

WISC Round 5

TOSS-UP

- 1) Physics – *Short Answer* Identify all of the following three statements that are true about a swinging frictionless pendulum: 1) The period is inversely proportional to acceleration due to gravity; 2) The pendulum experiences maximum horizontal acceleration in the middle of its swing; 3) The length of the rope is directly proportional to the period. [AT]

ANSWER: NONE OF THEM

BONUS

- 1) Physics – *Multiple Choice* Which of the following properties of a liquid is NOT needed to determine the surface tension of the liquid by using the Eötvös (UT-vush) rule? [JI]

- W) Critical temperature
- X) Density
- Y) Vapor pressure
- Z) Molar mass

ANSWER: Y) VAPOR PRESSURE



TOSS-UP

- 2) Biology – *Short Answer* What embryonic hormone, secreted in the first trimester, maintains the secretion of progesterone and estrogen by the corpus luteum and is commonly used as the target of the monoclonal antibodies used in pregnancy tests?

ANSWER: HUMAN CHORIONIC GONADOTROPIN (ACCEPT: HCG)

BONUS

- 2) Biology – *Short Answer* What specific genetic component has the ability to integrate copies of itself in other parts of the genome with the aid of reverse transcriptase?

ANSWER: RETROTRANSPOSON (DO NOT ACCEPT: TRANSPOSON)

TOSS-UP

3) Earth and Space – *Short Answer* What is the name of the mass limit for neutron stars, past which gravity overcomes the degeneracy pressure and the star collapses into a black hole? [JI]

ANSWER: TOLMAN-OPPENHEIMER-VOLKOFF LIMIT (ACCEPT: OPPENHEIMER-VOLKOFF LIMIT, TOV LIMIT)

BONUS

3) Earth and Space – *Multiple Choice* Which of the following is NOT a consequence of the active cryo-geysers at the South pole of Saturn's moon Enceladus? [JI]

- W) Enceladus has a small amount of liquid water near its south pole
- X) Enceladus has an albedo around 1
- Y) Enceladus' south pole has warmer areas corresponding to the geysers
- Z) Enceladus has a thin atmosphere

ANSWER: W) ENCELADUS HAS A SMALL AMOUNT OF LIQUID WATER NEAR ITS SOUTH POLE

TOSS-UP

4) Math – *Multiple Choice* Which of the following could be the side lengths of an obtuse triangle? [SA]

- W) 4, 5, 7
- X) 8, 8, 11
- Y) 9, 12, 14
- Z) 11, 11, 15

ANSWER: W) 4, 5, 7

BONUS

4) Math – *Short Answer* In an obtuse triangle with all integer degree angles, a and b are acute angles and both a and b are prime. If the third angle in the triangle is obtuse, then what is the smallest possible value of the third angle? [SA]

ANSWER: 92

TOSS-UP

5) Chemistry – *Short Answer* What specific daughter nuclide is produced from the beta-plus decay of magnesium-23? [JI]

ANSWER: SODIUM-23 (ACCEPT: Na-23; DO NOT ACCEPT: SODIUM)

BONUS

5) Chemistry – *Multiple Choice* The Favorskii rearrangement involves the contraction of a cyclic alpha-halo ketone to form a carboxylic acid. Which of the following organic molecules is a cyclic alpha-halo ketone? [JI]

- W) 3-bromo-2-hexanone
- X) Cyclopentanone
- Y) 2-chlorocyclohexanone
- Z) 1-bromo-2-chlorocyclohexane

ANSWER: Y) 2-CHLOROCYCLOHEXANONE

TOSS-UP

6) Energy – *Short Answer* Scientists at UC Davis have developed a tool that can predict whether trees in an area will regrow on their own after a wildfire. What term in ecology refers to the recolonization of a previously occupied land after a major disturbance? [SA]

ANSWER: SECONDARY SUCCESSION

BONUS

6) Energy – *Short Answer* The researchers at UC Davis plan to use prediction tools to figure out if replanting efforts will be beneficial for regrowth in the areas. After secondary succession, what term refers to the final state of an ecosystem? [SA]

ANSWER: CLIMAX COMMUNITY

TOSS-UP

7) Physics – *Multiple Choice* On a circular loop of a roller coaster, at which point would the normal force exerted by the track onto the car be greatest? [AT]

- W) top
- X) right
- Y) bottom
- Z) left

ANSWER: Y) BOTTOM

BONUS

7) Physics – *Short Answer* If the roller coaster loop has a radius of 5 meters and the cars together have a mass of 150 kg, what is the speed of the roller coaster at the top of the loop if it just completes the loop? [AT]

ANSWER: 7 METERS PER SECOND

TOSS-UP

8) Biology – *Short Answer* Long bone growth occurs at growth plates, where cartilage synthesized within the interior of the growth plates is converted to bone at the shaft facing ends. What cells are responsible for the synthesis of bone from cartilage?

ANSWER: OSTEOBLASTS

BONUS

8) Biology – *Short Answer* Identify all of the following three substances that may function as vasodilators: 1) Angiotensin II; 2) Epinephrine; 3) Vasopressin.

ANSWER: 2 ONLY

TOSS-UP

9) Earth and Space – *Multiple Choice* What type of drainage network forms when a river flows over uniform substrate on a gentle slope and is the most common drainage network? [JI]

- W) Dendritic
- X) Rectangular
- Y) Parallel
- Z) Radial

ANSWER: W) DENDRITIC

BONUS

9) Earth and Space – *Short Answer* What is the process called in which energetic rays from the sun cleave the bonds in water vapor to create oxygen in Earth's atmosphere? [JI]

ANSWER: PHOTODISSOCIATION



TOSS-UP

10) Math – *Multiple Choice* An isosceles triangle of height H is cut in half, forming two similar isosceles triangles with half the area. In terms of H, what is the height of the smaller triangle? [AT]

- W) H/2
- X) H/4
- Y) $\sqrt{2}$ times H/2
- Z) $\sqrt{2}$ times H/4

ANSWER: Y) $\sqrt{2}$ TIMES H/2

BONUS

10) Math – *Short Answer* What is the value of $(\sqrt{3} + i)^7$? (READ AS: open parenthesis square root of 3 plus i close parenthesis to the power of 7)? [SA]

ANSWER: $-64\sqrt{3} - 64i$

11) Chemistry – *Multiple Choice* On the phase diagram of sulfur, rhombic sulfur exists to the left of the monoclinic form and the boundary between them has a positive slope. Which of the following does this observation indicate? [JI]

TOSS-UP

- W) Rhombic sulfur is denser than monoclinic sulfur
- X) Monoclinic sulfur is denser than rhombic sulfur
- Y) Rhombic sulfur is more stable at very high temperatures and low pressures
- Z) Monoclinic sulfur is more stable at very high temperatures and low pressures

ANSWER: W) RHOMBIC SULFUR IS DENSER THAN MONOCLINIC SULFUR

BONUS

- 11) Chemistry – *Multiple Choice* Nitric acid and water form a negative azeotrope and the boiling points of these substances are 83 and 100 degrees celsius respectively. Which of the following is the boiling point, in degrees celsius, of a 68% nitric acid solution? [JI]

- W) 67
- X) 83
- Y) 94
- Z) 120

ANSWER: Z) 120

TOSS-UP

- 12) Energy – *Short Answer* Researchers at Thomas Jefferson National Accelerator Lab have made the most precise estimates yet of what lightest hadron? [JI]

ANSWER: PION

BONUS

- 12) Energy – *Multiple Choice* Scientists at Pacific Northwest National Lab have developed a system called HABITATS to mitigate algal blooms and recover nutrients and energy from algae. Algal blooms are most dependent on which of the following elements? [JI]

- W) Oxygen
- X) Magnesium
- Y) Phosphorus
- Z) Sulfur

ANSWER: Y) PHOSPHORUS

- 13) Physics – *Multiple Choice* Given that the peak voltage of an AC current is 20 Volts, which of the following is equal to the RMS voltage? [SA]

TOSS-UP

- W) $5\sqrt{2}$
- X) $10\sqrt{2}$
- Y) $15\sqrt{2}$
- Z) $20\sqrt{2}$

ANSWER: X) $10\sqrt{2}$

BONUS

- 13) Physics – *Short Answer* Identify all of the following three statements that are true regarding circuits: 1) The phase difference is positive in inductive circuits as current lags voltage. 2) The impedance in a DC circuit is equal to the resistance. 3) Impedance is a component of reactance. [SA]

ANSWER: 1 AND 2



TOSS-UP

- 14) Biology – *Short Answer* What primary meristematic tissue in plants gives rise to the vascular tissue?

ANSWER: PROCAMBIUM

BONUS

- 14) Biology – *Short Answer* Two kinds of receptors, NMDA and AMPA, are involved in long term potentiation, which can increase the strength of a synapse over time. NMDA and AMPA are receptors for what neurotransmitter?

ANSWER: GLUTAMATE (ACCEPT: GLUTAMIC ACID)

TOSS-UP

15) Earth and Space – *Multiple Choice* Which of the following best describes the resonance of the Moon with the Earth? [JI]

- W) 1 to 1
- X) 1 to 2
- Y) 2 to 3
- Z) 5 to 7

ANSWER: W) 1 TO 1

BONUS

15) Earth and Space – *Short Answer* What set of fusion reactions is hypothesized to occur in stars more than 1.3 solar masses to fuse hydrogen into helium? [JI]

ANSWER: CNO CYCLE (ACCEPT: CARBON-NITROGEN-OXYGEN CYCLE,
BETHE-WEIZSACKER CYCLE)



TOSS-UP

16) Math – *Multiple Choice* Which of the following regular polygons does not have an internal angle that is an integer? [SA]

- W) 12-gon
- X) 16-gon
- Y) 20-gon
- Z) 24-gon

ANSWER: X) 16-GON

BONUS

16) Math – *Short Answer* What is the area of a regular hexagon with side length 10? [SA]

ANSWER: $150\sqrt{3}$

TOSS-UP

17) Chemistry – *Short Answer* Find the change in internal energy of an ideal gas in the isothermal expansion from 1 to 5 liters against a constant pressure of 2.5 atmospheres? [JI]

ANSWER: 0

BONUS

17) Chemistry – *Multiple Choice* What is the pH of the solution that is made by combining 750 milliliters of 3 molar hydrochloric acid with 250 milliliters of 5 molar sodium hydroxide? [JI]

- W) 0
- X) 3
- Y) 6
- Z) 7

ANSWER: W) 0

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### **TOSS-UP**

18) Energy – *Short Answer* Scientists at Pacific Northwest National Lab are researching new ways to predict the formation and trajectory of hurricanes. What atmospheric circulation encourages hurricane formation near the equator, where this circulation lifts up air before it falls near 30 degrees latitude? [JI]

ANSWER: HADLEY CELL

### **BONUS**

18) Energy – *Multiple Choice* Researchers at Pacific Northwest National Lab have developed an ion separation technology known as slim, which is particularly effective when combined with mass spectrometry. Assuming that all the samples are not at all radioactive, the mass spectrum of which of the following elements would have only one peak? [JI]

- W) Hydrogen
- X) Helium
- Y) Lithium
- Z) Beryllium

ANSWER: Z) BERYLLIUM

## **TOSS-UP**

19) Physics – *Short Answer* Assuming that up is the positive direction, identify all of the following three statements that are true about a skydiver who just released his parachute: 1) His acceleration is negative; 2) His velocity is negative; 3) His net force is negative. [AT]

ANSWER: 2 ONLY

## **BONUS**

19) Physics – *Short Answer* The skydiver was falling at a terminal velocity of  $-56$  meters per second, and after releasing his parachute, he achieved a steady fall of  $-12$  meters per second in 4 seconds. If the skydiver had a mass of 80 kilograms, how much force did the air resistance from the parachute give the skydiver? [AT]

ANSWER: 1664 NEWTONS



## **TOSS-UP**

20) Biology – *Short Answer* When oxygen binds to one hemoglobin subunit, the shape of the other three subunits also changes, leading to an increase in the affinity of the hemoglobin molecule for oxygen. What is the name of this phenomenon? [CJ]

ANSWER: COOPERATIVITY

## **BONUS**

20) Biology – *Multiple Choice* Protists in which of the following genera are responsible for sleeping sickness? [CJ]

- W) Trichomonas
- X) Trypanosoma
- Y) Plasmodium
- Z) Entamoeba

ANSWER: X) TRYPANOSOMA

## **TOSS-UP**

21) Earth and Space – *Multiple Choice* What type of glacial landform is an elongated hill formed by the action of glacial ice on underlying sediment? [JI]

- W) Drumlin
- X) Esker
- Y) Moraine
- Z) Kame

ANSWER: W) DRUMLIN

## **BONUS**

21) Earth and Space – *Multiple Choice* Which of the following best explains why the distribution of elevations on Earth is bimodal? [JI]

- W) Earth has both mountains and oceanic trenches
- X) Continents vary between higher and lower elevations in different areas
- Y) There are two relative maxima for the average continental and sea floors elevations
- Z) The differing densities of continental and oceanic crust creates two distinct elevations on the curve

ANSWER: Y) THERE ARE TWO RELATIVE MAXIMA FOR THE AVERAGE  
CONTINENTAL AND SEA FLOOR ELEVATIONS

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## **TOSS-UP**

22) Math – *Short Answer* If  $\log_b x = 20$  and  $\log_a x = 10$ , then what is the value of  $\log_b a$ ? [SA]

ANSWER: 1/2

## **BONUS**

22) Math – *Short Answer* Given that the first and third elements of a harmonic sequence are 5 and 9, what is the fourth element in the harmonic sequence? [SA]

ANSWER: 15

## **TOSS-UP**

23) Chemistry – *Multiple Choice* Which of the following graphs for a first order chemical reaction will be linear? [JI]

- W) Concentration versus time
- X) Natural logarithm of concentration versus time
- Y) 1 over concentration versus time
- Z) Square root of concentration versus time

ANSWER: X) NATURAL LOGARITHM OF CONCENTRATION VERSUS TIME

## **BONUS**

23) Chemistry – *Short Answer* For the single displacement reaction between copper metal and silver nitrate, identify whether each of the following three elements is oxidized, reduced, or unchanged: 1) Copper; 2) Silver; 3) Nitrogen. [JI]

ANSWER: 1 - OXIDIZED, 2 - REDUCED, 3 - UNCHANGED (ACCEPT: EQUIVALENTS)