**TOSS-UP**

1) CHEMISTRY  *Multiple Choice*  Ceramic materials have all but which of the following properties?

W) Low density  
X) High thermal expansion  
Y) High ductility  
Z) High corrosion resistance

**ANSWER:** Y) HIGH DUCTILITY

**BONUS**

1) CHEMISTRY  *Short Answer*  What is the ground state electron configuration of iron in iron (III) sulfate?

**ANSWER:** [Ar]3d⁵

**TOSS-UP**

2) EARTH AND SPACE  *Multiple Choice*  Which of the following circumstances is linked most closely with the formation of sand dunes?

W) Drying of a lake  
X) Transgression of the sea  
Y) Folded mountain formation  
Z) Heavy glacial erosion

**ANSWER:** W) DRYING OF A LAKE

**BONUS**

2) EARTH AND SPACE  *Short Answer*  During which era did the initial opening of the present-day Atlantic Ocean most likely occur?

**ANSWER:** MESOZOIC
TOSS-UP

3) PHYSICS  Short Answer  A bicycle wheel undergoes constant angular acceleration for time $t$. Identify all of the following three choices at which the average acceleration equals the instantaneous acceleration: 1) $0.5t$, 2) $0.67t$, 3) $0.707t$.

ANSWER: ALL (ACCEPT 1, 2, 3)

BONUS

3) PHYSICS  Short Answer  What is the average force in newtons exerted on a 25 gram egg by a bed sheet if the egg hits the sheet at 4 meters per second and takes 0.2 seconds to stop, given acceleration due to gravity as 10 meters per second squared?

ANSWER: 0.5

TOSS-UP

4) ENERGY  Short Answer  A commercial scale gas atomizer will soon be developed in order to produce fine powder of what element, known for its strength, light weight, biocompatibility, and resistance to corrosion?

ANSWER: TITANIUM

BONUS

4) ENERGY  Short Answer  Biodiesel is made through a chemical process called transesterification [transuh-stuh-uh-fi-KAY-shuhn]. Vegetable oil and methanol react to form biodiesel and what other byproduct?

ANSWER: GLYCERIN (ACCEPT: GLYCEROL)
5) BIOLOGY  Short Answer  What is the term for the hypothesized process by which eukaryotes [yoo-KAR-ee-oh-ts] evolved a photosynthetic [foh-tuh-SIN-thuh-tik] organelle?

ANSWER: ENDO SYMBIOSIS

BONUS

5) BIOLOGY  Multiple Choice  Which of the following is NOT an example of energy coupling?

W) An ion releases energy as it travels through an ion channel down its concentration gradient
X) A kinase hydrolyzes ATP for energy to catalyze a reaction
Y) A transport molecule uses energy from one molecule going down its concentration gradient to power transport of another molecule up its gradient
Z) As protons move down their concentration gradient, ATP synthase gathers energy to catalyze the synthesis of ATP

ANSWER: W) AN ION RELEASES ENERGY AS IT TRAVELS THROUGH AN ION CHANNEL DOWN ITS CONCENTRATION GRADIENT

TOSS-UP

6) MATH  Short Answer  In the three by three matrix, \[
\begin{bmatrix}
-2 & 2 & 0 \\
4 & 1 & -5 \\
0 & 3 & 7
\end{bmatrix}
\] such that row one contains negative 2, 2, and 0; row two contains 4, 1, and negative 5; row three contains 8, 3, and 7]. which is the \( x_{2,3} \) element?

ANSWER: −5

BONUS

6) MATH  Short Answer  If the squared length of the diagonal of one face of a cube is 162, what is the surface area in square units of the cube?

ANSWER: 486
TOSS-UP

7) CHEMISTRY  *Multiple Choice*  Which of the following statements is true about alkenes [*AL-keens*] and alkynes [*AL-kyns*]?

W) Both are unsaturated compounds  
X) Both can undergo hydrogenation to lose hydrogens  
Y) Both can undergo oxygenation to lose oxygens  
Z) Both have carbon-carbon double bonds

**ANSWER:** W) BOTH ARE UNSATURATED COMPOUNDS

BONUS

7) CHEMISTRY  *Short Answer*  Name all of the following five substances which are classified as strong electrolytes: 1) carbonic acid; 2) hydrogen fluoride; 3) sodium chloride; 4) acetic acid; 5) hydrochloric acid.

**ANSWER:** 3, 5 (ACCEPT: SODIUM CHLORIDE, HYDROCHLORIC ACID)

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TOSS-UP

8) EARTH AND SPACE  *Multiple Choice*  Which of the following sedimentary rocks is most likely to be changed to slate during regional metamorphism?

W) Shale  
X) Conglomerate  
Y) Dolostone [*DO-luh-stohn*]  
Z) Breccia [*BRECH-ee-uh*]

**ANSWER:** W) SHALE

BONUS

8) EARTH AND SPACE  *Multiple Choice*  Which of the following describes a rock that is metamorphic and shows signs of foliation?

W) It has bands of coarse intergrown crystals of various sizes  
X) It has particles of 0.01 centimeters to 1.0 centimeters cemented together  
Y) It has intergrown crystals less than 0.1 centimeter in size  
Z) It has intergrown crystals, mostly 2.0 centimeters in size

**ANSWER:** W) IT HAS BANDS OF COARSE INTERGROWN CRYSTALS OF VARIOUS SIZES
TOSS-UP

9) PHYSICS Multiple Choice  Four particles are moving from north to south through a region with magnetic field directed from west to east. Which of the following particles bends downward?

W) Alpha  
X) Beta  
Y) Neutron  
Z) Graviton

ANSWER: X) BETA

BONUS

9) PHYSICS Short Answer  Forty-five joules of energy are added to a quantity of ideal gas, and the gas expands and does 34 joules of work. What is the change in internal energy of the gas, in joules?

ANSWER: 11

TOSS-UP

10) ENERGY Short Answer  What is the name for the layer in the center of a fuel cell which separates the anode and cathode and allows positive ions through but not electrons?

ANSWER: ELECTROLYTE (ACCEPT: MEMBRANE)

BONUS

10) ENERGY Short Answer  Regular gasoline with an octane rating of 87 has the same anti-knock qualities as a mixture with what percentages of iso-octane and heptane, respectively?

ANSWER: ISO-OCTANE = 87%; HEPTANE = 13%
TOSS-UP

11) BIOLOGY  Multiple Choice  Which of the following animals is considered a keystone species of the kelp forests of the Aleutian [uh-LOO-shuhn] Islands ecosystem?

W) Sea urchin  
X) Sea otter  
Y) Killer whale  
Z) Alaskan fur seals  

ANSWER: X) SEA OTTER

BONUS

11) BIOLOGY  Short Answer  What scientific term describes strategies, such as black widow coloration, used by some animals to alert or warn other animals of their presence and potential danger?

ANSWER: APOSEMATISM (ACCEPT: APOSEMATIC)

TOSS-UP

12) MATH  Multiple Choice  Which of the following equations is that of a line perpendicular to $3x - 7y = 5$?

W) $3x + 7y = 10$  
X) $7x + 3y = 10$  
Y) $7x - 3y = 10$  
Z) $3x - 7y = 10$  

ANSWER: X) $7x + 3y = 10$

BONUS

12) MATH  Short Answer  What is the multiplicity of the zero 1 in the polynomial $p(x) = x^4 + x^3 - 9x^2 + 11x - 4$?

ANSWER: 3
TOSS-UP

13) EARTH AND SPACE  Multiple Choice  In general, the probability of flooding decreases when there is an increase in the amount of which of the following?

W) Precipitation  
X) Infiltration  
Y) Runoff  
Z) Snow melt

ANSWER: X) INFILTRATION

BONUS

13) EARTH AND SPACE  Multiple Choice  Which of the following is the age of the most abundant surface bedrock in the Finger Lakes region of New York State?

W) Cambrian  
X) Devonian  
Y) Pennsylvanian  
Z) Permian

ANSWER: X) DEVONIAN

TOSS-UP

14) BIOLOGY  Short Answer  Cutaneous [kyoo-ATY-nee-uhs] sensation to the palm of the hand and thumb is provided primarily by which nerve?

ANSWER: MEDIAN

BONUS

14) BIOLOGY  Short Answer  By number, indentify all of the following five characteristics that apply to the iris plant: 1) floral parts in multiples of four or five, 2) root system with a central tap root, 3) parallel venation on leaves, 4) vascular bundles in stem arranged in a ring, 5) one cotyledon [kat-uhl-EED-uhn].

ANSWER: 3, 5
TOSS-UP

15) CHEMISTRY Multiple Choice Which of the following elements does NOT commonly form simple ions?

W) Silicon  
X) Oxygen  
Y) Lead  
Z) Sulfur

ANSWER: W) SILICON

BONUS

15) CHEMISTRY Short Answer How many total carbons are in the organic compound 1, 1-dichloro-3-ethyl-2,4 dimethylpentane [dy-METH-uhl-PEN-tayn]?

ANSWER: 9

TOSS-UP

16) EARTH AND SPACE Multiple Choice Which of the following surface ocean currents transports warm water to higher latitudes?

W) Labrador Current  
X) Falkland Current  
Y) Gulf Stream  
Z) West Wind Drift

ANSWER: Y) GULF STREAM

BONUS

16) EARTH AND SPACE Multiple Choice Which of the following internal layers of the Earth allows for isostacy [eye-SOS-tuh-see] of the crust?

W) Outer core  
X) Inner core  
Y) Asthenosphere  
Z) Lithosphere

ANSWER: Y) ASTHENOSPHERE
TOSS-UP

17) PHYSICS  Multiple Choice  When a tennis racket hits a tennis ball, how do the forces on each object compare?

W) The force on the tennis ball has a greater magnitude than the force on the racket
X) The force on the racket has a greater magnitude than the force on the ball
Y) The magnitude of the force on each object is the same
Z) The forces depend on the level of impact

ANSWER: Y) THE MAGNITUDE OF THE FORCE ON EACH OBJECT IS THE SAME

BONUS

17) PHYSICS  Short Answer  A wave with a frequency of 40 hertz has a wavelength of 2.5 meters. What is the phase velocity in meters per second?

ANSWER: 100

TOSS-UP

18) ENERGY  Multiple Choice  Which of the following conditions is NOT required to form coal?

W) A stagnant and stable water level
X) Heat and pressure over a long period of time
Y) An equal supply of both vegetation and sediment
Z) A plant accumulation rate equaling land subsidence rate

ANSWER: Y) AN EQUAL SUPPLY OF BOTH VEGETATION AND SEDIMENT

BONUS

18) ENERGY  Short Answer  Why, aside from making it possible to push more energy through a line in a given unit of time, is power transmitted at higher voltages over longer distances?

ANSWER: TO REDUCE TRANSMISSION LOSS (ACCEPT: TO REDUCE DISSIPATION, TO REDUCE ENERGY LOSS)
19) BIOLOGY  **Short Answer**  Damage to which human brain region results in anomalous circadian [uh-NOM-uh-lus sur-kay-dee-uhn] rhythms?

**ANSWER:** HYPOTHALAMUS

**BONUS**

19) BIOLOGY  **Multiple Choice**  Which of the following is true regarding osmoregulation in a freshwater fish?

W) Osmotic water loss occurs over body surface and via gills  
X) Nitrogenous wastes are excreted primarily in the form of uric acid  
Y) Copious amount of urine hypotonic to the blood is excreted  
Z) Excess salt is excreted from gills

**ANSWER:** Y) COPIOUS AMOUNT OF URINE HYPOTONIC TO THE BLOOD IS EXCRETED

**TOSS-UP**

20) MATH  **Short Answer**  In terms of a, b, c, and d, what is the slope of the line $3ax + 2by = cd$?

**ANSWER:** $-\frac{3a}{2b}$

**BONUS**

20) MATH  **Multiple Choice**  Which of the following points lies in the solution set for the system of two inequalities: $2y - x \geq -6$ and $2y - 3x < -6$?

W) (-4, -1)  
X) (3, 1)  
Y) (0, -3)  
Z) (4, 3)

**ANSWER:** X) (3, 1)
TOSS-UP

21) CHEMISTRY  *Multiple Choice*  In titration, which of the following is most commonly used as an acid-base indicator in the pH 8 to pH 10 range?

W) Phenolphthalein  [fee-knoll-THAY-lean]
X) Cresol red
Y) Bromthymol blue
Z) Methyl orange

**ANSWER:** W) PHENOLPHTHALEIN

BONUS

21) CHEMISTRY  *Short Answer*  To what total volume in milliliters would 100 milliliters of an 80% ethanol solution by volume need to be diluted to obtain a 20% solution by volume?

**ANSWER:** 400

TOSS-UP

22) EARTH AND SPACE  *Short Answer*  Of the 8 planets in the solar system, which one likely has the lowest escape velocity with respect to its own gravity?

**ANSWER:** MERCURY

BONUS

22) EARTH AND SPACE  *Short Answer*  The following four particles A, B, C, and D are of equal volume and are dropped into a column filled with water. Particle A is flat with a density of 2.5 grams per cubic centimeter. Particle B is flat with a density of 3.0 grams per cubic centimeter. Particle C is round with a density of 2.5 grams per cubic centimeter, and particle D is round with a density of 3.0 grams per cubic centimeter. Which particle would usually settle most rapidly?

**ANSWER:** PARTICLE D
TOSS-UP

23) PHYSICS  Short Answer  Sue and Ben are 5 and 10 meters, respectively, away from a balloon when it pops loudly. Sue's sound pressure meter recorded a level of 80 decibels. What did Ben's identical meter record in decibels to the nearest decibel?

ANSWER: 74

BONUS

23) PHYSICS  Multiple Choice  A current-carrying wire changes diameter from larger to smaller gauge. In which of the following locations would the current be greater?

W) Larger section
X) Smaller section
Y) At the location where the wire changes diameter
Z) It would be the same at all points

ANSWER: Z) IT WOULD BE THE SAME AT ALL POINTS

TOSS-UP

24) BIOLOGY  Short Answer  Name the genus of mosquito that most frequently serves as the vector for the debilitating dengue [DENG-gay] fever.

ANSWER: AEDES

BONUS

24) BIOLOGY  Short Answer  Indicate, respectively, the term to describe the stage in which two genetically different nuclei occur in the same cell, and the principal kingdom in which the stage occurs as a normal part of the organism’s life cycle.

ANSWER: STAGE = HETEROKARYOTIC; KINGDOM = FUNGI
TOSS-UP

25) MATH  Short Answer  How many points of intersection do the graphs of the functions $f(x) = x^2$ and $g(x) = 2^x$ have?

ANSWER: 3

BONUS

25) MATH  Short Answer  Evaluate the following: $\int_{0}^{2} \frac{1}{t} \cdot e^\ln t \, dt$ [the integral from 0 to 2 of 1 over t times e to the power of the natural log of t dt].

ANSWER: 2