## CENTENNIAL AUTUMN SCIENCE TOURNAMENT - ROUND 2

### TOSS-UP

1) Chemistry – *Short Answer* What principle states that no two electrons can have the same set of quantum numbers?

ANSWER: PAULI EXCLUSION PRINCIPLE

### BONUS

1) Chemistry – *Multiple Choice* Which of the following sets of quantum numbers would not be possible for an electron in a ground-state atom of Germanium, with atomic number 32?

W) n = 4, l = 1, ml = 0, ms = +1/2
X) n = 3, l = 2, ml = 2, ms = -1/2
Y) n = 4, l = 2, ml = -1, ms = +1/2
Z) n = 3, l = 0, ml = 0, ms = -1/2

ANSWER: Y) N = 4, L = 2, ML = -1, MS = +1/2

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### TOSS-UP

2) Physics – *Multiple Choice* If Kathy throws a ball from the ground at a velocity of 10 m/s at a 50 degree angle, how fast will the ball be going when it hits the ground, in meters per second?

W) 10 sin 50
X) 10 cos 50
Y) 10
Z) 12

ANSWER: Y) 10

### BONUS

2) Physics – *Short Answer* What is the term for a force which does 0 net work on any object that moves in any closed loop?

ANSWER: CONSERVATIVE
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**TOSS-UP**

3) Math – *Short Answer* A rectangular prism has side lengths 4, 5, and 6. What is the length of the space diagonal of the rectangular prism?

ANSWER: $\sqrt{77}$

**BONUS**

3) Math – *Short Answer* The volume of a rectangular prism with integer side lengths is 70. What is the maximum surface area of the rectangular prism?

ANSWER: 282

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**TOSS-UP**

4) Earth and Space – *Multiple Choice* Which of the following is the most abundant ion in seawater?

W) Chloride
X) Calcium
Y) Sodium
Z) Magnesium

ANSWER; W) CHLORIDE

**BONUS**

4) Earth and Space – *Short Answer* By name or number, order the following four ocean zones by depth from highest to lowest: 1) Bathypelagic; 2) Mesopelagic; 3) Abyssopelagic; 4) Hadopelagic.

ANSWER: 2, 1, 3, 4
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**TOSS-UP**

5) Energy – *Short Answer* Researchers at Brookhaven National Laboratory are studying the membranes of certain organelles found in plants. What plant organelle stores fats in tissues of germinating seeds and is a modified peroxisome?

ANSWER: GLYOXYSOME

**BONUS**

5) Energy – *Multiple Choice* Researchers at Los Alamos National Lab are taking a deeper look into the plasma membrane by studying receptors. Which of the following terms most accurately describes the signalling mechanism used by allergen responses?

W) Autocrine
X) Paracrine
Y) Juxtacrine
Z) Pericrine

ANSWER: X) PARACRINE

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**TOSS-UP**

6) Biology – *Short Answer* What enzyme do most pesticides target?

ANSWER: ACETYLCHOLINESTERASE

**BONUS**

6) Biology – *Short Answer* By name or number, identify all of the following 3 amino acids that are essential:
1) Tyrosine; 2) Serine; 3) Alanine.

ANSWER: NONE
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**TOSS-UP**

7) Chemistry – *Multiple Choice* Al2O3 is an example of which of the following?

W) Acidic oxide
X) Basic oxide
Y) Neutral oxide
Z) Amphoteric oxide

ANSWER: Z) AMPHOTERIC OXIDE

**BONUS**

7) Chemistry – *Short Answer* Indium oxide has formula In2O3, while thallium oxide has formula Tl2O. What phenomenon does this demonstrate?

ANSWER: INERT-PAIR EFFECT (ACCEPT: LAZY-PAIR EFFECT)

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**TOSS-UP**

8) Physics – *Short Answer* If a particle has position x(t)=12cos(t) - 3sin(t), then what is its instantaneous acceleration at time $\pi/2$?

ANSWER: 3

**BONUS**

8) Physics – *Short Answer* If a particle moving in one dimension has position 0 at time t = 0, and velocity 0 at time t = 0, and the particle's acceleration is never greater than 1, what is the greatest possible position the particle can achieve at time t = 1?

ANSWER: 1/2
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**TOSS-UP**

9) Math – *Short Answer* Evaluate $69^2 - 31^2$.

ANSWER: 3800

**BONUS**

9) Math – *Short Answer* Evaluate (1+sqrt(2))^3+(1-sqrt(2))^3 (READ: the quantity 1 plus the square root of 2 cubed plus the quantity 1 minus the square root of 2 cubed).

ANSWER: 14

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**TOSS-UP**

10) Energy – *Multiple Choice* Researchers at Argonne National Laboratory are researching how to make more efficient batteries. In a lithium-ion battery, what element serves as the anode?

W) Lithium
X) Cobalt
Y) Carbon
Z) Zinc

ANSWER: Y) CARBON

**BONUS**

10) Energy – *Multiple Choice* Researchers at Argonne National Laboratory are researching how to make more efficient batteries. In a standard copper-zinc voltaic cell, what is the effect of increasing the size of the copper anode on electric potential?

W) Voltage increases
X) Voltage decreases, but not to zero
Y) Voltage decreases to zero
Z) No change

ANSWER: Z) NO CHANGE
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**TOSS-UP**

11) Earth and Space – *Short Answer* What is the largest moon in the Solar System?

ANSWER: GANYMEDE

**BONUS**

11) Earth and Space – *Multiple Choice* Ganymede, Europa, and Io are in 1 to 2 to 4 orbital resonance around Jupiter. For each Europa-Ganymede conjunction, how many Io-Ganymede conjunctions are there?

W) 1
X) 2
Y) 3
Z) 4

ANSWER: Y) 3

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**TOSS-UP**

12) Biology – *Multiple Choice* Which of the following is not a common pioneer species?

W) Protists
X) Fungi
Y) Lichen
Z) Plankton

ANSWER: W) PROTISTS

**BONUS**

12) Biology – *Multiple Choice* A while ago, a certain habitat was struck hard with a forest fire, destroying a huge part of the ecosystem. What stage of succession is the area at if there is an abundance of oak trees?

W) Secondary succession
X) Seral community
Y) Cyclic succession
Z) Climax community

ANSWER: Z) CLIMAX COMMUNITY
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**TOSS-UP**

13) Chemistry – *Multiple Choice* Which of the following can not be derived from the combined gas law?

W) Avogadro's Law
X) Boyle's Law
Y) Charles' Law
Z) Gay-Lussac's Law

ANSWER: W) AVOGADRO'S LAW

**BONUS**

13) Chemistry – *Short Answer* An infinitely stretchable helium balloon with pressure 1 atmosphere and temperature 300 Kelvins floats up into the sky, where external atmospheric pressure decreases linearly by 0.1 atmospheres every 50 kilometers above the earth's surface. Simultaneously, temperature decreases linearly by 1 degree celsius every kilometer. To the nearest kilometer, how high must the balloon be for its volume to be half its original volume on the surface?

ANSWER: 9

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**TOSS-UP**

14) Math – *Multiple Choice* Sophia has 5 fangs on a table, 1 green, 1 blue, 1 red, and 2 purple. How many different ways can she put them in a line on the table if the only thing she cares about is the color of the fangs?

W) 20
X) 30
Y) 60
Z) 120

ANSWER: Y) 60

**BONUS**

14) Math – *Short Answer* I roll an unfair die labeled from 1 to 6, with the probability of rolling a face proportional to the number on the face. What is the expected value of my roll?

ANSWER: 91/21
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**TOSS-UP**

15) Physics – *Short Answer* A 5 kg ball is motionless at the top of a 245 meter hill. Assuming the acceleration due to gravity to be 10 meters per second squared, if the ball rolls down the hill, in meters per second, what will be its velocity at the bottom of the hill?

ANSWER: 70

**BONUS**

15) Physics – *Short Answer* 2 boxes are sliding on a frictionless surface towards each other. The first box has mass 10 and is sliding at 1 m/s, and the second box has mass 1 and is sliding at 12 m/s. They collide completely inelastically. After the impact, how fast will the second box be moving, in meters per second?

ANSWER: 2/11

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**TOSS-UP**

16) Earth and Space – *Short Answer* What is the name of the series that follows the same pattern, but is not the same as the Goldich Dissolution Series used to describe why certain minerals are commonly found together while exploring why other possibilities are rare?

ANSWER: BOWEN' S REACTION SERIES

**BONUS**

16) Earth and Space – *Short Answer* What is the name of the boundary between the Earth's crust and mantle?

ANSWER: MOHOROVICIC DISCONTINUITY (ACCEPT: MOHO)
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**TOSS-UP**

17) Biology – *Short Answer* Name the three kinds of plant ground tissue cells in order of decreasing cell wall thickness.

ANSWER: SCLERENCHYMA, COLLENCHYMA, PARENCHYMA

**BONUS**

17) Biology – *Multiple Choice* Which of the following is true about hepatophyta?

W) They have a dominant diploid gametophyte lifestyle
X) They have a dominant diploid sporophyte lifestyle
Y) They have a dominant haploid gametophyte lifestyle
Z) They have a dominant haploid sporophyte lifestyle

ANSWER: Y) THEY HAVE A DOMINANT HAPLOID GAMETOPHYTE LIFESTYLE

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**TOSS-UP**

18) Energy – *Multiple Choice* Researchers at Lawrence Berkeley National Lab are studying how to use water at different temperatures to transfer energy. In one cycle in a Carnot cycle, which of the following quantities is positive?

W) Change in entropy
X) Work
Y) Change in internal energy
Z) Heat

ANSWER: Z) HEAT

**BONUS**

18) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab are studying how to use water at different temperatures to transfer energy. In a Carnot engine with an efficiency of 50% and a heat of 250J over the high temperature isothermal path, what is the total useful work done in one cycle?

ANSWER: 125J
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**TOSS-UP**

19) Chemistry – *Multiple Choice* What are the units of the rate constant for a third-order reaction?

W) Molarity over seconds
X) 1 over seconds
Y) 1 over molarity seconds
Z) 1 over molarity squared seconds

ANSWER: Z) 1 OVER MOLARITY SQUARED SECONDS

**BONUS**

19) Chemistry – *Multiple Choice* The half-life of a 2nd order reaction is T for an initial concentration of reactant C. Which of the following represents the half-life of the same reaction with initial concentration C/2?

W) T/4
X) T/2
Y) 2T
Z) 4T

ANSWER: Y) 2T

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**TOSS-UP**

20) Physics – *Multiple Choice* Which of these statements is true about a cannonball fired straight up at escape velocity, ignoring air resistance?

W) The cannonball will never reach 0 velocity
X) The cannonball will eventually experience 0 gravitational force exerted by Earth
Y) The cannonball will eventually experience 0 gravitational field exerted by Earth
Z) The cannonball will never reach its original velocity divided by the square root of 2

ANSWER: W) The cannonball will never reach 0 velocity

**BONUS**

20) Physics – *Short Answer* What fundamental particle is made of 2 down quarks and 1 up quark?

ANSWER: NEUTRON
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**TOSS-UP**

21) Math – *Multiple Choice* What is the least number n such that in a group of n people, at least 4 people must be born in the same month?

W) 4
X) 5
Y) 37
Z) 49

ANSWER: Y) 37

**BONUS**

21) Math – *Short Answer* By name or number, identify all of the following 4 numbers which cannot be the area of a triangle with two side lengths 4 and 5: 1) 6; 2) 8; 3) 10; 4) 12.

ANSWER: 4 ONLY

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**TOSS-UP**

22) Earth and Space – *Multiple Choice* Which of the following is closest to the time, in years, between a sunspot minimum and a sunspot maximum?

W) 5
X) 10
Y) 15
Z) 20

ANSWER: W) 5

**BONUS**

22) Earth and Space – *Short Answer* Variation in sunspot location and area are plotted on what diagram?

ANSWER: BUTTERFLY DIAGRAM
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**TOSS-UP**

23) Biology – *Short Answer* In mammals, what neural structure in the hypothalamus regulates circadian rhythm?

ANSWER: SUPRACHIASMATIC NUCLEUS

**BONUS**

23) Biology – *Short Answer* — Callosal disconnection syndrome is characterized by the severing or lesioning of what part of the brain?

ANSWER: CORPUS CALLOSUM