CENTENNIAL AUTUMN SCIENCE TOURNAMENT - ROUND 1

TOSS-UP

1) Biology – *Multiple Choice* Which of the following is not a part of the endomembrane system?

W) Vacuole
X) Lysosome
Y) Rough endoplasmic reticulum
Z) Peroxisome

ANSWER: Z) PEROXISOME

BONUS

1) Biology – *Short Answer* What kind of microtubule arrangement characterizes mature basal bodies?

ANSWER: 9 PLUS 0

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TOSS-UP

2) Physics – *Multiple Choice* A car has velocity 5 m/s. A truck is driving in the same direction as the car at 10 m/s. To the car driver, who perceives herself as stationary, how fast, in meters per second is the truck moving?

W) 5
X) 10
Y) 15
Z) Cannot be determined

ANSWER: W) 5

BONUS

2) Physics – *Short Answer* A car drives north at 6 m/s, and a truck drives west at 8 m/s. After how many seconds will they be 50 meters apart?

ANSWER: 5
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TOSS-UP

3) Chemistry – *Short Answer* What element on the Periodic Table has the highest first ionization energy?

ANSWER: HELIUM (ACCEPT: He)

BONUS

3) Chemistry – *Multiple Choice* Which of the following elements has the highest electron affinity?

W) Oxygen
X) Fluorine
Y) Sulfur
Z) Chlorine

ANSWER: Z) CHLORINE

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TOSS-UP

4) Math – *Short Answer* Charlie sells pizzas in groups of 5 and 9. What is the maximum number of pizzas he cannot sell?

ANSWER: 31

BONUS

4) Math – *Multiple Choice* Let $n = 3x + 7y$, where x and y are integers. Which of the following can n not be?

W) 13
X) 131
Y) 1331
Z) None of the above

ANSWER: Z) NONE OF THE ABOVE
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TOSS-UP

5) Earth and Space – *Multiple Choice* At which of the following locations on an HR diagram would you expect to see a blue giant?

W) Top-left
X) Top-right
Y) Bottom-left
Z) Bottom-right

ANSWER: W) TOP-LEFT

BONUS

5) Earth and Space – *Short Answer* RR Lyrae stars can be found on what part of the HR diagram?

ANSWER: INSTABILITY STRIP

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TOSS-UP

6) Energy – *Multiple Choice* Researchers at Ames National Laboratory are studying methods to separate rare-earth metals. Which of the following is not a rare Earth metal?

W) Lanthanum
X) Actinium
Y) Neodymium
Z) Cadmium

ANSWER: Z) CADMIUM

BONUS

6) Energy – *Short Answer* Researchers at Pacific Northwest National Laboratories are studying the effects of greenhouse gases in the atmosphere. Rank the following three gases in terms of increasing root mean squared speed, given that they are all at the same temperature: 1) Hydrogen Chloride 2) Krypton 3) Argon

ANSWER: 2, 3, 1
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TOSS-UP

7) Physics – *Multiple Choice* Which of the following is not a base SI unit of measure?

W) Meters
X) Seconds
Y) Kilograms
Z) Degrees Celsius

ANSWER: Z) DEGREES CELSIUS

BONUS

7) Physics – *Multiple Choice* Isaac throws a ball at 10 meters per second at a 30 degree angle from the ground, and Brandon simultaneously throws a ball at 5 meters per second at a 60 degree angle from the horizontal. Which ball will hit the ground first?

W) Isaac's ball will hit the ground before Brandon's ball
X) Brandon's ball will hit the ground before Isaac's ball
Y) The two balls will hit the ground at the same time
Z) Cannot be determined

ANSWER: X) BRANDON'S BALL WILL HIT THE GROUND BEFORE ISAAC'S BALL

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TOSS-UP

8) Chemistry – *Short Answer* The number of possible microstates of a system is related to the macroscopic entropy of that system by what constant?

ANSWER: BOLTZMANN'S CONSTANT (ACCEPT: kB)

BONUS

8) Chemistry – *Multiple Choice* A reaction is spontaneous at low temperatures and non-spontaneous at high temperatures. Which of the following must be the signs of delta H and delta S, respectively?

W) Positive, positive
X) Positive, negative
Y) Negative, positive
Z) Negative, negative

ANSWER: Z) NEGATIVE, NEGATIVE
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TOSS-UP

9) Biology – *Short Answer* What bonds link glycerol to fatty acids in a triglyceride?

ANSWER: ESTER LINKAGES

BONUS

9) Biology – *Short Answer* Ramachandran plots detailing the energetically allowed regions for the angles phi and psi deal mostly with what kind of chemical interaction?

ANSWER: VAN DER WAALS (ACCEPT: LONDON DISPERSION FORCES)

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TOSS-UP

10) Math – *Multiple Choice* It is currently 11:59 AM. What time would it be in 138 hours?

W) 4:59 AM
X) 5:59 AM
Y) 4:59 PM
Z) 5:59 PM

ANSWER: X) 5:59 AM

BONUS

10) Math – *Multiple Choice* What is the sum of the infinite geometric series with second term 4 and third term 2?

ANSWER: 16
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TOSS-UP

11) TOSS-UP 11 Earth and Space – *Short Answer* By name or number, order the following 4 sediments by diameter from largest to smallest: 1) Clay; 2) Gravel; 3) Silt; 4) Sand.

ANSWER: 2, 4, 3, 1

BONUS

11) Earth and Space – *Short Answer* What is the name of ocean sediment derived from space?

ANSWER: COSMOGENOUS

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TOSS-UP

12) Energy – *Multiple Choice* Researchers at SLAC National Lab are studying kinematics at high energy. Which of the following quantities is not part of a kinematic equation?

W) Distance
X) Velocity
Y) Acceleration
Z) Time

ANSWER: W) DISTANCE

BONUS

12) Energy – *Short Answer* Researchers at Oak Ridge National Lab are creating programs to model kinematics. When plotted against time, the graph of what quantity will have a slope of velocity?

ANSWER: DISPLACEMENT
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TOSS-UP

13) Biology – *Short Answer* What are the two kinds of deaths that cells can undergo?

ANSWER: APOPTOSIS AND NECROSIS

BONUS

13) Biology – *Multiple Choice* Which of the following is closest to the percentage of transposons in the human body in accordance with all cells?

W) 10
X) 23
Y) 44
Z) 65

ANSWER: Y) 44

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TOSS-UP

14) Chemistry – *Multiple Choice* Acetic acid, with pKa 4.7, is titrated with sodium hydroxide. Which of the following is closest to the pH of the solution at the equivalence point?

W) 5
X) 6
Y) 7
Z) 8

ANSWER: Z) 8

BONUS

14) Chemistry – *Short Answer* A 50 milliliter sample of phosphoric acid is titrated with 30 mL of 3 molar sulfuric acid. What is the molarity of the sample of the phosphoric acid?

ANSWER: 1.2
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TOSS-UP

15) Physics – *Multiple Choice* A mass M produces a gravitational field around it. What best describes the gravitational field vector at a point outside of the mass?

W) A vector which points towards the closest point on the surface of M
X) A scalar quantity
Y) A vector which points directly away from the center of mass
Z) A vector which points directly towards the center of mass

ANSWER: Z) A VECTOR WHICH POINTS DIRECTLY TOWARDS THE CENTER OF MASS

BONUS

15) Physics – *Short Answer* By name or number, identify all of the following 3 quantities that are necessarily zero in an inertial frame of reference: 1) Net force; 2) Velocity; 3) Total Energy.

ANSWER: 1 ONLY

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TOSS-UP

16) Math – *Multiple Choice* What is the equation of the line through the points (3, 4) and (5, 3)?

W) $2x + y = 10$
X) $x - 2y = -5$
Y) $x + 2y = 11$
Z) $-2x + y = -2$

ANSWER: Y) $X + 2Y = 11$

BONUS

16) Math – *Short Answer* In standard form, what is the equation of the line perpendicular to $y = 3x + 5$ through the point (1, 8)?

ANSWER: $X + 3Y = 25$ (DO NOT ACCEPT: $y = -1/3x + 25/3$, $y - 8 = -1/3(x-1)$)
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TOSS-UP

17) Earth and Space – *Short Answer* IC 1101, the largest currently known galaxy, is an example of what type of galaxy?

ANSWER: ELLIPTICAL

BONUS

17) Earth and Space – *Short Answer* In contrast to flocculent galaxies, what type of galaxies have well-defined spiral arms?

ANSWER: GRAND DESIGN

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TOSS-UP

18) Energy – *Short Answer* Researchers at Los Alamos National Laboratory are studying protein folding and unfolding. On what level of protein folding are zinc fingers found in?

ANSWER: SECONDARY STRUCTURE

BONUS

18) Energy – *Short Answer* Researchers at Los Alamos National Laboratory are analysing amino acid sequences in certain proteins. What amino acid does glutamic acid mutate into on residue 6 of beta hemoglobin, causing sickle cell anemia?

ANSWER: VALINE
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TOSS-UP

19) Biology – *Short Answer* If thirteen fructose molecules were joined together through dehydration reactions, what would be the resulting compound?

ANSWER: $C_{78}H_{13}O_{65}$

BONUS

19) Biology – *Short Answer* In cellular respiration, what is the name of the compound the iron-sulfur protein in complex I passes electrons to?

ANSWER: UBIQUINONE (ACCEPT: COENZYME Q-10, UBIDCARENONE, UBIQUINOL)

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TOSS-UP

20) Physics – *Short Answer* While on Earth's surface, Bob exerts a force of 500 Newtons on the Earth. If the Earth is exactly 10^{23} times more massive than Bob, how much force does the Earth exert on Bob, in newtons?

ANSWER: 500

BONUS

20) Physics – *Short Answer* What shape does the orbit of an orbiting body take, given that the orbiting body has a velocity strictly greater than the escape velocity of the body it orbits?

ANSWER: HYPERBOLA (ACCEPT: HYPERBOLIC)
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TOSS-UP

21) Chemistry – *Multiple Choice* The conversion of carbon-14 to nitrogen-14 is an example of which of the following types of radioactive decay?

W) Alpha
X) Beta plus
Y) Beta minus
Z) Gamma

ANSWER: Y) BETA MINUS

BONUS

21) Chemistry – *Short Answer* By name or number, identify all of the following 4 particles that are released in beta-plus decay: 1) Electron; 2) Positron; 3) Neutrino; 4) Antineutrino.

ANSWER: 2 AND 3

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TOSS-UP

22) Earth and Space – *Short Answer* In an earthquake, what is the name of the point where waves originate?

ANSWER: HYPOCENTER (ACCEPT: FOCUS)

BONUS

22) Earth and Space – *Short Answer* By name or number, order the following 4 kinds of waves from slowest to fastest: 1) L-waves; 2) P-waves; 3) S-waves; 4) R-waves.

ANSWER: 4, 1, 3, 2
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TOSS-UP

23) Math – *Short Answer* What is the area of an equilateral triangle with side length 2?

ANSWER: $\sqrt{3}$

BONUS

23) Math – *Short Answer* By name or number, identify all of the following 4 shapes that always have at least 2 lines of symmetry: 1) Rectangle; 2) Kite; 3) Circle; 4) Regular heptagon.

ANSWER: 1, 3, 4