

### [ROUND 3]

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#### TOSS-UP

1) Math – *Multiple Choice* What is the derangement of 6?

- W) 513
- X) 247
- Y) 244
- Z) 265

ANSWER: Z) 265

#### BONUS

1) Math – *Multiple Choice* Baranyai's Theorem states that the  $k$  vertices of the hypergraph may be partitioned into subsets of  $r$  vertices in  $(k-1) \choose (r-1)$  ways. Thus, 13 vertices of a hypergraph can be partitioned into how many subsets of 5 vertices?

- W) 460
- X) 495
- Y) 515
- Z) 535

ANSWER: X) 495

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#### TOSS-UP

2) Chemistry – *Short Answer* Give the full electron configuration of Cu.

ANSWER:  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

#### BONUS

2) Chemistry – *Short Answer* Give the full electron configuration of Ra.

ANSWER:  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^2$

**TOSS-UP**

3) Biology – *Short Answer* What two monosaccharides make up sucrose?

ANSWER: GLUCOSE AND FRUCTOSE

**BONUS**

3) Biology – *Multiple Choice* Which of the following is closest to the number of cellulose molecules that are in a microfibril?

- W) 10
- X) 35
- Y) 80
- Z) 125

ANSWER: Y) 80



**TOSS-UP**

4) Earth and Space Science – *Multiple Choice* What is the term for a gently sloping layer of bedrock, usually coming off a mountain, that can form a bajada with the mountain's eroded sediment?

- W) Pediment
- X) Mesa
- Y) Derecho
- Z) Wadi

ANSWER: W) PEDIMENT

**BONUS**

4) Earth and Space Science – *Short Answer* Which of Kepler's Laws describes a planet's orbit as an ellipse with the sun at one focus?

ANSWER: KEPLER'S FIRST LAW

### TOSS-UP

5) Physics – *Short Answer* State all of the following 4 units that can be used to measure magnetic field strength:  
1) Tesla 2) Gauss 3) Weber per square meter 4) Ampere-Volt

ANSWER: 1, 2 AND 3

### BONUS

5) Physics – *Short Answer* What is the net electric flux, to the nearest 100 kilovolt-meters, through a gaussian surface with a radius of 5 meters and an enclosed charge of 4.5 microcoulombs?

ANSWER: 500



### TOSS-UP

6) Math – *Multiple Choice* 2021 independent fair coins are tossed by Ephram. What is the expected number of consecutive TT pairs?

- W) 101
- X) 202
- Y) 505
- Z) 1010

ANSWER: Y) 505

### BONUS

6) Math – *Multiple-Choice* Three clever monkeys divide a pile of bananas. The first monkey takes some bananas from the pile, keeps three-fourths of them, and divides the rest equally between the other two. The second monkey takes some bananas from the pile, keeps one-fourth of them, and divides the rest equally between the other two. The third monkey takes the remaining bananas from the pile, keeps one-twelfth of them, and divides the rest equally between the other two. Given that the pile starts out with a positive number of bananas, each monkey receives a whole number of bananas whenever the bananas are divided, and the numbers of bananas the first, second, and third monkeys have at the end of the process are in the ratio 3:2:1, what is the least possible total for the number of bananas?

- W) 338
- X) 372
- Y) 408
- Z) 422

ANSWER: Y) 408

### TOSS-UP

7) Chemistry – *Short Answer* What element in the group 1A on the periodic table has the highest ionization energy?.

ANSWER: HYDROGEN

### BONUS

7) Chemistry – *Multiple Choice* Which of the following is a colorless ion?

- W) Fe  $2^{+}$
- X) Fe  $3^{+}$
- Y) Pb  $3^{+}$
- Z) Zn  $2^{+}$

ANSWER: Z) Zn  $2^{+}$



### TOSS-UP

8) Biology – *Multiple Choice* Valine is substituted for what amino acid in the formation of a sickle-cell?

- W) Glutamic Acid
- X) Lysine
- Y) Glycine
- Z) Aspartic Acid

ANSWER: W) GLUTAMIC ACID

### BONUS

8) Biology – *Multiple Choice* Which of the following is an essential amino acid?

- W) Leucine
- X) Serine
- Y) Alanine
- Z) Glutamate

ANSWER: W) LEUCINE

### TOSS-UP

9) Earth and Space Science – *Multiple Choice* How many constellations are officially recognized?

W) 77

X) 88

Y) 99

Z) 101

ANSWER: X) 88

### BONUS

9) Earth and Space Science – *Short Answer* Name all of the following constellations through which the ecliptic does not pass:

1) Draco

2) Aquarius

3) Leo

4) Pisces

ANSWER: 1) DRACO

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### TOSS-UP

10) Physics – *Short Answer* A ball is falling off a 150 meter high cliff at a terminal velocity of 8 meters per second. What is the net force on the ball, in newtons?

ANSWER: 0

### BONUS

10) Physics – *Short Answer* A block of mass 5 kilograms is initially sitting atop a frictionless ramp at a height of 3.2 meters. If the block slides down the ramp and, as it moves with a constant velocity after sliding down the ramp, collides into a spring with a spring constant 8 Newtons/meter, by how much is the spring compressed, in simplest radical form in meters?

ANSWER:  $2\sqrt{10}$

## TOSS-UP

11) Math – *Multiple Choice* 10 friends are solving the following problem where each person will give an answer to this question and they are the only individuals answering this question.

Your answer to this problem will be an integer 0 through 100. From all the individuals who submitted an answer to this problem, let the average answer be  $\gamma$ . Find the value of  $\left\lfloor \frac{13}{10}\gamma \right\rfloor$ . If the correct answer is  $x$  and your submitted answer is  $y$  then your score will be  $|x - y|$ .

If one of them accidentally wrote 50 then the number the remaining 9 people should each choose so that their score is minimized can be written as  $\frac{m}{n}$ . Find  $m + n$ .

- W) 25
- X) 26
- Y) 27
- Z) 28

ANSWER: Y) 27

## BONUS

11) Math – *Short Answer* Ephram has 6 Among Us Tasks to complete.

Admin: Swipe Card

Electrical: Calibrate Distributor

Shields: Prime Shields

Weapons: Clear Asteroids

Medbay: Submit Scan

Navigation: Chart Course

The distance from Navigation to Medbay is 1

The distance from Medbay to Weapons is 2

The distance from Weapons to Shields is 4

The distance from Shields to Electrical is 8

The distance from Electrical to Admin is 16

His first task has to be Weapons and then he can choose to do whatever task he wants to do next then what is the maximum distance I travel to finish all my tasks exactly once?

ANSWER: 86

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**TOSS-UP**

**TOSS-UP**

12) Chemistry – *Short Answer* The mole fraction of nitrogen in the air is 0.8899. Calculate the partial pressure of N<sub>2</sub> in air when the atmospheric pressure is 760.(3 sig figs) torr?

ANSWER: 676 torr.

**BONUS**

12) Chemistry – *Short Answer* A sample of gas at 15 degrees celsius and 1 atm has a volume of 3 L. What volume will this gas occupy at 45 degrees celsius and 1 atm.

ANSWER: 3.31 L

### TOSS-UP

13) Biology – *Short Answer* Which organelle responsible for hydrolyzing macromolecules is not present in plant cells?

ANSWER: LYSOSOME

### BONUS

13) Biology – *Short Answer* What protein subunit makes up microfilaments?

ANSWER: ACTIN



### TOSS-UP

14) Earth and Space Science – *Multiple Choice* Arroyos are found in which one of the following biomes?

W) Tundra

X) Forest

Y) Aquatic

Z) Desert

ANSWER: Z) DESERT

### BONUS

14) Earth and Space Science – *Short Answer* Outwash plains form in front of melting glaciers, and carry sediment away from the glacier. What type of stream is usually predominant in outwash plains?

ANSWER: BRAIDED STREAMS



### TOSS-UP

15) Physics – *Short Answer* What quantity is represented by the area under the curve of a force vs position graph?

ANSWER: WORK

### BONUS

15) Physics – *Short Answer* A solid ball of mass 10 kilograms and radius 2 meters rolls without slipping down an incline of height 7 meters. What is the final linear velocity of the ball at the bottom of the ramp, in appropriate units?

ANSWER: 10 METERS PER SECOND

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16) Energy – *Short Answer* Los Alamos National Lab is studying the increased predictability of complex physics of internal combustion engines and their function. Internal combustion engines, which rely on the principles of adiabatic processes, have an internal energy that is equal to the negative of what quantity?

ANSWER: WORK

### BONUS

16) Energy– *Short Answer* Calculate the COP of an ideal refrigerator that operates between temperatures of 180 and 330 Kelvin.

ANSWER: 1.2

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### TOSS-UP

17) Energy – *Multiple Choice* Researchers at Jefferson National Lab have studied the lifetime of the neutral pion, which is shortened by the breaking of chiral symmetry predicted by quantum chromodynamics. What is the name for the breaking of chiral symmetry?

W) Chiral Break

X) Chiral Error

Y) Chiral Anomaly

Z) Chiral Disruption

ANSWER: Y) CHIRAL ANOMALY

### BONUS

17) Energy – *Multiple Choice* Scientists at Brookhaven National Lab, Fermi, Lawrence Berkeley National Lab, and others around the world are building new focusing and kicker magnets for the LHC, which increase the chance of potential collisions. Which of the following terms describes the rate at which the particles are made to collide?

### TOSS-UP

- W) Instantaneous Luminosity
- X) Quantum Luminosity
- Y) Collision Luminosity
- Z) Hadron Luminosity

ANSWER: W) INSTANTANEOUS LUMINOSITY

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### TOSS-UP

18) Energy – *Multiple Choice* Researchers at Los Alamos National Lab drive cars, which use heat engines to operate. When heat engines are used to produce energy through fossil fuels, the excess heat released as the output of the heat engine needs to be absorbed by the surrounding environment, raising its temperature. What is the name given to the resulting pollution type?

- W) Thermal Pollution
- X) Heat Death Pollution
- Y) Carbon-Capture Pollution
- Z) Entropic Pollution

ANSWER: THERMAL POLLUTION

### BONUS

18) Energy – *Short Answer* Researchers at SLAC use the Fermi Gamma Ray Telescope, which orbits at 350 miles above the Earth, to search for signs of what elusive particles that allow galaxies to spin at their current velocities without falling apart?

ANSWER: DARK MATTER