TOSS-UP

1) Math — Short Answer If log base 4 of $x$ is 2.5, what is $x$?

ANSWER: 32

BONUS

1) Math — Short Answer What is the $y$-coordinate of the $y$-intercept of the line with slope $-4/5$ that contains the point $(-3, 8)$?

ANSWER: $28/5$ (ACCEPT 5 3/5, 5.6)

TOSS-UP

2) Earth and Space — Short Answer What is the name for the southern-most latitude for which it is possible for the Sun to be at the zenith?

ANSWER: TROPIC OF CAPRICORN

BONUS

2) Earth and Space — Short Answer Order the following four objects in the night sky in increasing order of brightness: 1) Venus; 2) Uranus; 3) Sirius; 4) Andromeda [ann-DRAW-meh-dah] Galaxy.

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

3) Physical Science – *Multiple Choice*  For an object falling in the presence of air resistance, which of the following quantities will asymptotically approach a non-zero constant?

W) Position
X) Velocity
Y) Acceleration
Z) Force

ANSWER: X) VELOCITY

BONUS

3) Physical Science – *Short Answer*  An object remains in uniform circular motion while having its velocity doubled and its radius of revolution tripled. By what factor is its centripetal acceleration multiplied?

ANSWER: 4/3

TOSS-UP

4) Energy – *Multiple Choice*  Scientists at the Joint Genome Institute recently conducted epigenetic sequencing of fungi *[fun-ji]*. Which of the following is primarily measured in epigenetic analysis?

W) Methylation on DNA bases
X) Quantity of RNA transcripts
Y) Sequences of various genes
Z) Quantity of various proteins

ANSWER: W) METHYLATION ON DNA BASES

BONUS

4) Energy – *Short Answer*  Scientists at SLAC *[slack]* are working on improving the sensitivity of what interferometer *[inter-feer-AW-meh-ter]* that was responsible for the first detection of gravitational waves?

ANSWER: LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY (ACCEPT: LIGO, ALIGO)
TOSS-UP

5) Life Science – Multiple Choice  Which of the following kingdoms contains organisms that directly produce methane as a byproduct of metabolism?

W) Bacteria  
X) Archaea [ar-KEE-ah]  
Y) Fungi [fun-ji]  
Z) Animalia  

ANSWER: X) ARCHAEA

BONUS

5) Life Science – Short Answer  Identify all of the following three stages of meiosis [my-OH-sis] that are marked by the synapsis [sih-NAP-sis] of homologous [ha-MAWL-uh-gus] chromosomes: 1) Prophase I; 2) Prophase II; 3) Metaphase II.

ANSWER: 1

TOSS-UP

6) Earth and Space – Multiple Choice  Which of the following is an effect of El Niño on the southern United States' climate?

W) An increase in tornadoes  
X) Fewer rainfalls  
Y) Drier winters  
Z) Warmer winters  

ANSWER: W) AN INCREASE IN TORNADOES

BONUS

6) Earth and Space – Short Answer  Identify all of the following three statements that are true of rock types: 1) Granite and andesite are chemically equivalent; 2) Gabbro and basalt [bah-SALT] are chemically equivalent; 3) Gabbro is an extrusive rock.

ANSWER: 2
**TOSS-UP**

7) Math – *Multiple Choice*  A triangle has two sides of length 6 and 11. Which of the following is NOT possible for the length of the third side?

W) 6  
X) 11  
Y) 16  
Z) 17  

ANSWER: Z) 17

**BONUS**

7) Math – *Short Answer*  Evaluate $3 \log_2 8 + 4 \log_3 81 - \frac{1}{2} \log_4 4096$.

ANSWER: 22

**TOSS-UP**

8) Physical Science – *Short Answer*  Evangelista Torricelli is famous for inventing what tool that measures atmospheric pressure?

ANSWER: BAROMETER

**BONUS**

8) Physical Science – *Short Answer*  Identify all of the following three properties that are typical of nonmetals: 1) Ductile; 2) Poor electrical conductance; 3) Form basic oxides.

ANSWER: 2
TOSS-UP

9) Energy – *Short Answer*  Scientists at Lawrence Livermore National Laboratory have developed a laser-based tabletop device to measure carbon-14 concentrations. Biological samples must be homogenized, dried, and combusted before they are measured. In what compound does the spectrometer measure the carbon-14 abundance?

**ANSWER: CARBON DIOXIDE (ACCEPT: CO₂)**

**BONUS**

9) Energy – *Multiple Choice*  Scientists at Lawrence Berkeley National Lab recently published a study on the distribution of dust in the Milky Way. Which of the following best explains how they can detect the dust?

W) Interstellar dust easily scatters red light, so stars seen through it appear bluer than expected
X) Interstellar dust easily scatters blue light, so stars seen through it appear redder than expected
Y) The dust generates photons
Z) The gravitational effects of the dust are measurable

**ANSWER: X) INTERSTELLAR DUST EASILY SCATTERS BLUE LIGHT, SO STARS SEEN THROUGH IT APPEAR REDDER THAN EXPECTED**

TOSS-UP

10) Earth and Space – *Multiple Choice*  Which of the following is closest to the number of astronomical units from the Earth to Proxima Centauri?

W) 3 times ten to the 5th
X) 3 times ten to the 6th
Y) 3 times ten to the 7th
Z) 3 times ten to the 8th

**ANSWER: W) 3 TIMES TEN TO THE 5th**

**BONUS**

10) Earth and Space – *Short Answer*  Identify all of the following three statements that are true of Earth’s magnetic field: 1) It is responsible for blocking gamma radiation from the Sun; 2) It is responsible for the formation of the Van Allen belts; 3) Its strength is tens of microteslas at Earth’s surface.

**ANSWER: 2 AND 3**
TOSS-UP

11) Life Science – Multiple Choice  Having a single ventricle limits oxygen delivery for a three-chambered heart. Which of the following animals has a three-chambered heart?

W) Mouse  
X) Eagle  
Y) Chimpanzee  
Z) Frog  

ANSWER: Z) FROG

BONUS

11) Life Science – Short Answer  Elastin is a protein that is most commonly found in which of the four general classes of human tissue?

ANSWER: CONNECTIVE

TOSS-UP

12) Energy – Multiple Choice  Researchers at Argonne National Lab Chemical Sciences and Engineering Division are studying the decomposition of H₂CO into H₂ and CO. If they are specifically examining the hydrogen-carbon bond stretching and breaking, what type of structure are they examining?

W) Product  
X) Second order  
Y) Transition state  
Z) Intermediate  

ANSWER: Y) TRANSITION STATE

BONUS

12) Energy – Short Answer  Scientists at Los Alamos National Lab recently discovered that optical phonons in some 2D lattices condense into what phase of ultracold matter composed of particles with integer spins?

ANSWER: BOSE-EINSTEIN CONDENSATE
TOSS-UP

13) Earth and Space – Multiple Choice  What is the general term for an erosional or non-depositional surface between strata of different ages?

W) Unconformity
X) Fault
Y) Cross bedding
Z) Syncline

ANSWER: W) UNCONFORMITY

BONUS

13) Earth and Space – Short Answer  Identify all of the following three statements that are true of erosion and soil: 1) Eroded materials are deposited at new locations by a process called weathering; 2) Humus is the gravel-like covering above the bedrock; 3) A soil horizon is a distinct layer within a cross section of the soil.

ANSWER: 3

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TOSS-UP

14) Math – Short Answer  If a number is increased by 60%, by what percent is its square increased?

ANSWER: 156

BONUS

14) Math – Short Answer  One angle of an isosceles triangle measures 74 degrees. In degrees, what are the possible measures of the smallest angle of the triangle?

ANSWER: 32 AND 53
TOSS-UP

15) Life Science – Short Answer For each gene, what is the maximum number of different alleles [ah-LEELZ] a human can inherit?

ANSWER: TWO

BONUS

15) Life Science – Short Answer Identify all of the following three steps of aerobic respiration that produce carbon dioxide: 1) Glycolysis [glye-KAWL-eh-sis]; 2) Krebs cycle; 3) Oxidative phosphorylation [faws-four-il-AY-shun].

ANSWER: 2

TOSS-UP

16) Physical Science – Multiple Choice Which of the following substances contains a covalent bond?

W) Dichlorine
X) Argon
Y) Sodium chloride
Z) Neon

ANSWER: W) DICHLORINE

BONUS

16) Physical Science – Short Answer What group of elements possesses a stable outer energy level?

ANSWER: 18 (ACCEPT: NOBLE GASES)
TOSS-UP

17) Math – Short Answer  The point (−4, 7) is reflected over the y-axis. In what quadrant does the reflected point lie?

ANSWER: 1 (ACCEPT: FIRST)

BONUS

17) Math – Short Answer  How many edges does a regular dodecahedron have?

ANSWER: 30

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TOSS-UP

18) Life Science – Short Answer  What fluid bathes the inside of a joint capsule and lubricates movement?

ANSWER: SYNOVIAL FLUID

BONUS

18) Life Science – Multiple Choice  A macrophage [MACRO-fayj] engulfs a bacterial cell and then creates molecules that trigger itself to migrate to the lymph node. What type of signaling is this?

W) Endocrine [EN-doh-krin]
X) Neuroendocrine [NOOR-oh-en-doh-krin]
Y) Paracrine [para-krin]
Z) Autocrine [auto-krin]

ANSWER: Z) AUTOCRINE
TOSS-UP

19) Physical Science – *Multiple Choice*  Which of the following quantities related to a light wave increases with increasing energy carried by each photon?

W) Amplitude  
X) Speed  
Y) Wavelength  
Z) Frequency

ANSWER: Z) FREQUENCY

BONUS

19) Physical Science – *Short Answer*  Identify all of the following three statements that are true of electrical devices: 1) Transformers convert alternating current to direct current; 2) Household electrical outlets provide alternating current; 3) Batteries produce direct current.

ANSWER: 2 AND 3

TOSS-UP

20) Math – *Short Answer*  What is the $x$-intercept of the line with equation $5x - 4y = -40$?

ANSWER: (–8, 0) (ACCEPT: –8)

BONUS

20) Math – *Short Answer*  The graph of the line with equation $y = -3x + 4$ is reflected through the $x$-axis. What is the slope-intercept equation of the reflected line?

ANSWER: $y = 3x - 4$
TOSS-UP

21) Earth and Space – *Short Answer* What is the chemical formula of the mineral quartz?

ANSWER: SiO₂

BONUS

21) Earth and Space – *Short Answer* What scale is used to measure the intensity of an earthquake based on its damage?

ANSWER: MODIFIED MERCALLI (ACCEPT: MODIFIED MERCALLI INTENSITY INDEX)

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TOSS-UP

22) Physical Science – *Short Answer* What is the general term for compounds used in titrations that react with acids or bases to produce a color change?

ANSWER: INDICATORS

BONUS

22) Physical Science – *Short Answer* Identify all of the following three terms that can be used to describe methanol: 1) Covalent; 2) Polar; 3) Ionic.

ANSWER: 1 AND 2
TOSS-UP

23) Life Science – Short Answer  In plants, light-dependent oxidative phosphorylation ([faus-four-il-AY-shun]) takes place in what organelle?

ANSWER: CHLOROPLAST

BONUS

23) Life Science – Short Answer  What family of enzymes is responsible for synthesizing new DNA during replication?

ANSWER: DNA POLYMERASES (ACCEPT: POLYMERASES)