Round Robin 1

TOSS-UP

1) Math – *Short Answer* What is the largest positive integer that cannot be formed by summing a multiple of 13 and a multiple of 7?

ANSWER: 71

BONUS

1) Math – *Short Answer* Suppose Talon has 4 red daggers, 4 blue daggers, and 4 white daggers. If he wants to guarantee he gets at least 1 red dagger, at least how many daggers must he randomly take?

ANSWER: 9

TOSS-UP

2) Chemistry – *Multiple Choice* Which of the following is a triprotic acid?

W) Hydrobromic acid
X) Phosphorous acid
Y) Phosphoric acid
Z) Sulfuric acid

ANSWER: Y) Phosphoric acid

BONUS

2) Chemistry – *Short Answer* Highly electronegative groups can often cause or increase the magnitude of polarization of nearby bonds. What is the name of this effect?

ANSWER: Inductive effect

TOSS-UP

3) Earth and Space – *Short Answer* Identify all of the following ores that are principal ores of Iron: 1) Magnetite, 2) Bauxite, 3) Hematite.

ANSWER: 1 and 3

BONUS

3) Earth and Space – *Short Answer* In which U.S. state is the San Andreas Fault primarily located, and what type of fault is it?

ANSWER: California, strike-slip fault (accept: transform fault)

TOSS-UP

4) Biology – *Multiple Choice* Which of the following molecules serves as the main structural component of fungal cell walls?

W) Cellulose
X) Chitin
Y) Glycogen
Z) Pectin

ANSWER: X) Chitin

BONUS

4) Biology – *Short Answer* Which cellular organelle in eukaryotes is primarily responsible for producing ATP through oxidative phosphorylation?

ANSWER: Mitochondria

TOSS-UP

5) Physics (Mech) – *Short Answer* Eli drops a Minecraft-sized anvil onto William's head as he walks by. If Eli is in a window 100 meters above the ground, and William is 10 meters tall, then, to the nearest second, how long does it take for the anvil to hit William's head?

ANSWER: 4 seconds

BONUS

5) Physics (Mech) – *Short Answer* Three springs connected in series have equivalent spring constant 20 Newtons per meter. What would be the equivalent spring constant in Newtons per meter if you were to connect these springs in parallel?

ANSWER: 180 Newtons per meter

TOSS-UP

6) Math – *Multiple Choice* Which one of the following is not a possible set of side lengths for an obtuse triangle?

W) 4, 7, 9
X) 8, 11, 14
Y) 10, 12, 16
Z) 20, 21, 29

ANSWER: Z) 20, 21, 29

BONUS

6) Math – *Multiple Choice* The graph which of the following functions has a hole?

W) $\frac{x^2+4}{x-2}$
X) $\frac{x^2-7x+12}{x-5}$
Y) $\frac{x^2-16x+60}{x^2-17x+72}$
Z) $\frac{x^2-18x+77}{x^2-15x+56}$

ANSWER: Z) $\frac{x^2-18x+77}{x^2-15x+56}$

TOSS-UP

7) Earth and Space – *Short Answer* Deneb, Altair, and Vega form what asterism that appears in the summer of the northern sky?

ANSWER: Summer Triangle

BONUS

7) Earth and Space – *Short Answer* What series describes the temperature at which certain minerals crystallize when cooled, or melt when heated, also explaining why certain rocks are never found at the same spot?

ANSWER: Bowen's reaction series

TOSS-UP

8) Chemistry – *Multiple Choice* In the 1700s, it was theorized that all acids had to contain oxygen. Which acid disproves this idea?

W) Acetic acid
X) Sulfuric acid
Y) Hydroiodic acid
Z) Nitrous acid

ANSWER: Y) Hydroiodic acid

BONUS

8) Chemistry – *Short Answer* What theory of acids and bases would classify NH_4^+ as an acid, but would not classify NH_3 as a base?

ANSWER: Arrhenius

TOSS-UP

9) Biology – *Short Answer* What hormone, produced by adipocytes, promotes satiety?
ANSWER: Leptin

BONUS

9) Biology – *Short Answer* What process describes the uptake of DNA by a bacterial cell from its surroundings?
ANSWER: Transformation

TOSS-UP

10) Energy – *Short Answer* An algorithm which maximizes the short term reward at each timestep is called what?
ANSWER: Greedy

BONUS

10) Energy – *Multiple Choice* Which of the following could be classified as a greedy algorithm?
W) Breadth-first-search
X) Bubble Sort
Y) Dijkstra's Algorithm
Z) Bellman-Ford Algorithm
ANSWER: Y

TOSS-UP

11) Physics (EM) – *Multiple Choice* Gauss's Law for Magnetism is most closely related to which of the following statements?
W) The direction of the magnetic Lorentz force is perpendicular to the velocity of a charge
X) The direction of the magnetic Lorentz force is perpendicular to the magnetic field
Y) There are no magnetic monopoles
Z) The magnetic field from a current-carrying wire is inversely proportional to distance from the wire
ANSWER: Y

BONUS

11) Physics (Mech) – *Short Answer* If the coefficient of static friction is large enough, a block on an inclined plane sloping rightwards will tip over and fall if what point is farther right than its bottom right corner?
ANSWER: Center of Mass

TOSS-UP

12) Math – *Short Answer* At Akhil's school, there is a Spanish club with 24 students, and a French club with 19 students. If 3 students are part of both clubs, then what is the probability that a student chosen from either club will only be in one club?
ANSWER: 37/40

BONUS

12) Math – *Short Answer* Conrad is betting on Valorant games. To decide how much he is going to bet, he rolls a 6, 8, 10, 12, and 20 sided dice, finds their arithmetic mean, and bets 100 times that amount. What is the expected amount of money he will bet?
ANSWER: $610

TOSS-UP

13) Biology – *Multiple Choice* In the process of photosynthesis, which molecule acts as the primary electron donor in the light-dependent reactions?
W) Water
X) NADPH
Y) ATP
Z) Glucose
ANSWER: W

BONUS

13) Biology – *Multiple Choice* McNair is an aspiring bodybuilder. Attempting to maximize gains, he increases his blood glucose levels after a workout by eating an apple. Which of the following hormones is he most likely trying to increase?
W) Thyroid hormones
X) ADH
Y) Glucagon
Z) Insulin
ANSWER: Z

TOSS-UP

14) Chemistry – *Short Answer* What is the bond order of the nitrogen-oxygen bond in nitrate?
ANSWER: 4/3

BONUS

14) Chemistry – *Short Answer* What is the hybridization of the carbon atom in formaldehyde?
ANSWER: sp^2

TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following rocks is a mafic plutonic igneous rock?
W) Gabbro
X) Basalt
Y) Granite
Z) Diorite
ANSWER: W) Gabbro

BONUS

15) Earth and Space – *Short Answer* By name or number, order the following life stages of the Sun from earliest to latest: 1) Main-sequence, 2) Hayashi track, 3) White dwarf, 4) Red giant.
ANSWER: 2 1 4 3

TOSS-UP

16) Energy – *Multiple Choice* Which of the following distributions would best model the outcome of a single coin flip?
W) Normal
X) Geometric
Y) Bernoulli
Z) Poisson
ANSWER: Y

BONUS

16) Energy – *Multiple Choice* Which of the following steps do not occur during the training loop of a machine learning model?
W) Loss Computation
X) Gradient Descent
Y) Hyperparameter Fine-Tuning
Z) Weight Updating
ANSWER: Y

TOSS-UP

17) Physics (Thermo) – *Short Answer* What is the term for a curve on a P-V diagram where there is no change in temperature?

ANSWER: Isotherm

BONUS

17) Physics (Thermo) – *Short Answer* On an isotherm, the pressure is proportional to what power of the volume?

ANSWER: -1

TOSS-UP

18) Math – *Short Answer* How many trailing zeros are there in the expansion of 125 factorial?

ANSWER: 31

BONUS

18) Math – *Short Answer* Which one of the following equations has 2 real solutions?

W) $x^2 + 6x + 15 = 0$
X) $x^2 + 6x + 12 = 0$
Y) $x^2 + 6x + 9 = 0$
Z) $x^2 + 6x + 8 = 0$

ANSWER: Z) $x^2 + 6x + 8 = 0$

TOSS-UP

19) Physics (Mech) – *Short Answer* A planet has escape velocity v. If the mass is doubled, which of the following is closest to the new escape velocity?
W) v
X) $\sqrt{2}v$
Y) $2v$
Z) $4v$
ANSWER: X

BONUS

19) Physics (Mech) – *Short Answer* The formula for escape velocity most directly comes from which of the following laws?
W) Conservation of Angular Momentum
X) Conservation of Energy
Y) The Law of Orbits
Z) Newton's Third Law
ANSWER: X

TOSS-UP

20) Chemistry – *Multiple Choice* To the nearest integer, what is the pH of a 0.1 M solution of acetic acid, which has a pKa of 4.74?
W) 1
X) 2
Y) 3
Z) 4
ANSWER: Y) 3

BONUS

20) Chemistry – *Multiple Choice* When pH equals 13, what range is the van't Hoff factor of phosphoric acid in?
W) Between 0 and 1
X) Between 1 and 2
Y) Between 2 and 3
Z) Between 3 and 4
ANSWER: Z) Between 3 and 4

TOSS-UP

21) Biology – *Short Answer* What term describes a glycerol molecule with three saturated fatty acids attached on the same side?

ANSWER: Triacylglycerol (Accept: Triglyceride)

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BONUS

21) Biology – *Multiple Choice* How many chambers does a frog heart have?

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

ANSWER: Y

TOSS-UP

22) Earth and Space – *Multiple Choice* Which of the following terms refers to the low altitude area of a glacier or ice sheet where snow melted in the summer is typically greater than snow gathered in the winter?

W) Breaking Zone
X) Crevasse
Y) Ablation Zone
Z) Calving Area

ANSWER: Y

BONUS

22) Earth and Space – *Short Answer* McNair, an aspiring hydrologist, is studying Carlsbad Caverns National Park. Carlsbad Caverns National Park is a huge cave system that was formed by rainwater slowly dissolving limestone, and seeping through sinkholes and fractures to form underground river systems. All of this is characteristic of a certain kind of topography. What is this topography?

ANSWER: Karst topography

TOSS-UP

23) Energy – *Short Answer* What activation function can be defined piecewise as 0 for $x < 0$ and a linear graph with slope 1 for $x \geq 0$?

ANSWER: ReLU/Rectified linear unit

BONUS

23) Energy – *Multiple Choice* Methods in computational chemistry often solve the Schrodinger equation associated with what quantity for a molecule?

W) Kinetic Energy
X) Potential Energy
Y) Lagrangian
Z) Hamiltonian

ANSWER: Z