

## WISC Round 4

### TOSS-UP

1) Physics – *Multiple Choice* Which of the following statements regarding objects in fluids is incorrect? [SA]

W) The buoyant force on the object depends on the density of the fluid.

X) The buoyant force for the same object and fluid is smaller on the moon than on the earth.

Y) An object completely submerged at a 10 meter depth experiences a lower buoyancy than the same object at a 1 meter depth.

Z) The larger the volume of fluid an object displaces, the higher its buoyant force.

ANSWER: Y) AN OBJECT COMPLETELY SUBMERGED AT A 10 METER DEPTH EXPERIENCES A LOWER BUOYANCY THAN THE SAME OBJECT AT A 1 METER DEPTH.

### BONUS

1) Physics – *Short Answer* A cube with uniform mass density and a mass of 8 kilograms is placed in water. What is the minimum side length of the cube, in meters, such that the cube floats? [SA]

ANSWER: 0.2 METERS

### TOSS-UP

2) Biology – *Short Answer* What term describes an individual that has both male and female reproductive systems?

ANSWER: HERMAPHRODITE

### BONUS

2) Biology – *Short Answer* Identify all of the following three cells that are originally synthesized by the bone marrow: 1) Neutrophils; 2) Monocytes; 3) Erythrocytes.

ANSWER: ALL (ACCEPT: NEUTROPHILS, MONOCYTES, ERYTHROCYTES)

### TOSS-UP

3) Earth and Space – *Short Answer* What barred spiral galaxy in the Virgo Supercluster is currently on a collision course with the Milky Way? [JI]

ANSWER: ANDROMEDA GALAXY (ACCEPT: M31, MESSIER 31, NGC 224)

### BONUS

3) Earth and Space – *Multiple Choice* The Wilson-Bappu effect demonstrates the remarkable correlation between the width of the Ca II K emission line and which of the following properties of stars? [JI]

- W) Distance
- X) Spectral class
- Y) Absolute magnitude
- Z) Mass

ANSWER: Y) ABSOLUTE MAGNITUDE

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### TOSS-UP

4) Math – *Short Answer* If December 1st, 2021 is on a Wednesday, then what day of the week is December 31st, 2021? [AT]

ANSWER: FRIDAY

### BONUS

4) Math – *Multiple Choice* Which of the following is closest to the standard deviation for a sampling distribution if the population parameter has a proportion of 0.5 and the sample size is 25? [JI]

- W) 0.07
- X) 0.1
- Y) 0.14
- Z) 0.22

ANSWER: X) 0.1

### TOSS-UP

5) Chemistry – *Multiple Choice* How many atoms are contained within one unit cell of a crystal with a primitive cubic structure? [JI]

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

ANSWER: W) 1

### BONUS

5) Chemistry – *Short Answer* What is the concentration, in moles per liter, of hydrochloric acid in a solution created by mixing 200 milliliters of 3 molar hydrochloric acid and 300 milliliters of 4 molar hydrochloric acid? [JI]

ANSWER: 3.6 MOLES PER LITER

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### TOSS-UP

6) Energy – *Short Answer* Scientists at the Tokyo Institute of Technology are working on developing low-temperature catalysts for the production of what compound, which is essential in the production of plant fertilizers and is traditionally produced using the Haber-Bosch process at high temperatures? [SA]

ANSWER: AMMONIA (ACCEPT:  $\text{NH}_3$ )

### BONUS

6) Energy – *Multiple Choice* The scientists at Tokyo Institute of Technology are using a Ruthenium-based catalyst to help synthesize ammonia at low temperatures. Which of the following statements is incorrect about Ruthenium? [SA]

- W) It belongs to the platinum group.
- X) It has a filled 5s shell.
- Y) It is paramagnetic.
- Z) It has an oxidation number of +8 in Ruthenium tetroxide.

ANSWER: X) IT HAS A FILLED 5S SHELL

### TOSS-UP

7) Physics – *Multiple Choice* A square diamond has charges on all four corners, all with charge  $Q$ . If the top and right charges are positive, and the left and bottom charges are negative, then what is the direction of the electric field at the center of the square? [AT]

- W) Upper right
- X) Upper left
- Y) Lower right
- Z) Lower left

ANSWER: Z) LOWER LEFT

### BONUS

7) Physics – *Short Answer* Two charges distance  $d$  apart have a charge of  $+q$  and  $-q$ . If the electric field in between the two charges is  $E$ , what is the magnitude of the electric field a distance  $d$  away from one of the charges along the same axis, in terms of  $E$ ? [AT]

ANSWER:  $(3/8)E$



### TOSS-UP

8) Biology – *Short Answer* What medical term describes the abnormal sounds made by turbulent blood flow through the valves of the heart? [CJ]

ANSWER: MURMURS (ACCEPT: HEART MURMURS)

### BONUS

8) Biology – *Multiple Choice* Which of the following best describes the cross section of a typical monocot root? [CJ]

- W) A vascular cylinder consisting of a central lobed core of xylem and phloem surrounded by cortex
- X) A vascular cylinder with a core of parenchyma surrounded by a ring of xylem and phloem
- Y) Vascular bundles arranged in a ring surrounding the pith
- Z) Vascular bundles scattered throughout the ground tissue with no separate cortex and pith

ANSWER: Y) VASCULAR BUNDLES ARRANGED IN A RING SURROUNDING THE PITH

### TOSS-UP

9) Earth and Space – *Short Answer* In a limnic eruption, what gas erupts from lake waters to form a cloud capable of suffocating people and animals? [JI]

ANSWER: CARBON DIOXIDE (ACCEPT: CO<sub>2</sub>)

### BONUS

9) Earth and Space – *Short Answer* Describe how the temperature varies in each of the following layers of the atmosphere as altitude increases, saying whether it increases or decreases.  
1) Troposphere, 2) Stratosphere, 3) Mesosphere, 4) Thermosphere [JI]

ANSWER: 1 - DECREASE, 2 - INCREASE, 3 - DECREASE, 4 - INCREASE (ACCEPT: EQUIVALENTS)



### TOSS-UP

10) Math – *Short Answer* What is the area of the triangle with vertices at points (0, 0), (4, 5), and (4, -1)? [AT]

ANSWER: 12

### BONUS

10) Math – *Multiple Choice* Which of the following values is the greatest for the set {4, 2, 0, 6, 9, 3}? [AT]

- W) Mean
- X) Median
- Y) Variance
- Z) Interquartile range

ANSWER: Y) VARIANCE

### TOSS-UP

11) Chemistry – *Multiple Choice* How many atomic orbitals are there with principal quantum number 3? [SA]

- W) 5
- X) 7
- Y) 9
- Z) 11

ANSWER: Y) 9

### BONUS

11) Chemistry – *Short Answer* Order the following four atomic orbitals from lowest to highest energy: 1) 4f; 2) 5d; 3) 6s; 4) 5p. [SA]

ANSWER: 4, 3, 1, 2 (5p, 6s, 4f, 5d)



### TOSS-UP

12) Energy – *Short Answer* Scientists at Pacific Northwest National Lab are using the 3d structure of proteins to accelerate testing and research on possible treatments for the novel coronavirus. What technique was most likely used to determine the structure of these proteins in which high-energy electromagnetic waves are shined through a substance to determine its structure? [JI]

ANSWER: X-RAY CRYSTALLOGRAPHY

### BONUS

12) Energy – *Short Answer* Researchers at Stanford University are working on creating a single dose nano-particle vaccine for SARS-CoV-2. This vaccine would consist of a nanoparticle covered with what proteins found on the surface of the coronavirus, which allows the virus to bind to receptors and enter the host cells? [JI]

ANSWER: SPIKE PROTEINS (ACCEPT: SPIKE GLYCOPROTEINS, S PROTEINS)

### TOSS-UP

13) Physics – *Short Answer* If a pendulum with a length  $L$  takes 4 seconds to swing from one side to the other, then how long must a second pendulum be, in terms of  $L$ , if it takes 8 seconds to swing across? [AT]

ANSWER:  $4L$

### BONUS

13) Physics – *Multiple Choice* Ball A has a mass of 4 kg and approaches Ball B at a velocity of 2 meters per second. Ball B has a mass of 6 kg and travels in the same direction as Ball A at 1 meter per second. When the two balls collide elastically, what is the sum of the final speeds of both balls, in meters per second? [AT]

- W) 3
- X) 2.8
- Y) 2.6
- Z) 2.4

ANSWER: Y) 2.6



### TOSS-UP

14) Biology – *Multiple Choice* Which of the following types of glial cells are involved in protecting the central nervous system from pathogens?

- W) Astrocytes
- X) Ependymal Cells
- Y) Schwann Cells
- Z) Microglia

ANSWER: Z) MICROGLIA

### BONUS

14) Biology – *Short Answer* What sensory system allows most fishes and aquatic amphibians to detect low frequency aquatic pressure waves produced by moving objects?

ANSWER: LATERAL LINE SYSTEM (ACCEPT: LATERIS SYSTEM)

### TOSS-UP

15) Earth and Space – *Short Answer* Identify all of the following four stars that are on the main sequence of the HR diagram: 1) Betelgeuse; 2) Sirius A; 3) Rigel; 4) The Sun. [CJ]

ANSWER: 2 AND 4 (SIRIUS A AND THE SUN)

### BONUS

15) Earth and Space – *Short Answer* Identify all of the following three statements that accurately contrast the Kuiper Belt and the Oort cloud: 1) The Kuiper Belt is donut-shaped, the Oort Cloud is spherical 2) The Kuiper Belt extends from about 1,000 to 100,000 AU, the Oort Cloud extends from about 100 to 1,000 AU 3) Comets may originate from the Kuiper Belt, comets can not originate from the Oort Cloud [JI]

ANSWER: 1 ONLY



### TOSS-UP

16) Math – *Short Answer* In a double elimination bracket with 32 teams, what is the maximum number of games that need be played to determine a winner? [AT]

ANSWER: 63

### BONUS

16) Math – *Short Answer* What are the coordinates of the vertex of the parabola  $y = 3x^2 + 15x - 12$ ? [SA]

ANSWER: (-5/2, -123/4)



### TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following species does NOT have the same number of electrons as the others? [SA]

- W)  $\text{Zn}^{2+}$
- X)  $\text{Cu}^+$
- Y)  $\text{Ga}^{4+}$
- Z) Ni

ANSWER: Y)  $\text{Ga}^{4+}$

### BONUS

17) Chemistry – *Multiple Choice* In joules, what is the change in Helmholtz free energy of a system if the system does 70 joules of work on its surroundings and absorbs 90 joules of heat, if the entropy of the system does not change? [JI]

ANSWER: 20 JOULES



### TOSS-UP

18) Energy – *Short Answer* Scientists at Fermilab recently recorded the first measurements of single-proton interaction by using the MicroBooNE detector. These interactions occur via charged-current quasielastic scattering and produce a proton and a muon from the interaction of a nucleus and what other fundamental particle, which interacts only with the weak nuclear force and gravity? [JI]

ANSWER: NEUTRINO

### BONUS

18) Energy – *Short Answer* Researchers at CERN are studying an uncommon decay pathway of the Higgs boson into two muons. This pathway is uncommon because muons do not interact as strongly with the Higgs field. Order the following three particles in order of increasing strength of their interaction with the Higgs field: 1) Muon; 2) Neutrino; 3) Z boson. [JI]

ANSWER: 2, 1, 3 (ACCEPT: NEUTRINO, MUON, Z BOSON)

### TOSS-UP

19) Physics – *Short Answer* You need to cross a river 10 meters wide with a current going to the left at a constant speed of 3 meters per second. If you try to row directly across the river at a speed of 5 meters per second, how far from your original position will you be when you land on the other side of the river? [AT]

ANSWER:  $2\sqrt{34}$

### BONUS

19) Physics – *Short Answer* The next time you went rowing, you wanted to land straight across to the other side of the river. You decide to angle your boat so that you move straight across the river. The river is still 10 meters wide, and the current has a speed of 3 meters per second. If your rowing speed is 5 meters per second, how long will it take you to row directly across the river by angling your boat? [AT]

ANSWER: 2.5 SECONDS



### TOSS-UP

20) Biology – *Short Answer* Deuterostomes primarily include chordates, hemichordates, and members of what other animal phylum?

ANSWER: ECHINODERMATA

### BONUS

20) Biology – *Short Answer* Which of the following animal phyla is NOT a member of the clade Lophotrochozoa?

- W) Nematoda
- X) Annelida
- Y) Platyhelminthes
- Z) Mollusca

ANSWER: W) NEMATODA

### TOSS-UP

21) Earth and Space – *Multiple Choice* Which of the following minerals has the chemical formula  $\text{Na}_3\text{AlF}_6$ ? [JI]

- W) Cryolite
- X) Bauxite
- Y) Ilmenite
- Z) Sillimanite

ANSWER: W) CRYOLITE

### BONUS

21) Earth and Space – *Multiple Choice* What is the name of the dark, rusty-brown coating of iron and manganese oxide and clay that coats the surface of rocks in the desert? [JI]

- W) Desert pavement
- X) Desert varnish
- Y) Desert paint
- Z) Desert saltation

ANSWER: X) DESERT VARNISH



### TOSS-UP

22) Math – *Short Answer* Given that set A contains the first three prime numbers, and the universal set contains the first five prime numbers, what numbers does the complement of A contain? [SA]

ANSWER: 7 AND 11 (ACCEPT IN ANY ORDER)

### BONUS

22) Math – *Multiple Choice* For the matrix with top row 4, A and bottom row B, 3, which of the following pairs of values for A and B, respectively, will NOT make the matrix singular? [JI]

- W) 3 and 4
- X) -6 and -2
- Y) -1 and 12
- Z) 2 and 6

ANSWER: Y) -1 AND 12

### TOSS-UP

23) Chemistry – *Multiple Choice* In a phase diagram, what term describes the temperature and pressure at which two phases of a substance become indistinguishable? [SA]

- W) Triple point
- X) Critical point
- Y) Deposition point
- Z) Equilibrium point

ANSWER: X) CRITICAL POINT

### BONUS

23) Chemistry – *Multiple Choice* If the rate constant of the first order reaction “A yields B” is .0345 inverse seconds, what will be the concentration of A after 1 minute if the initial concentration of A was 2 molar? [JI]

- W) 0.125 molar
- X) 0.25 molar
- Y) 0.5 molar
- Z) 1.0 molar

ANSWER: X) 0.25 MOLAR