

WISC Round 7

TOSS-UP

1) Physics – *Multiple Choice* Which of the following statements is true about parallel plate capacitors? [SA]

- W) The voltage across a capacitor is inversely proportional to the charge stored in it.
- X) The voltage across a capacitor is directly proportional to the charge stored in it.
- Y) The energy stored in a capacitor is directly proportional to the square of its capacitance.
- Z) The energy stored in a capacitor is inversely proportional to the square of its capacitance.

ANSWER: X) THE VOLTAGE ACROSS A CAPACITOR IS DIRECTLY PROPORTIONAL TO THE CHARGE STORED IN IT

BONUS

1) Physics – *Short Answer* You initially have a parallel plate capacitor with capacitance 20 millifarads. If you decide to replace the vacuum between the plates with an insulator with a dielectric constant of 10 and double the area of plates while halving the distance between them, what is the new capacitance in millifarads? [SA]

ANSWER: 800 MILLIFARADS

TOSS-UP

2) Biology – *Multiple Choice* Which of the following layers of a tree trunk is part of the bark?

- W) Primary xylem
- X) Vascular cambium
- Y) Secondary xylem
- Z) Secondary phloem

ANSWER: Z) SECONDARY PHLOEM

BONUS

2) Biology – *Short Answer* What filament-like structure anchors nonvascular plants to the surfaces they grow on?

ANSWER: RHIZOID

TOSS-UP

3) Earth and Space – *Multiple Choice* A star of which of the following spectral classes is expected to have the strongest Balmer lines in its absorption spectrum? [CJ]

- W) O
- X) A
- Y) G
- Z) M

ANSWER: X) A

BONUS

3) Earth and Space – *Short Answer* Identify all of the following three statements that are true of magnetic effects in sunspots: 1) Sunspot pairs have reversed magnetic polarity in the North and South hemisphere of the Sun; 2) Magnetic field strength in sunspots can be determined from the splitting of spectral lines due to the Zeeman effect; 3) Magnetic field effects cause most new sunspot cycles to start very near to the equator. [JI]

ANSWER: 1 AND 2

TOSS-UP

4) Math – *Multiple Choice* What is the limit of $\cos(x)$ over x as x approaches 0? [AT]

- W) Infinity
- X) Negative infinity
- Y) Zero
- Z) Does not exist

ANSWER: Z) DOES NOT EXIST

BONUS

4) Math – *Short Answer* What is the area bounded by the curves $y = x^2$ and $x = y^2$? [SA]

ANSWER: 1/3

TOSS-UP

5) Chemistry – *Multiple Choice* Given that the change in Gibbs free energy for a reaction is positive, then which of the following statements is INCORRECT? [SA]

- W) The equilibrium constant is greater than one.
- X) If the change in entropy is positive, then the reaction must have taken place at a relatively low temperature.
- Y) The reaction is nonspontaneous.
- Z) If the reaction was exothermic, then the change in entropy must have been negative.

ANSWER: W) THE EQUILIBRIUM CONSTANT IS GREATER THAN ONE.

BONUS

5) Chemistry – *Short Answer* Order the following three chemicals by increasing boiling point:

- 1) Methanol; 2) Dimethyl ether; 3) Methyl formate. [JI]

ANSWER: 2, 3, 1 (DIMETHYL ETHER, METHYL FORMATE, METHANOL)



TOSS-UP

6) Energy – *Short Answer* Scientists at NASA are studying globular clusters in the galaxy NGC 1052-DF4 to understand an absence of dark matter. Identify all of the following three statements which are true regarding globular clusters: 1) Globular clusters contain mostly Population II stars; 2) Globular clusters tend to orbit within the disk of a galaxy; 3) Globular clusters tend to be symmetrical. [SA]

ANSWER: 1 AND 3

BONUS

6) Energy – *Short Answer* Scientists at NASA are studying galaxies that contain low amounts of dark matter. They found evidence that neighboring larger galaxies are stripping away the dark matter from smaller ones. What term describes this phenomenon, which also occurs when supermassive blackholes cause spaghettification in close-by stars? [SA]

ANSWER: TIDAL DISRUPTION (ACCEPT: TIDAL STRIPPING)

TOSS-UP

7) Physics – *Multiple Choice* What type of harmonic oscillator takes the longest to reach equilibrium but never oscillates? [SA]

- W) Undamped
- X) Underdamped
- Y) Critically damped
- Z) Overdamped

ANSWER: Z) OVERDAMPED

BONUS

7) Physics – *Short Answer* The quantum mechanical equivalent of a classical harmonic oscillator is the quantum harmonic oscillator. What term refers to the lowest possible energy that a quantum mechanical system can have? [SA]

ANSWER: ZERO-POINT ENERGY (ACCEPT: ZPE)

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## **TOSS-UP**

8) Biology – *Short Answer* What response occurs in infected plant tissue that results in rapid cell death at and near the site of infection? [CJ]

ANSWER: HYPERSENSITIVE RESPONSE

## **BONUS**

8) Biology – *Multiple Choice* Which of the following physiological changes will NOT cause an increase in the blood flow across a blood vessel, assuming all other variables are kept constant?

- W) Decreasing blood hematocrit
- X) Decreasing the length of the vessel
- Y) Decreasing the radius of the vessel
- Z) Increasing the pressure gradient across the vessel

ANSWER: Y) DECREASING THE RADIUS OF THE VESSEL

## **TOSS-UP**

9) Earth and Space – *Multiple Choice* What is the term for the area of higher elevation that was not covered by a lava flow after a volcanic eruption, even if surrounding areas were? [JI]

- W) Kipuka
- X) Caldera
- Y) Fumarole
- Z) Eruption plateau

ANSWER: W) KIPUKA

## **BONUS**

9) Earth and Space – *Short Answer* A perthite is formed from the intergrowth of two types of what mineral? [JI]

ANSWER: FELDSPAR



## **TOSS-UP**

10) Math – *Short Answer* How many edges does a tetrahedron have? [SA]

ANSWER: 6

## **BONUS**

10) Math – *Multiple Choice* A quadratic polynomial of the form  $x^2 + ax + b$  has roots m and n. Given that  $m^2 + n^2 = a - b$  and that a is a Mersenne prime, what is the minimum value of b? [SA]

- W) 6
- X) 8
- Y) 10
- Z) 12

ANSWER: W) 6

## **TOSS-UP**

11) Chemistry – *Short Answer* By what process are alkenes able to react with themselves to create chained compounds such as polyethylene? [JI]

ANSWER: POLYMERIZATION (ACCEPT: ADDITION POLYMERIZATION, RADICAL POLYMERIZATION)

## **BONUS**

11) Chemistry – *Multiple Choice* Which of the following is nearest to the edge length, in picometers, of a unit cell of a substance with a face-centered cubic structure if the radius of each of the atoms is 280 picometers? [JI]

- W) 280.w
- X) 560
- Y) 650
- Z) 800

ANSWER: Z) 800

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## **TOSS-UP**

12) Energy – *Short Answer* Scientists at the Technical University of Munich are researching materials for information storage. What type of magnetic materials are they studying, in which the atoms, which behave as tiny magnets, are aligned in an antiparallel arrangement? [SA]

ANSWER: ANTIFERROMAGNETS

## **BONUS**

12) Energy – *Short Answer* The scientists at the Technical Institute of Munich are specifically interested in quantized excitations of electron spin in the antiferromagnetic materials. What term refers to these excitations which are treated as quantized spin waves in quantum mechanics? [SA]

ANSWER: MAGNONS

## **TOSS-UP**

13) Physics – *Short Answer* Identify all of the following three statements which are true about Compton scattering: 1) It is inelastic; 2) The wavelength shift decreases as the scattering angle increases; 3) The scattering is usually caused by a charged particle. [SA]

ANSWER: 1 AND 3

## **BONUS**

13) Physics – *Multiple Choice* Which of the following statements is incorrect about light? [SA]

W) In Young's double slit experiment, increasing the distance between slits would decrease the distance between light and dark spots on the screen.

X) The critical angle for diamond is lower than that of water.

Y) Brewster's law states that a light ray becomes perfectly polarized when a 90 degree angle is formed between the reflected and refracted rays

Z) Fraunhofer diffraction occurs when light from a point source meets an obstacle, forming a fringed image

ANSWER: Z) FRAUNHOFER DIFFRACTION IS PRODUCED WHEN LIGHT FROM A POINT SOURCE MEETS AN OBSTACLE, FORMING A FRINGED IMAGE

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## **TOSS-UP**

14) Biology – *Short Answer* What mineral, which is formed when calcium, phosphate, and hydroxyl ions are deposited on a collagen matrix, forms the hard part of bone?

ANSWER: HYDROXYAPATITE

## **BONUS**

14) Biology – *Multiple Choice* The membrane attack complex, a protein complex that creates pores in the cell membrane, leading to cell lysis, is caused by which of the following?

W) The secretion of perforin by cytotoxic T cells when bound to an infected cell

X) The binding of complement proteins to an antigen-antibody complex on a foreign cell

Y) The recognition of foreign cells by plasma cell antibodies

Z) The phagocytosis of an opsonized pathogen by a macrophage

ANSWER: X) THE BINDING OF COMPLEMENT PROTEINS TO AN ANTIGEN-ANTIBODY COMPLEX ON A FOREIGN CELL

## **TOSS-UP**

15) Earth and Space – *Short Answer* What type of metamorphism occurs when rocks adjacent to an igneous intrusion are altered by the extreme heat of the magma? [JI]

ANSWER: CONTACT METAMORPHISM

## **BONUS**

15) Earth and Space – *Multiple Choice* Which of the following statements derived from Kepler's Laws is NOT true? [JI]

- W) One of the foci of a planet's orbit is in the Sun
- X) A planet's orbit always sweeps the same area in the same amount of time
- Y) Planet's orbit in ellipses around the sun
- Z) The cube of a planet's orbital period is proportional to the square of the semi-major axis

ANSWER: Z) THE CUBE OF A PLANET'S ORBITAL PERIOD IS PROPORTIONAL TO THE SQUARE OF THE SEMI-MAJOR AXIS

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## **TOSS-UP**

16) Math – *Short Answer* What is the slope of the tangent line to the curve  $y = 2^x$  at  $y = 4$ ? [SA]

ANSWER: 4LN(2) (ACCEPT: 4 NATURAL LOG OF 2)

## **BONUS**

16) Math – *Multiple Choice* There are an infinite number of boxes labeled 1, 2, 3, and so on. There are two balls that are each independently placed in the boxes. Let k be the label of a box. The probability that you will place a ball in a given box is equal to 2 raised to the power of negative k. What is the probability that the two balls are placed in different boxes? [SA]

- W) 1/6
- X) 1/3
- Y) 1/2
- Z) 2/3

ANSWER: Z) 2/3

## **TOSS-UP**

17) Chemistry – *Short Answer* Order the following three 0.1 molar solutions from lowest to highest pH: 1) Calcium cyanide; 2) Barium iodide; 3) Aluminum chloride. [JI]

ANSWER: 3, 2, 1 (ALUMINUM CHLORIDE, BARIUM IODIDE, CALCIUM CYANIDE)

## **BONUS**

17) Chemistry – *Short Answer* What term is used to describe the difference in energy between the staggered and eclipsed conformations of a molecule? [JI]

ANSWER: TORSIONAL STRAIN



## **TOSS-UP**

18) Energy – *Short Answer* Scientists at UW Madison recently solved a 50 year old mystery about the orbit of other galaxies around the Milky Way. This mystery involved what two irregular dwarf galaxies, labeled Small and Large, that orbit around the Milky Way? [JI]

ANSWER: MAGELLANIC CLOUDS (ACCEPT: SMALL AND LARGE MAGELLANIC CLOUDS, SMC AND LMC, NUBECULA MINOR/MAJOR)

## **BONUS**

18) Energy – *Multiple Choice* Argonne National Lab scientists are researching ways to streamline the production of lithium from brine. Though most lithium production comes from brine, what other lithium containing mineral contributes a significant portion of the production? [JI]

- W) Ilmenite
- X) Spodumene
- Y) Cassiterite
- Z) Scheelite

ANSWER: X) SPODUMENE

## **TOSS-UP**

19) Physics – *Short Answer* There are three tuning forks. The first one is tuned at a frequency of 250 Hertz, and second one is tuned at a frequency of 242 Hertz. When the first and third forks are beat, you hear a beat frequency of 15 Hertz. When the second and third forks are beat, you hear a beat frequency of 7 Hertz. What is the frequency of the third fork? [SA]

ANSWER: 235 HERTZ

## **BONUS**

19) Physics – *Short Answer* A 10 meter long string produces a standing wave with a fundamental frequency of 20 Hertz. What is the tension in the string given its mass is 20 kilograms? [SA]

ANSWER: 320,000 NEWTONS



## **TOSS-UP**

20) Biology – *Multiple Choice* Water and ions may enter the root of a plant without having to cross the cell membrane of root cells until they reach the endodermis through which of the following routes? [CJ]

- W) Apoplastic
- X) Symplastic
- Y) Transmembrane
- Z) Casparyan

ANSWER: W) APOPLASTIC

## **BONUS**

20) Biology – *Short Answer* What molecular biology technique stimulates a cell to take up a nucleic acid molecule by using electrical pulses to create transient pores in the phospholipid bilayer?

ANSWER: ELECTROPORATION

## **TOSS-UP**

21) Earth and Space – *Multiple Choice* Which of the following may not be used as a standard candle to estimate distances in the universe? [JI]

- W) RR Lyrae variables
- X) T Tauri Stars
- Y) Type Ia (“one a”) supernova
- Z) Cepheid variables

ANSWER: X) T TAURI STARS

## **BONUS**

21) Earth and Space – *Short Answer* Identify all of the following three statements which match the type of unconformity with an appropriate description. 1) Angular unconformity - the layers of the unconformity lie at different orientations; 2) Nonconformity - newer igneous rocks have been deposited on top of old sedimentary rocks; 3) Disconformity - the layers have been flipped so the oldest stones are closer to the surface and the younger are below. [JI]

ANSWER: 1 ONLY

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TOSS-UP

22) Math – *Multiple Choice* 5 fair coins are tossed simultaneously. What is the probability that at least two of them land on heads? [SA]

- W) 11/16
- X) 3/4
- Y) 13/16
- Z) 7/8

ANSWER: Y) 13/16

BONUS

22) Math – *Short Answer* 10 people are sitting in a particular arrangement around a circular table. Three people are to be selected. Find the number of ways to select these three people given that no two are sitting adjacent to each other. [SA]

ANSWER: 50

TOSS-UP

23) Chemistry – *Multiple Choice* According to collision theory, a chemical reaction is literally a collision of molecules. In order to predict the rate constant for a reaction, all of the following must be known except: [JI]

- W) Energy requirement
- X) Collision frequency
- Y) Steric factor
- Z) Equilibrium constant

ANSWER: Z) EQUILIBRIUM CONSTANT

BONUS

23) Chemistry – *Multiple Choice* Which of the following statements is NOT true of deviations from Raoult's law? [JI]

- W) Negative azeotropes cause negative deviations, and positive azeotropes cause positive deviations
- X) Negative enthalpy of mixing causes positive deviations, and positive enthalpy of mixing causes negative deviations
- Y) A mixture of two very similar compounds will have very little deviation in either direction
- Z) Deviations can often be predicted from the relative strength of intermolecular forces in mixtures and their pure components

ANSWER: X) NEGATIVE ENTHALPY OF MIXING CAUSES POSITIVE DEVIATIONS, AND POSITIVE ENTHALPY OF MIXING CAUSE NEGATIVE DEVIATIONS.