

TOSS-UP

1) Earth and Space — *Short Answer* What acid, formed from the reaction of carbon dioxide and water, is the most common agent of chemical weathering on Earth's surface?

ANSWER: CARBONIC ACID (ACCEPT: H_2CO_3)

BONUS

1) Earth and Space — *Short Answer* Identify all of the following three igneous rocks that are intrusive: 1) Gabbro; 2) Basalt; 3) Rhyolite [*RYE-oh-lite*].

ANSWER: 1

TOSS-UP

2) Energy — *Multiple Choice* Scientists at Argonne National Lab are studying the force that holds nuclei together. What is this force?

- W) Gravity
- X) Electromagnetic
- Y) Weak
- Z) Strong

ANSWER: Z) STRONG

BONUS

2) Energy — *Multiple Choice* New computer simulations at Princeton Plasma Physics Lab have shown that adding a porous layer around a reservoir of liquid lithium could aid in heat absorption and transfer in a nuclear fusion reactor. This system could potentially be deployed in what toroidal [*tore-OY-dul*] device?

- W) Tokamak [*TOH-kah-mak*]
- X) Spallator
- Y) Solenoid
- Z) Lawson device

ANSWER: W) TOKAMAK

TOSS-UP

3) Math — *Short Answer* The least-squares regression line of a trade data set is $y = 1.9x + 5.3$, where x is the number of boxes shipped and y is the shipping time in minutes. According to this model, how many more minutes will it take the firm to ship one additional box?

ANSWER: 1.9 (ACCEPT: 1 9/10, 19/10)

BONUS

3) Math — *Short Answer* An arithmetic sequence has fourth term 7 and eighth term 31. What is the positive difference between consecutive terms for the sequence?

ANSWER: 6

TOSS-UP

4) Physics — *Multiple Choice* Which of the following equations describes the distribution of velocities among the particles of an ideal gas?

- W) Planck's law
- X) Maxwell-Boltzmann equation
- Y) Wien's law
- Z) Clausius-Clapeyron relation

ANSWER: X) MAXWELL-BOLTZMANN EQUATION

BONUS

4) Physics — *Short Answer* A current of 6 amperes is flowing through a loop of wire containing a resistor. In a span of one minute, how many coulombs of charge flow through the resistor?

ANSWER: 360

TOSS-UP

5) Biology — *Multiple Choice* Which of the following best describes the trophic [*TROH-fik*] status of a green and highly-productive lake?

- W) Eutrophic
- X) Oligotrophic [*AW-lig-oh-troh-fik*]
- Y) Mesotrophic
- Z) Dystrophic

ANSWER: W) EUTROPHIC

BONUS

5) Biology — *Multiple Choice* In eukaryotic cells, which of the following metabolic reactions does NOT occur within the mitochondrion?

- W) Citric acid cycle
- X) Glycolysis [*glye-KAWL-eh-sis*]
- Y) Pyruvate decarboxylation
- Z) Oxidative phosphorylation

ANSWER: X) GLYCOLYSIS

TOSS-UP

6) Chemistry — *Short Answer* What state of matter has fixed volume and shape?

ANSWER: SOLID

BONUS

6) Chemistry — *Short Answer* The energy required to make the n equals one to n equals infinity transition for a bound electron is also known as what?

ANSWER: IONIZATION ENERGY (ACCEPT: IONIZATION)

TOSS-UP

7) Earth and Space — *Short Answer* Generally speaking, the world's largest earthquakes occur at what type of plate boundary?

ANSWER: CONVERGENT (ACCEPT: SUBDUCTION ZONE, OCEAN-CONTINENT CONVERGENT)

BONUS

7) Earth and Space — *Multiple Choice* Ultramafic [*ultra-MAY-fik*] magma is slowly cooling. Which of the following minerals will crystalize out first?

- W) Olivine [*AW-liv-een*]
- X) Pyroxene [*pie-ROX-een*]
- Y) Biotite
- Z) Quartz

ANSWER: W) OLIVINE

TOSS-UP

8) Energy — *Multiple Choice* Scientists at Brookhaven National Lab are installing a new detector in their Relativistic Heavy Ion Collider. Which of the following is true regarding special relativity?

- W) In every medium, the speed of light is the upper limit for the speed of an object in that medium
- X) Quantum entanglement permits instantaneous communication
- Y) Events can occur in different orders for different observers
- Z) Neutrinos can travel faster than light in a vacuum

ANSWER: Y) EVENTS CAN OCCUR IN DIFFERENT ORDERS FOR DIFFERENT OBSERVERS

BONUS

8) Energy — *Multiple Choice* Scientists at Brookhaven National Laboratory are studying collisions of polarized protons. Which of the following best describes linearly polarized light?

- W) Electric field parallel to the direction of propagation
- X) Magnetic field aligned in a single direction
- Y) Parallel electric and magnetic fields
- Z) Out-of-phase electric and magnetic fields

ANSWER: X) MAGNETIC FIELD ALIGNED IN A SINGLE DIRECTION

TOSS-UP

9) Math — *Short Answer* What is the discriminant of the quadratic function $y = x^2 - 6x + 7$?

ANSWER: 8

BONUS

9) Math — *Multiple Choice* A 12-foot ladder leans against a vertical wall. If the height on the wall where the top of the ladder touches is known, what inverse trig function could most directly be used to find the angle that the ladder makes with the ground?

- W) Inverse cosine
- X) Inverse cotangent
- Y) Inverse sine
- Z) Inverse tangent

ANSWER: Y) INVERSE SINE

TOSS-UP

10) Physics — *Short Answer* Identify all of the following three quantities that are vectors: 1) Momentum; 2) Impulse; 3) Force.

ANSWER: ALL

BONUS

10) Physics — *Short Answer* What law states that a planetary orbit sweeps out area around its star at a constant rate?

ANSWER: KEPLER'S SECOND LAW (ACCEPT: KEPLER'S SECOND; do not accept: KEPLER'S)

TOSS-UP

11) Biology — *Short Answer* What is the term for the phase of the cardiac cycle during which the ventricles are relaxing?

ANSWER: DIASTOLE (ACCEPT: DIASTOLIC)

BONUS

11) Biology — *Short Answer* By mass, what three elements are the most abundant in humans?

ANSWER: CARBON, HYDROGEN, OXYGEN (IN ANY ORDER)

TOSS-UP

12) Chemistry — *Multiple Choice* What process separates volatiles by differences in boiling point?

- W) Fractional distillation
- X) Chromatography
- Y) NMR spectroscopy
- Z) Mass spectrometry

ANSWER: W) FRACTIONAL DISTILLATION

BONUS

12) Chemistry — *Multiple Choice* What is the term for the ease of distortion of an electron cloud by an external entity?

- W) Ionizability [*ionize-ah-BIL-ih-tee*]
- X) Polarizability [*polar-eyes-ah-BIL-itee*]
- Y) Hydrophilicity
- Z) Hardness

ANSWER: X) POLARIZABILITY



TOSS-UP

13) Earth and Space — *Multiple Choice* What Galilean *[gal-ih-LAY-en]* moon is the closest to Jupiter, and subjected to intense tidal heating that drives prolific volcanism?

W) Callisto *[kah-LIS-toh]*

X) Ganymede *[GAN-ih-meed]*

Y) Titan

Z) Io *[EYE-oh]*

ANSWER: Z) IO

BONUS

13) Earth and Space — *Short Answer* If the diameter of a telescope is multiplied by 5, by what factor is its light-gathering power multiplied?

ANSWER: 25

TOSS-UP

14) Energy — *Multiple Choice* Scientists at Argonne National Lab are using the third-most abundant gas in dry air as a scintillation medium. What is this gas?

- W) Nitrogen
- X) Neon
- Y) Xenon [*ZEE-non*]
- Z) Argon

ANSWER: Z) ARGON

BONUS

14) Energy — *Short Answer* Researchers at Argonne National Lab are modeling the properties of hafnia, which has chemical formula HfO_2 . In this compound, what is the oxidation state of hafnium [*HALF-nee-um*]?

ANSWER: +4 (ACCEPT: 4)

TOSS-UP

15) Math — *Short Answer* If f of x is equal to $5x^2 - 11x + 3$, what is f of 1?

ANSWER: -3

BONUS

15) Math — *Short Answer* What is the integral from 1 to 4 of open parenthesis $x^2 + 2$ close parenthesis dx ?

ANSWER: 27



TOSS-UP

16) Physics — *Multiple Choice* Which of the following is true regarding resistors connected in parallel to a battery?

- W) The resistances are added
- X) Each resistor has the same current through it
- Y) Each resistor has the same voltage across it
- Z) There will be a short circuit unless the resistances are equal

ANSWER: Y) EACH RESISTOR HAS THE SAME VOLTAGE ACROSS IT

BONUS

16) Physics — *Multiple Choice* Which of the following is the term for the constant obtained by dividing the ideal gas constant by Avogadro's constant?

- W) Planck constant
- X) Boltzmann constant
- Y) Newton constant
- Z) Fine structure constant

ANSWER: X) BOLTZMANN CONSTANT

TOSS-UP

17) Biology — *Multiple Choice* Which of the following metallic elements can be found in hemoglobin?

- W) Magnesium
- X) Iron
- Y) Calcium
- Z) Zinc

ANSWER: X) IRON

BONUS

17) Biology — *Multiple Choice* In newly-saturated soils, which of the following processes consumes oxygen more rapidly than it can be replenished by diffusion from the atmosphere?

- W) Denitrification [*dee-ny-trih-fih-KAY-shun*]
- X) Methanogenesis [*meth-an-oh-JEN-eh-sis*]
- Y) Photosynthesis
- Z) Respiration

ANSWER: Z) RESPIRATION

TOSS-UP

18) Chemistry — *Multiple Choice* Which of the following is NOT a homogeneous mixture?

- W) Gasoline
- X) Air
- Y) Smoke
- Z) Vinegar

ANSWER: Y) SMOKE

BONUS

18) Chemistry — *Multiple Choice* Which of the following is NOT true for the reaction between silver nitrate and sodium chloride in solution?

- W) Nitrate ion is not included in the net ionic equation
- X) Silver ion is a spectator ion
- Y) Silver chloride precipitates
- Z) One mole of sodium nitrate is produced per mole of silver nitrate reacted

ANSWER: X) SILVER ION IS A SPECTATOR ION