Round Robin 2

TOSS-UP

1) Physics – *Short Answer* A top on a table wobbles uniformly about an axis. What is the angle in degrees between the torque due to gravity about its base on the top and the angular momentum due to the spin of the top?

ANSWER: 90

BONUS

1) Physics – *Short Answer* Eli, who weighs 50 kg is sprinting circular laps with radius 2 meters around the Belmont convention center at 10 m/s. He loses mass to gas at a rate of 2 kg/s. Assume the momentum of his gas is negligible. If the radius of the circle eli runs in and his velocity are constant, what is the magnitude of the torque exerted on Eli in Newton-Meters?

ANSWER: 40 Newton-meters

TOSS-UP

2) Chemistry – *Multiple Choice* Inside a container with a fixed pressure, hydrogen gas reacts with oxygen gas to make water vapor. Which change will result in more oxygen gas being present at equilibrium?

W) Throwing in a chunk of sodium
X) Injecting argon
Y) Lowering the temperature
Z) Turning on a dehumidifier

ANSWER: X) Injecting Argon

BONUS

2) Chemistry – *Short Answer* An ideal gas, initially at STP, has its temperature increased to 136 $^{\circ}C$ and its pressure increased to 3.0 atm. To two significant figures and in liters, what is the gasses' new molar volume?

ANSWER: 11 L

TOSS-UP

3) Earth and Space – *Multiple Choice* Which of the following telescope arrangements collects light at one end, and brings it to focus at the other end using a mirror angled at 45 degrees?
W) Galilean
X) Newtonian
Y) Cassegrain
Z) Keplerian

ANSWER: X) Newtonian

BONUS

3) Earth and Space – *Short Answer* What phenomenon present in refracting telescopes occurs as a lens is not able to bring all wavelengths of light to a single point, leading to some colors getting distorted?

ANSWER: Chromatic aberration

TOSS-UP

4) Math – *Short Answer* What is the surface area of an octahedron with edge length 2?
ANSWER: $8\sqrt{3}$

BONUS

4) Math – *Short Answer* The diagonal of a regular pentagon with side length 1 is what constant?

ANSWER: Phi (Accept: Golden ratio, Golden Mean, Golden Number, Divine Section, Extreme and Mean Ratio, any common name for the golden ratio)

TOSS-UP

5) Biology – *Multiple Choice* Which of the following structures is the main site of T cell maturation?
W. Thymus
X. Spleen
Y. Bone marrow
Z. Lymph nodes

ANSWER: W) Thymus

BONUS

5) Biology – *Short Answer* Put the following four stages of food processing in order from first to last. 1) Ingestion 2) Absorption 3) Elimination 4) Digestion
ANSWER: 1,4,2,3

TOSS-UP

6) Energy – *Short Answer* A process in which the probability of future states only depends on the current state is known as what?
ANSWER: Markovian (ACCEPT: Markov Chain)

BONUS

6) Energy – *Multiple Choice* Which of the following could best be used for image classification?
W) Recurrent Neural Network
X) Convolutional Neural Network
Y) Fully Connected Neural Network
Z) K-Nearest neighbors
ANSWER: X) Convolutional Neural Network

TOSS-UP

7) Physics – *Short Answer* Akhil, a Science Olympiad student, turns on the water from the 0.1 cm radius faucet in his dorm at MSU. Unfortunately, the water, flowing at 10 m/s, is brown and dirty, so Akhil attempts to prank William by piping it into his Diet Coke with a straw. If the radius of the straw is 0.02 cm, what is the new velocity of the water in meters per second assuming steady incompressible laminar flow?

ANSWER: 250 m/s

BONUS

7) Physics – *Short Answer* While Akhil and the other ASFA students are suffering at MSU, Ryan is staying in a hotel. In the hotel lobby, there is a water pitcher containing still water of height 1 meter and base radius 4 m^2. Ryan takes a rock and breaks a hole 0.2 meters from the bottom. To the nearest integer, and in meters per second, what is the instantaneous velocity of the water flowing out of the hole?

ANSWER: 4 m/s

TOSS-UP

8) Biology – *Multiple Choice* Eli has McNair in a rear naked choke with his arm constricting McNair's neck. Which of the following arteries must McNair immediately defend to maximize his chances of survival?
W. Brachial
X. Carotid
Y. Iliac
Z. Anterior circumflex
ANSWER: X) Carotid

BONUS

8) Biology – *Multiple Chioce* McNair injects Akhil's left ventricle scar with a solution of retroviruses in an attempt to permanently reprogram the fibroblasts into functional cardiomyocytes. Overexpression of which of the following classes of proteins would be most effective in this process?
W. Transcription factors
X. Chaperonins
Y. Transport proteins
Z. Nucleases
ANSWER: W) Transcription Factors

TOSS-UP

9) Chemistry – *Multiple Choice* The reactant concentration for some reaction at time t=1 is C. If the reaction is second order, what is the reactant concentration at time t=3?
W. C/3
X. C
Y. 3C
Z. 9C
ANSWER: W) C/3

BONUS

9) Chemistry – *Short Answer* What is the term for the scattering of light by a colloid?
ANSWER: Tyndall Effect

TOSS-UP

10) Math – *Short Answer* For x between $\frac{\pi}{2}$ and π, if $\sin(x)$ [sine of x] is 5/13, what is the value of $\cot(x)$ [cotangent of x]?
ANSWER: $\frac{-12}{5}$

BONUS

10) Math – *Short Answer* After his math exam, Clark decides to celebrate. He arrives at a party at 6:00, and will leave uniformly randomly at any time before 8:00. Albert, who had finished the exam earlier, arrives at 5:00, and will leave uniformly randomly at any time before 8:00. What is the probability that Clark leaves before Albert?
ANSWER: $\frac{1}{3}$

TOSS-UP

11) Earth and Space – *Multiple Choice* Which of the following is NOT a Milankovitch cycle?
W) Axial precession
X) Axial tilt
Y) Magnetic field reversals
Z) Eccentricity of Earth's axis
ANSWER: Y) Magnetic field reversals

BONUS

11) Earth and Space – *Multiple Choice* What moraine is formed when 2 glaciers come together?
W) End Moraine
X) Lateral Moraine
Y) Medial Moraine
Z) Ground Moraine
ANSWER: Y) Medial Moraine

TOSS-UP

12) Chemistry – *Multiple Choice* Which of the following substances takes up the least volume at 2 atm and 368 K?
W) NO_2
X) H_2
Y) H_2O
Z) SO_2
ANSWER: Y) H_2O

BONUS

12) Chemistry – *Short Answer* With a density of 22.6 g/cm3, what is the densest stable material found on Earth?
ANSWER: Osmium

TOSS-UP

13) Energy – *Multiple Choice* In quantum computing, what object represents the state space of a qubit?
W) Riemann Sphere
X) Bell Square
Y) Bloch Sphere
Z) Dirac Donut
ANSWER: Y) Bloch Sphere

BONUS

13) Energy – *Short Answer* Identify all of the following four answer choices that describe a stack. 1) First-in 2) First-out 3) Last-in 4) Last-out
ANSWER: 2, 3

TOSS-UP

14) Physics (Modern) – *Multiple Choice* Which of the following interactions has a carrier particle that has nonzero mass and spin less than 2?
W) Electromagnetic Interaction
X) Gravity
Y) Weak Interaction
Z) Strong Interaction
ANSWER: Y

BONUS

14) Physics (Mech) – *Short Answer* A wave moves along a string with a speed v. If the wave moves to a string with two times the linear mass density and 27 times the tension of the previous string, what is the new speed of the wave in terms of v?
ANSWER: $\frac{3\sqrt{6}}{2}\ v$ (3 root 6 over 2 v)

TOSS-UP

15) Chemistry – *Multiple Choice* Which of the following is typically true about crystals and glasses?
W) Crystals have short-range order, glasses have short-range order
X) Crystals have short-range order, glasses have long-range order
Y) Crystals have long-range order, glasses have short-range order
Z) Crystals have long-range order, glasses have long-range order
ANSWER: Y

BONUS

15) Chemistry – *Short Answer* Raymond and his team of all-star chemists are studying the superoxide anion. Superoxide is an ion that contains oxygen in what oxidation state?
ANSWER: -(1/2)

TOSS-UP

16) Math – *Short Answer* Find the product of the diagonals of isosceles trapezoid $ABCD$, where $AB = 6$, $BC = 20$, $CD = 30$, and $DA = 20$.
ANSWER: 580

BONUS

16) Math – *Short Answer* A "one to one and onto" correspondence between two sets is known as a what?
ANSWER: Answer: Bijection (Accept: Bijective Function)

TOSS-UP

17) Energy – *Multiple Choice* What is the lower bound for the time complexity of a comparison sorting algorithm?
W) $O(n)$
X) $O(n^2)$
Y) $O(n \log(n))$
Z) $O(n^2 \log(n))$
ANSWER: Y) $O(n \log(n))$

BONUS

17) Energy – *Short Answer* WolframAlpha is an example of what type of software that allows for the evaluation of mathematical expressions through a symbolic representation?
ANSWER: Computer Algebra System

TOSS-UP

18) Earth and Space – *Multiple Choice* What term is given to the maximum height for typical cloud formation due to the presence of a thermal inversion?
W) Stratopause
X) Altopause
Y) Mesopause
Z) Tropopause
ANSWER: Tropopause

BONUS

18) Earth and Space – *Short Answer* What property of minerals describes its ability to doubly refract incident light when shone at specific angles?
ANSWER: Birefringence

TOSS-UP

19) Biology – *Short Answer* Albert is looking at different cytoskeletal elements under a microscope. He picks up one of his samples, and notices that it seems to be made up of a globular protein with two distinct subunits. Which cytoskeletal element is he most likely looking at?

ANSWER: Microtubules

BONUS

19) Biology – *Short Answer* Identify all of the following three statements that are true about membrane proteins:

1) Peripheral proteins are only found on the extracellular side of the plasma membrane;
2) Transmembrane proteins contain hydrophilic regions in their 3D structure;
3) Membrane proteins are typically less mobile than phospholipids in the membrane.

ANSWER: 2 and 3

TOSS-UP

20) Physics (Thermo) – *Multiple Choice* You apply heat to the top of a rectangular iron plate. Which of the following best describes what will happen to the plate?

W) It will expand uniformly
X) It will contract uniformly
Y) It will bend upwards
Z) It will bend downwards

ANSWER: Z

BONUS

20) Physics (Mech) – *Short Answer* The area swept out by an orbit in a fixed time t is proportional to what power of the angular momentum?

ANSWER: 1

TOSS-UP

21) Math – *Short Answer* Clark, who has recently obtained his driver's license, leaves his house and cruises along the highway at 40 miles per hour when he realizes that he forgot his important packs of gum. He turns around and heads in the opposite direction at 60 miles per hour, stopping when he arrives at his house. What is the average speed of Clark's car along this round trip?

ANSWER: 48

BONUS

21) Math – *Multiple Choice* Which one of the following is closest to the natural log of the limit as n goes to infinity of $\left(1 - \frac{3}{n}\right)^{-2n}$?

W) 2
X) 3
Y) 6
Z) 12

ANSWER: Y) 6

TOSS-UP

22) Earth and Space – *Multiple Choice* By what factor is the competence of a stream multiplied if the stream's velocity is multiplied by 3?

W) $\frac{1}{3}$
X) $\sqrt{3}$
Y) 3
Z) 9

ANSWER: Z) 9

BONUS

22) Earth And Space – *Short Answer* In contrast to an ablation zone, what term refers to the area of higher elevation, where there is a net increase in snow?

ANSWER: Zone of accumulation (ACCEPT: accumulation zone)

TOSS-UP

23) Biology – *Short Answer* In genetics, what is the term for a trait that is controlled by multiple genes?

ANSWER: Polygenic

BONUS

23) Biology – *Multiple Choice* Which of the following best describes the principle of competitive exclusion?

W) Two species can coexist in the same niche indefinitely

X) Two species cannot coexist if they occupy the same niche and compete for the same resources

Y) Two species can coexist as long as they share at least one resource

Z) Two species can only coexist if they are phylogenetically related

ANSWER: X) Two species cannot coexist if they occupy the same niche and compete for the same resources