W) STRUCTURAL ISOMERS



TOSS-UP

6) Earth and Space – *Short Answer* What mass movement of ocean water is referred to as the ocean conveyer belt?

ANSWER: THERMOHALINE CIRCULATION

BONUS

6) Earth and Space – *Short Answer* Identify all of the following three statements that are true of the Eagle Nebula: 1) It is an emission nebula; 2) It has a diameter of about 1 million light years; 3) It is part of the Kuiper belt.

ANSWER: 1

TOSS-UP

7) Biology – *Multiple Choice* Which of the following electrophoresis methods is used to analyze RNA?

- W) Northern Blot
- X) Southern Blot
- Y) Eastern Blot
- Z) Western Blot

ANSWER: W) NORTHERN BLOT

BONUS

7) Biology – *Multiple Choice* All of the following changes would result in an increase in blood pressure, except:

- W) Increased cardiac output
- X) Increased heart rate
- Y) Increased diameter of arterioles
- Z) Increased stroke volume

ANSWER: Y) INCREASED DIAMETER OF ARTERIOLES



TOSS-UP

8) Earth and Space – *Short Answer* Crater Lake in Oregon occupies what type of volcanic feature?

ANSWER: CALDERA

BONUS

8) Earth and Space – *Multiple Choice* NASA's QuickSCAT satellite mapped winds over all of Earth's oceans. Which of the following is NOT true of this satellite?

- W) It bounced microwaves off the ocean surface
- X) It retrieved both wind direction and speed
- Y) Its orbit was geosynchronous
- Z) It was powered by solar arrays

ANSWER: Y) ITS ORBIT WAS GEOSYNCHRONOUS

TOSS-UP

9) Energy – *Short Answer* In large coal and nuclear power plants, the plant's power rating is measured in either "megawatts e" or "megawatts t." What does "t" stand for?

ANSWER: THERMAL

BONUS

9) Energy – *Short Answer* Some nuclear fuels contain thorium which undergoes a neutron capture event followed by two beta minus decays. What element is produced at the end of these three processes?

ANSWER: URANIUM



TOSS-UP

10) Physics – *Multiple Choice* Which of the following circuit elements resists instantaneous changes in the voltage applied to it?

- W) Inductor
- X) Capacitor
- Y) Resistor
- Z) Transformer

ANSWER: X) CAPACITOR

BONUS

10) Physics – *Short Answer* If a helicopter loses engine power at a sufficient height and speed, it is able to autorotate to the ground, extracting energy from the air and, sometimes, landing safely. In this case, gravitational potential energy is converted into what type of energy?

ANSWER: MECHANICAL (ACCEPT: KINETIC, ROTATIONAL, ROTATIONAL KINETIC;
DO NOT ACCEPT: POTENTIAL)

TOSS-UP

11) Math – *Short Answer* What is the discriminant of the quadratic function $y = x^2 - 4x + 10$?

ANSWER: -24

BONUS

11) Math – *Short Answer* What is the derivative evaluated at $x = 7$ of the fraction with numerator $x^3 - 1$ and denominator $x - 1$?

ANSWER: 15

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**TOSS-UP**

12) Chemistry – *Short Answer* At what temperature, in degrees Celsius, does the change in enthalpy for the oxidation of 1 mole of graphite under 1 atmosphere of oxygen to generate carbon dioxide exactly equal the standard enthalpy of formation of carbon dioxide?

ANSWER: 25

**BONUS**

12) Chemistry – *Short Answer* Identify all of the following three compounds that have  $sp^2$  [S-P-2] hybridized central atoms: 1) Nitrogen trichloride; 2) Carbon dioxide; 3) Hydrocyanic acid.

ANSWER: NONE OF THEM

### TOSS-UP

13) Physics – *Short Answer* A ball is thrown at a 30 degree angle with respect to the horizontal at a speed of 60 meters per second. At what time, to the nearest whole second, does the ball reach the highest point in its trajectory?

ANSWER: 3

### BONUS

13) Physics – *Multiple Choice* Given that it relates the energy of a photon to its frequency, what are the SI units of Planck's constant?

- W) Joule seconds
- X) Watts
- Y) Newton meters
- Z) Watts per second

ANSWER: W) JOULE SECONDS

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TOSS-UP

14) Chemistry – *Multiple Choice* Many salts dissolve to a greater extent in hot water than cold water. Which of the following best explains this fact?

- W) Most salts dissolve endothermically
- X) Most salts dissolve exothermically
- Y) There are more collisions between salt ions and water molecules at a higher temperature
- Z) The ion-dipole forces between water molecules and salt ions increase with temperature

ANSWER: W) MOST SALTS DISSOLVE ENDOTHERMICALLY

BONUS

14) Chemistry – *Multiple Choice* A protein chemist isolates a new enzyme. Which of the following techniques, when performed alone, would be most useful for determining its size?

- W) NMR spectroscopy
- X) MALDI-TOF mass spectrometry
- Y) Elemental analysis
- Z) Gravimetric analysis

ANSWER: X) MALDI-TOF MASS SPECTROMETRY

TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following is a sedimentary rock?

- W) Scoria
- X) Granite
- Y) Basalt
- Z) Shale

ANSWER: Z) SHALE

BONUS

15) Earth and Space – *Short Answer* Identify all of the following three processes that remove nitrogen gas from Earth's atmosphere: 1) Nitrogen fixation; 2) Denitrification; 3) Forest fires.

ANSWER: 1 ONLY



TOSS-UP

16) Energy – *Short Answer* What one-carbon alcohol can be used directly as fuel in flex-fuel cars due to its high octane rating?

ANSWER: METHANOL

BONUS

16) Energy – *Multiple Choice* Which of the following is the least geographically-restricted form of grid-scale energy storage?

- W) Pumped hydro
- X) Batteries
- Y) Compressed air
- Z) Hot water

ANSWER: X) BATTERIES

TOSS-UP

17) Biology – *Multiple Choice* Topoisomerases [*toh-poh-eye-SAW-mer-aces*] are involved in which of the following processes?

- W) DNA transcription
- X) DNA replication
- Y) RNA translation
- Z) RNA processing

ANSWER: X) DNA REPLICATION

BONUS

17) Biology – *Short Answer* What early developmental stage of an animal follows the morula stage and consists of a single, spherical layer of cells enclosing a hollow, central cavity?

ANSWER: BLASTULA



TOSS-UP

18) Math – *Short Answer* Evaluate the following expression: log base 3 of 27 + log base 5 of 25.

ANSWER: 5

BONUS

18) Math – *Short Answer* What is the slope of the tangent line to the function $F(x) = 1000 - 200x - 5x^2$ at $x = 4$?

ANSWER: -240

TOSS-UP

19) Earth and Space – *Short Answer* What band of tall clouds and thunderstorms, also known among sailors as the doldrums, occurs at low latitudes between the Northern and Southern hemisphere trade winds?

ANSWER: INTERTROPICAL CONVERGENCE ZONE (ACCEPT: ITCZ)

BONUS

19) Earth and Space – *Multiple Choice* Jupiter appears brightest in which of the following configurations relative to the Earth?

- W) Conjunction
- X) Quasi conjunction [*KWAH-zye kon-JUNK-shun*]
- Y) Quadrature
- Z) Opposition

ANSWER: Z) OPPOSITION



TOSS-UP

20) Math – *Short Answer* What is the value of 60 factorial divided by open parenthesis 59 factorial times 3 factorial close parenthesis?

ANSWER: 10

BONUS

20) Math – *Short Answer* Identify all of the following three integer operations that are commutative: 1) Addition; 2) Subtraction; 3) Multiplication.

ANSWER: 1 AND 3

TOSS-UP

21) Biology – *Multiple Choice* Which of the following hormones is a precursor of both estrogen and testosterone?

- W) Cortisol
- X) Ergosterol [*ur-GAWS-tur-awl*]
- Y) Aldosterone [*al-DOSS-ter-own*]
- Z) DHEA

ANSWER: Z) DHEA

BONUS

21) Biology – *Multiple Choice* Based on the formation of a phragmoplast [*FRAG-moh-plast*], which of the following pairs of organisms are most closely related?

- W) Cyanobacteria and ameobas
- X) Land plants and green algae
- Y) Red algae and brown algae
- Z) Land plants and cyanobacteria

ANSWER: X) LAND PLANTS AND GREEN ALGAE



TOSS-UP

22) Physics – *Short Answer* Carbon-10 has a half-life of approximately 19 seconds. Approximately how long, in seconds, will it take for a sample of carbon-10 to decay to one-sixteenth of its original size?

ANSWER: 76

BONUS

22) Physics – *Multiple Choice* Which of the following dictates that the maximum percentage of power that can be extracted from a p-n junction solar cell is 33.7%?

- W) Biot Savart's Law
- X) Ampere's Law
- Y) Shockley - Queisser [*KYE-zur*] Limit
- Z) Betz's Law

ANSWER: Y) SHOCKLEY-QUEISSER LIMIT

TOSS-UP

23) Chemistry – *Multiple Choice* An aqueous solution contains silver ions, barium ions, iron (III) ions, and nitrate ions. Upon addition of sodium chloride, which of the following will precipitate out of the solution first?

- W) Iron (III) chloride
- X) Barium chloride
- Y) Sodium nitrate
- Z) Silver chloride

ANSWER: Z) SILVER CHLORIDE

BONUS

23) Chemistry – *Short Answer* Other than hydrogen and the noble elements What non-noble element has the lowest energy valence orbitals?

ANSWER: FLUORINE