CCWT Middleton Round

TOSS-UP

1) Physics – *Short Answer* According to Noether's theorem, a system with time-symmetry will conserve what quantity?

ANSWER: ENERGY

BONUS

1) Physics – *Short Answer* Identify all of the following three particles that are baryons. 1) Proton; 2) Pion; 3) Sigma.

ANSWER: 1 AND 3

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TOSS-UP

2) Chemistry – *Multiple Choice* Which of the following functional groups is most likely to form from the acid-catalyzed hydration of an alkene?

W) Primary Alcohol
X) Secondary Alcohol
Y) Tertiary Alcohol
Z) Aldehyde

ANSWER: Y) TERTIARY ALCOHOL

BONUS

2) Chemistry – *Short Answer* The gaseous reaction $CH_4 + H_2O$ yields CO_2+H_2 has a K_p of 36. If the reaction takes place in a vessel at 300 Kelvin, what is the value of K_c for this reaction?

ANSWER: 36
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TOSS-UP

3) Energy – *Short Answer* Scientists at Middleton High School labs are studying the force between protons and neutrons in the nucleus. In particular, they are studying the residual strong force, which is mediated by what hadron?

ANSWER: PION (ACCEPT: YUKAWA PION)

BONUS

3) Energy – *Short Answer* Scientists at Middleton labs are studying different crystal structures. One particular structure they are studying is Perovskite. Identify all of the following three minerals that are found in all perovskites. 1) Calcium; 2) Barium; 3) Titanium.

ANSWER: 1 AND 3

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TOSS-UP

4) Earth and Space – *Short Answer* If a star has a parallax of 0.2, to the nearest light-year, how far is the star from earth?

ANSWER: 16

BONUS

4) Earth and Space – *Multiple Choice* Which of the following best describes how lobate scarps on Mercury were formed?

W) Cooling
X) Tectonic activity
Y) Magnetic reversals
Z) Upwelling

ANSWER: W) COOLING
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TOSS-UP

5) Math – *Multiple Choice* Which of the following functions is neither odd nor even?

W) $y= \sin(x)+x$
X) $y= \cos(x)+x$
Y) $y= \tan(x)+x$
Z) $y= \sec(x)+x^2$

ANSWER: X) Y=COS(X)+X

BONUS

5) Math – *Short Answer* How many ways are there to seat 7 people in a row such that switching two people would result in alphabetical order?

ANSWER: 21

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TOSS-UP

6) Chemistry – *Multiple Choice* Which of the following is closest to the pK_a of acetylene?

W) 15
X) 20
Y) 25
Z) 30

ANSWER: Y) 25

BONUS

6) Chemistry – *Short Answer* What is the name given to the potential difference between a half-reaction's thermodynamically determined reduction potential and the experimentally observed reduction potential?

ANSWER: OVERPOTENTIAL
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TOSS-UP

7) Physics – *Short Answer* A 10-kilogram ball is thrown vertically from the ground, into the air at 10 meters per second. To the nearest Joule, how much potential energy does the ball have at its highest point?

ANSWER: 490

BONUS

7) Physics – *Multiple Choice* Which of the following best describes why Maxwell added the displacement current term to Ampere's law?

W) Changing magnetic fields induce electric fields
X) Changing electric fields induce magnetic fields
Y) Ampere's law is inaccurate when magnetic fields are too strong
Z) Ampere's law fails at relativistic velocities

ANSWER: X) CHANGING ELECTRIC FIELDS INDUCE MAGNETIC FIELDS

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TOSS-UP

8) Biology – *Multiple Choice* In invertebrates, what neurotransmitter is present at the neuromuscular junction?

W) Glycine
X) Acetylcholine
Y) GABA
Z) Glutamate

ANSWER: Z) GLUTAMATE

BONUS

8) Biology – *Short Answer* Order the following three elements in increasing proximity to the 5' end of mRNA. 1) Poly-A tail; 2) 5' UTR; 3) TATA box.

ANSWER: 1, 2, 3
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TOSS-UP

9) Earth and Space – *Multiple Choice* Which of the following planets has the highest albedo?

W) Mercury
X) Venus
Y) Jupiter
Z) Neptune

ANSWER: X) VENUS

BONUS

9) Earth and Space – *Multiple Choice* Which of the following stages of stellar evolution is chronologically last?

W) Horizontal Branch
X) Henyey Track
Y) Asymptotic Giant Branch
Z) Red Giant Branch

ANSWER: Y) ASYMPTOTIC GIANT BRANCH

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TOSS-UP

10) Math – *Multiple Choice* Which of the following numbers has the greatest sum of its distinct prime factors?

W) 74
X) 75
Y) 76
Z) 77

ANSWER: W) 74

BONUS

10) Math – *Short Answer* A triangle is circumscribed around a square of side length 2. If the triangle is acute, what is the maximum integer area of the triangle?

ANSWER: 8

TOSS-UP
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11) Physics – *Short Answer* According to the Born interpretation, the probability density function is proportional to what power of the wavefunction?

ANSWER: 2

BONUS

11) Physics – *Multiple Choice* An ideal gas is compressed adiabatically from a volume of 5 liters to a volume of 3 liters. Which of the following best describes the signs of delta T and delta S, for this system, respectively?

W) Positive and Negative
X) Positive and Zero
Y) Zero and Negative
Z) Zero and Positive

ANSWER: X) POSITIVE AND ZERO

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TOSS-UP

12) Energy – *Multiple Choice* Scientists at Owen National Labs are studying the Gram Stain in order to classify the bacteria that infect Owen. Which of the following counterstains do they most likely use in this technique?

W) Safranin
X) Fuchsine
Y) Eosin
Z) Haematoxylin

ANSWER: W) SAFRANIN

BONUS

12) Energy – *Short Answer* Scientists at Nihar National Labs are studying Nihar's famous muscles. In order to activate smooth muscle contraction, the myosin light chain must be phosphorylated by a kinase, which is activated by what messenger protein?

ANSWER: CALMODULIN

TOSS-UP

13) Biology – *Multiple Choice* Which of the following types of cells releases HCl and intrinsic factor in the stomach?
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W) Chief Cells
X) Parietal Cells
Y) Goblet Cells
Z) S Cells

ANSWER: X) PARIETAL CELLS

BONUS

13) Biology – *Multiple Choice* Which of the following proteins would most likely not be found in or connected to the extracellular matrix in an animal?

W) Proteoglycans
X) Spectrin
Y) Fibronectin
Z) Collagen

ANSWER: X) SPECTRIN

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TOSS-UP

14) Earth and Space – *Multiple Choice* The clouds on Jupiter are most commonly composed of which of the following compounds?

W) Methane
X) Ethylene
Y) Ammonia
Z) Sulfur dioxide

ANSWER: Y) AMMONIA

BONUS

14) Earth and Space – *Short Answer* What are the names of the resonances that lead to spiral density waves in galaxies?

ANSWER: LINDBLAD RESONANCE

TOSS-UP
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15) Math – *Short Answer* How many quadrilaterals have three sides of lengths 3, 4, and 5?

ANSWER: 11

BONUS

15) Math – *Short Answer* What is the indefinite integral of csc(x), dx?

ANSWER: -LN|CSC(X)+COT(X)|+C

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TOSS-UP

16) Chemistry – *Multiple Choice* Which of the following best describes the nitro group towards electrophilic aromatic substitution?

W) Electron withdrawing, activating
X) Electron withdrawing, deactivating
Y) Electron donating, activating
Z) Electron donating, deactivating

ANSWER: X) ELECTRON WITHDRAWING, DEACTIVATING

BONUS

16) Chemistry – *Short Answer* Identify all of the following three nucleon numbers that are magic. 1) 8; 2) 12; 3) 16

ANSWER: 1 ONLY

TOSS-UP

17) Energy – *Short Answer* Scientists at Harry National Labs are studying the quantum harmonic oscillator's role to predict the behavior of molecular vibrations. The zero-point energy of a quantum harmonic oscillator is equal to Planck's constant times the angular frequency, divided by what quantity?

ANSWER: 4PI

BONUS
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17) Energy – *Multiple Choice* Scientists at the Jin household are studying the Cosmic Microwave Background and its relation to the Sunyaev-Zeldovich effect. The inverse of which of the following types of processes occur in the Sunyaev-Zeldovich effect?

W) Rayleigh Scattering
X) Schaeffer-Bergmann diffraction
Y) Kelvin-Helmholtz Cooling
Z) Compton Scattering

ANSWER: Z) COMPTON SCATTERING

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TOSS-UP

18) Biology – *Short Answer* What is the coefficient of relatedness between two first cousins?

ANSWER: 0.125

BONUS

8) Biology *Multiple Choice* Which of the following groups would not be considered an opisthokont?

W) Nucleariid
X) Animal
Y) Fungi
Z) Chlorophyte

ANSWER: Z) CHLOROPHYTE

TOSS-UP

9) Earth and Space *Short Answer* What is the name of the flat zone that forms when a downgoing oceanic plate interacts with a continental plate and is often associated with earthquakes?

ANSWER: WADATI-BENIOFF ZONE

BONUS

19) Earth and Space – *Multiple Choice* Which of the following satellites is incorrectly matched with its corresponding range of electromagnetic radiation?
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W) Spitzer and Radio
X) Chandra and X-ray
Y) Fermi and Gamma
Z) Very Large Array and Radio

ANSWER: W) SPITZER AND RADIO

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TOSS-UP

20) Math – *Multiple Choice* Which of the following is equal to the inverse of 4, modulo 5?

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

ANSWER: Z) 4

BONUS

20) Math – *Short Answer* A staircase has 8 steps. A frog can either leap 1, 2, or 3 steps forward at a time. How many ways are there for the frog to climb the staircase?

ANSWER: 81
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TOSS-UP

21) Physics – *Multiple Choice* Which of the following particles has at least one strange quark?

W) Pion
X) Axion
Y) Hyperon
Z) Lambda

ANSWER: Y) HYPERON

BONUS

21) Physics – *Short Answer* The electric potential is given everywhere by the equation $V(x,y,z) = x^2y^2z^3$. What is the magnitude of the electric field at the point (1, 1, 1)?

ANSWER: SQRT(17)

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TOSS-UP

22) Chemistry – *Multiple Choice* By name or number, rank the following three carboxylic acid derivatives in increasing reactivity. 1) Acid Anhydride; 2) Acid Chloride; 3) Ester.

ANSWER: 3, 1, 2

BONUS

22) Chemistry – *Short Answer* What postulate in organic chemistry states that transition states resemble the products or reactants, depending on the differences in energy?

ANSWER: HAMMOND'S POSTULATE
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TOSS-UP

23) Biology – *Short Answer* Plastocyanin is a carrier protein which contains what metal at its center?

ANSWER: COPPER

BONUS

23) Biology – *Short Answer* The pentose phosphate pathway occurs in what cell organelle?

ANSWER: CYTOPLASM (ACCEPT: CYTOSOL)