ROUND 17

TOSS-UP

1) Physics – *Short Answer* What quantity, relevant to the calculation of Reynold's Number, has units of pascal seconds and is defined as the ratio of viscosity of a fluid to the density of the fluid.

ANSWER: DYNAMIC VISCOSITY

BONUS

1) Physics – *Multiple Choice* A pipe of radius 10.0 meters has a flow rate of 2.0 meters per second. The dynamic viscosity of the water is 2.0×10^{-4} pascal seconds. What is Reynold's number in scientific notation of the flow, given that the density of water is 1000 kilograms per meter cubed.

W) $5.0 * 10^2$
X) $2.0 * 10^4$
Y) $5.0 * 10^6$
Z) $2.0 * 10^8$

ANSWER: Z) $2.0 * 10^8$

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TOSS-UP

2) Energy – *Short Answer* Researchers are using an isotope of fluorine to track the movement of sugars in a corn plant. They used a PET to image the flow of sugars in the corn plant. What type of subatomic particle does this imaging technique detect, allowing it to map the movement of radioisotopes?

ANSWER: POSITRON

BONUS

2) Energy – *Multiple Choice* What isotope of fluorine was most likely used in this experiment?

W) Fluorine-18
X) Fluorine-19
Y) Fluorine-20
Z) Fluorine-21
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ANSWER: FLUORINE-18

ROUND 17

TOSS-UP

3) Chemistry – *Multiple Choice* Which is not a factor that stabilizes carbocations?

W) Increasing the number of adjacent carbon atoms
X) Increasing the number of adjacent pi bonds
Y) Increasing the number of adjacent atoms with lone pairs of electrons
Z) Increased s character of the hybrid orbitals

ANSWER: Z) INCREASED S CHARACTER OF THE HYBRID ORBITALS

BONUS

3) Chemistry – *Short Answer* Order the following by number from best to worst leaving group:
1) Fluoride; 2) Bromide; 3) Iodide; 4) Nitrate

ANSWER: 3, 2, 4, 1

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TOSS-UP

4) Biology - *Multiple Choice* Which of the following is the closest to the number of sudoriferous glands in the body?

W) 30,000
X) 300,000
Y) 3,000,000
Z) 30,000,000

ANSWER: Y) 3,000,000

BONUS

4) Biology - *Short Answer* Which skin cancer is characterized by a pearly edge and a dome shaped nodule?

ANSWER: BASAL CELL CARCINOMA
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ROUND 17

TOSS-UP

5) Math – *Short Answer* 49. What is the area under the curve $y = e^x + 2x^2 + 4x + 2$ and over the x-axis on the interval x is between -4 and 2.

ANSWER: $36 + e^2 - 1/e^4$

BONUS

5) Math – *Short Answer* What is a point on the surface of the graph of a function where the slopes in orthogonal directions are all zero, but which is not a local extremum of the function?

ANSWER: SADDLE POINT

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TOSS-UP

6) Earth and Space - *Short Answer* Caused by mechanical weathering, what features are created when slabs of an exposed mass of igneous rock start to peel away, leaving behind a rounded hill-like landform?

ANSWER: EXFOLIATION DOMES

BONUS

6) Earth and Space - *Multiple Choice* Not all rocks erode and weather at the same rate. This phenomenon is known as differential weathering and is responsible for many of the unique rock formations found on Earth. Which of the following is NOT a landform created by differential weathering?

W) butte
X) hoodoo
Y) escarpment
Z) inselberg

ANSWER: Y) ESCARPMENT
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ROUND 17

TOSS-UP

7) Energy – *Multiple Choice* Scientists at Pacific Northwest National Laboratory have utilized the cyanobacterium *Cyanothece* for energy production. What has this cyanobacterium been shown to be the first to do, that makes it so useful for energy production?

W) It can grow at rates unparalleled to any other cyanobacterium.
X) It can release methane while performing photosynthesis.
Y) It can release natural gas while performing photosynthesis.
Z) It can produce oxygen and hydrogen simultaneously.

ANSWER: Z) IT CAN PRODUCE OXYGEN AND HYDROGEN SIMULTANEOUSLY

BONUS

7) Energy – *Short Answer* What is the main challenge with using cyanobacterium to commercially produce hydrogen?

ANSWER: PRODUCTION OF OXYGEN HINDERS PRODUCTION OF HYDROGEN

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TOSS-UP

8) Biology - *Short Answer* What is the only bone that does not articulate with any other bone?

ANSWER: HYOID BONE

BONUS

8) Biology - *Multiple Choice* Which fontanelle closes around 2 months after birth?

W) Anterior
X) Mastoid
Y) Posterior
Z) Sphenoidal

ANSWER: W) POSTERIOR
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ROUND 17

TOSS-UP

9) Physics – *Short Answer* An increase in the magnitude of rotational motion in some stars is known as what?

ANSWER: GLITCH

BONUS

9) Physics – *Short Answer* Jocelyn Bell and Antony Hewish discovered what type of star that undergoes rotational motion at a rapid rate, causing them to emit beams of EM radiation in a periodic fashion?

ANSWER: PULSAR

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TOSS-UP

10) Chemistry – *Short Answer* What is the term for a molecule that contains an equal number of positive-charged and negatively-charged functional groups?

ANSWER: ZWITTERION

BONUS

10) Chemistry – *Short Answer* What is the specific name for a zwitterion that cannot isomerize to an all-neutral form?

ANSWER: BETAINE

TOSS-UP

11) Math – *Short Answer* How many prime factors does $8^6 - 1$ have?

ANSWER: 4

BONUS

11) Math – *Short Answer* What is the product of all positive integral divisors of $12^6 - 3^6$? Express your answer as a prime factorization.
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ROUND 17

ANSWER: $3^{288} * 5^{36} * 7^{36} * 13^{36}$

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TOSS-UP

12) Earth and Space - *Multiple Choice* By how much does the apparent magnitude of a star change if the distance from the observer to the star is multiplied by 5?

W) log(5)
X) log(2)
Y) 5log(5)
Z) -5log(2)

ANSWER: Y) 5log(5)

BONUS

12) Earth and Space - *Multiple Choice* One way to estimate distances between celestial objects is to use redshift to find recessional velocity, which can then be used in Hubble's law to find distance. Which of the following best describes one of the reasons why the distance solved using this method could be inaccurate when applied to objects very far away?

W) gravitational lensing causes the redshift to drastically increase
X) celestial objects farther away tend to have a higher recessional velocity
Y) extinction of radiation with long wavelengths causes the objects to appear redder
Z) extinction of radiation with short wavelengths causes the objects to appear redder

ANSWER: Z) EXTINCTION OF RADIATION WITH SHORT WAVELENGTHS CAUSES THE OBJECTS TO APPEAR REDDER
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ROUND 17

TOSS-UP

13) Biology - *Short Answer* What level of nucleic acid structure is characterized by glycosidic bonds?

ANSWER: PRIMARY

BONUS

13) Biology - *Short Answer* By name or number identify all of the following four structures that are characteristic of secondary nucleic acid structure in DNA: 1) double helix, 2) stem loop, 3) pseudoknot, 4) bulges.

ANSWER: 1 ONLY

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TOSS-UP

14) Energy – *Short Answer* Scientists at Oak Ridge National Laboratory are studying the effects of rates of reaction in microbes on the concentration of methylmercury. One of the steps in their experiment was using a multi-site kinetic sorption model to conduct research into the kinetics of microbial reactions. What sorption model assumes that an absorbate behaves ideally at isothermal conditions explains absorption through this assumption?

ANSWER: LANGMUIR ADSORPTION MODEL (ACCEPT: LANGMUIR)

BONUS

14) Energy – *Short Answer* One of the questions researchers attempted to answer in this experiment was how the rate of reaction behaves in comparison to the concentration of reaction. Classify each of the following reactions as zero order, first order, or second order: 1) Radioactive decay of Carbon-14, 2) The reverse of the Haber Process, 3) Decomposition of nitrosyl bromide.

ANSWER: 1) FIRST ORDER, 2) ZERO ORDER, 3) SECOND ORDER
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ROUND 17

TOSS-UP

15) Physics – *Multiple Choice* The principal axes of rotation are the unit eigenvectors of what construct?

W) Angular Momentum
X) Moment of Inertia
Y) Angular Velocity
Z) Torque

ANSWER: X) MOMENT OF INERTIA

BONUS

15) Physics – *Short Answer* What type of radiation, sometimes referred to as magnetobremsstrahlung radiation is emitted when charged particles experience a force perpendicular to their direction of velocity?

ANSWER: SYNCHROTRON RADIATION (ACCEPT: SYNCHROTRON)

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TOSS-UP

16) Earth and Space - *Multiple Choice* The conditions our solar system existed in early in its evolution can be best understood by using which of the following methods?

W) studying geologic features of the Earth
X) studying seismic activity in the Sun
Y) analyzing the composition of chondrites
Z) analyzing the volcanic activity of Io

ANSWER: Y) ANALYZING THE COMPOSITION OF CHONDRITES

BONUS

16) Earth and Space - *Multiple Choice* Asteroids that share similar orbital properties are often put together into families. First identified by Kiyotsugu Hirayama, which of the following is the most commonly accepted theory regarding the formation of asteroid families?

W) asteroid families are formed from the remnants of collisions that happened between asteroids
X) asteroid families are created by the unique gravitational fields found between Jupiter and Mars
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Y) asteroid families are formed by the accretion of interstellar dust
Z) asteroid families are formed from the remnants of tails of comets

ANSWER: W) ASTEROID FAMILIES ARE FORMED FROM THE REMNANTS OF COLLISIONS THAT HAPPENED BETWEEN ASTEROIDS

ROUND 17

TOSS-UP

17) Chemistry – *Short Answer* What is the term for an escape of a gas from an aqueous solution?

ANSWER: EFFERVESCENCE

BONUS

17) Chemistry – *Multiple Choice* Which of the following protons will appear farthest downfield in the ^{1}H [Proton]-NMR spectrum?

W) Alkyne
X) Aromatic
Y) Carboxylic acid
Z) Aldehyde

ANSWER: Y) CARBOXYLIC ACID

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TOSS-UP

18) Math – *Multiple Choice* Which of the following is not a classification of numbers based on their relationship to the sum of their proper divisors?

W) Perfect
X) Sufficient
Y) Abundant
Z) Deficient

ANSWER: X) SUFFICIENT

BONUS

18) Math – *Short Answer* What is the sum of the proper divisors of a number called?

ANSWER: ALIQUOT SUM
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ROUND 17

TOSS-UP

19) Chemistry – *Multiple Choice* Which type of strain results from atoms being forced closer than their Van der Waals radii allow?

W) Torsional
X) Steric
Y) Angular
Z) Ring

ANSWER: STERIC

BONUS

19) Chemistry – *Short Answer* Which of the chair conformations of methylcyclohexane is the most stable?

ANSWER: EQUATORIAL

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TOSS-UP

20) Physics – *Short Answer* In the relativistic dispersion equation, identify all of the following 3 statements that are true about the energy of a particle using the ultrarelativistic limit: 1) Energy is directly proportional to the speed of light, 2) Energy is directly proportional to momentum, 3) Energy is directly proportional to rest mass

ANSWER: 1 AND 2

BONUS

20) Physics – *Multiple Choice* Photons are a discrete unit of what form of wave?

W) Sound Waves
X) Seismic Waves
Y) String Waves
Z) Dirac Waves

ANSWER: W) SOUND WAVES
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ROUND 17

TOSS-UP

21) Earth and Space - *Multiple Choice* Which of the following best describes Pacific Decadal Oscillation?

W) a periodic fluctuation of climate in the Pacific Ocean with phases that can last decades
X) a periodic fluctuation of climate in the Pacific Ocean with ten phases, each lasting between 11 and 12 months
Y) a periodic fluctuation in sea level of the Pacific Ocean with phases that can last decades
Z) a periodic fluctuation in sea level of the Pacific Ocean with ten phases, each lasting between 10 and 11 months

ANSWER: W) A PERIODIC FLUCTUATION OF CLIMATE IN THE PACIFIC OCEAN WITH PHASES THAT CAN LAST DECADES

BONUS

21) Earth and Space - *Multiple Choice* Which of the following best describes the movement of fish living in cold and warm waters in the Northern Hemisphere during El Nino?

W) cold water fish move northwards and warm water fish move southwards
X) cold water fish move northwards and warm water fish move northwards
Y) cold water fish move southwards and warm water fish move northwards
Z) cold water fish move southwards and warm water fish move southwards

ANSWER: X) COLD WATER FISH MOVE NORTHWARDS AND WARM WATER FISH MOVE NORTHWARDS

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TOSS-UP

22) Biology - *Short Answer* What is the name of the specific protein found in eukaryotic cell membranes that maintains its stability by forming hexagonal or pentagonal shapes?

ANSWER: SPECTRIN

BONUS

22) Biology - *Short Answer* By name or number, identify all of the following 4 proteins that are part of the cytoskeleton: 1) Troponin, 2) Dynein, 3) G-protein, 4) Spectrin

ANSWER: 1, 2, 4 (ACCEPT ALL BUT 3)
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ROUND 17

TOSS-UP

23) Math – *Short Answer* 51. Find the value of x in the equation $\sqrt{1 + sin(x)} = sin(\frac{\pi}{6}) + cos(\frac{\pi}{6})$ given that $0 < x < \frac{\pi}{2}$

W) π/12
X) π/6
Y) π/3
Z) 2π/3

ANSWER: Y) $\frac{\pi}{3}$

BONUS

23) Math – *Short Answer* Find the value of x in the equation $arctan(2) + arctan(\frac{1}{4}) - arctan(x) = \frac{\pi}{4}$ given that 0 < x < 1.

ANSWER: $\frac{7}{11}$