TOSS-UP

1) Biology – *Multiple Choice*  In green plants, energy is stored mainly in which of the following forms?

W) Cellulose  
X) Starch  
Y) Glucose  
Z) ATP  

ANSWER: X) STARCH

BONUS

1) Biology – *Short Answer*  What sheet of muscle separates the thoracic and abdominopelvic cavities?

ANSWER: DIAPHRAGM

TOSS-UP

2) Earth and Space – *Multiple Choice*  The earliest known single-celled life forms on Earth belong to which of the following taxonomic groups?

W) Fungi  
X) Protoctista  
Y) Plantae  
Z) Monera  

ANSWER: Z) MONERA

BONUS

2) Earth and Space – *Short Answer*  What is the chief commercial ore of aluminum?

ANSWER: BAUXITE
3) Math – *Multiple Choice*  A differentiable function $f$ has domain the closed interval from $-3$ to $4$ and range the closed interval from $5$ to $12$. If $f^{\prime}$ of $x$ is greater than $0$ for all $x$ in the domain, what is $f$ of $-3$?

W) $-3$
X) $4$
Y) $5$
Z) $12$

ANSWER: Y) $5$

**BONUS**

3) Math – *Short Answer*  How many two-digit positive integers do NOT have $5$ or $6$ as a digit?

ANSWER: $56$

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4) Energy – *Short Answer*  Methyl-tertiary-butyl-ether [*methil-ter-shee-air-ee- byu-till-eethur*], abbreviated MTBE, replaced lead in gasoline due to several environmental benefits. In order to raise octane rating in current gasoline, what has subsequently replaced MTBE?

ANSWER: ETHANOL

**BONUS**

4) Energy – *Multiple Choice*  Which of the following is the best estimate of the electricity consumption of a petascale [*PEH-tah-scale*] supercomputer today?

W) $8$ kilowatts
X) $80$ kilowatts
Y) $8$ megawatts
Z) $80$ megawatts

ANSWER: Y) $8$ MEGAWATTS
TOSS-UP

5) Chemistry – Multiple Choice  Which of the following is an example of an ionic compound?

W) Methane  
X) Chlorine dioxide  
Y) Dinitrogen trioxide  
Z) Calcium sulfide  

ANSWER: Z) CALCIUM SULFIDE

BONUS

5) Chemistry – Short Answer  What is the geometry of sulfur tetrafluoride [(tetrah-FLOOR-ide)?

ANSWER: SEESAW

TOSS-UP

6) Physics – Short Answer  A proton is traveling counterclockwise in a circle in the $x = 0$ plane. In what direction is its magnetic field vector?

ANSWER: POSITIVE X

BONUS

6) Physics – Short Answer  What is the adjective for the type of materials that will create an induced magnetic field opposite to an externally applied magnetic field?

ANSWER: DIAMAGNETIC
TOSS-UP

7) Earth and Space – Short Answer Most long-period comets are thought to originate from what region in the solar system?

ANSWER: OORT CLOUD

BONUS

7) Earth and Space – Short Answer In 1943, a volcano suddenly appeared in a corn field in the village of Paricutin and began erupting lava bombs and ash. What type of volcano was this?

ANSWER: CINDER CONE (ACCEPT: SCORIA CONE)

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TOSS-UP

8) Chemistry – Short Answer What quantity, in milliliters, of a 0.5 molar solution of sulfuric acid would be required to neutralize 30 mL of a 0.1 molar solution of sodium hydroxide?

ANSWER: 3

BONUS

8) Chemistry – Short Answer Identify all of the following three statements that are TRUE of ideal concentration cells: 1) They obey the Nernst equation; 2) At equilibrium, they have a positive redox potential; 3) They have a positive standard redox potential.

ANSWER: 1
9) Biology – Multiple Choice  Which of the following types of tissue do monocot roots possess at their center that dicot roots do not?

W) Xylem
X) Pith
Y) Collenchyma [koh-LEN-kimma]
Z) Trichomes

ANSWER: X) PITH

BONUS

9) Biology – Short Answer  Identify all of the following three processes that are considered active transport: 1) Uptake of glucose via channels; 2) Sodium-calcium exchange; 3) Mucus secretion.

ANSWER: 2 AND 3

TOSS-UP

10) Physics – Short Answer  What type of circuits, which include types such as high-pass and low-pass filters, are composed of a resistor and a capacitor?

ANSWER: RC CIRCUIT

BONUS

10) Physics – Short Answer  An object’s position \( x \) as a function of time \( t \) is: \( x = t^3 - t^2 + 3t + 5 \). What is the object’s acceleration at time 2?

ANSWER: 10
TOSS-UP

11) Energy – *Multiple Choice* Which of the following weather conditions and times of year is best for achieving efficient energy conversion in a solar thermal plant?

W) Partly cloudy day in fall  
X) Rainy day in spring  
Y) Partly sunny day in winter  
Z) Overcast day in summer

ANSWER: W) PARTLY CLOUDY DAY IN FALL

BONUS

11) Energy – *Multiple Choice* Which of the following accounts for the largest proportion of total US domestic energy production?

W) Natural gas  
X) Petroleum  
Y) Coal  
Z) Nuclear

ANSWER: W) NATURAL GAS

TOSS-UP

12) Math – *Short Answer* What is the period of the function with equation $y = 4 \sin (7x + 3) + 2$?

ANSWER: $2\pi/7$ (ACCEPT: $(2/7)\pi$)

BONUS

12) Math – *Short Answer* What is the area in the first quadrant between the graphs of $y = 4x$ and $y = x^3$?

ANSWER: 4
TOSS-UP

13) Physics – *Multiple Choice*  A mass on a spring oscillates at a frequency of 200 hertz, creating a low-pitch sound. Which of the following can be done to increase the frequency of the sound produced?

W) Increase the mass
X) Use a stiffer spring
Y) Approach the mass-spring system at a high speed
Z) Remove the air in the room

ANSWER: X) USE A STIFFER SPRING

BONUS

13) Physics – *Short Answer*  Identify all of the following three particles that are leptons:  
1) Neutrino; 2) Gluon; 3) Positron.

ANSWER: 1 AND 3

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TOSS-UP

14) Biology – *Short Answer*  In collies, what neurotransmitter is released by somatic motor neurons to induce muscle contraction?

ANSWER: ACETYLCHOLINE

BONUS

14) Biology – *Multiple Choice*  With which of the following is protein binding to a TATA [*TAH-tah*] box activity associated?

W) DNA replication
X) Transcription
Y) Translation
Z) Elongation

ANSWER: X) TRANSCRIPTION
TOSS-UP

15) Math – Short Answer  In what quadrants does the graph of the equation \( y = 4x - 3 \) lie?

ANSWER: 1, 3, AND 4 (ACCEPT: FIRST, THIRD, AND FOURTH or ALL BUT SECOND)

BONUS

15) Math – Short Answer  What is the least common multiple of 14, 16, and 18?

ANSWER: 1008

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TOSS-UP

16) Energy – Short Answer  DOE scientists recently published a paper in which nanoscale circuitry [sur-cah-tree] was developed by printing a carbon-based semiconductor on a germanium [jer-MAYN-ee-um] surface. What allotrope of carbon are the semiconductors based on?

ANSWER: GRAPHENE

BONUS

16) Energy – Short Answer  What is the only baseload electrical power source in the US that is virtually carbon neutral, and supplies 20% of baseload electrical power?

ANSWER: NUCLEAR POWER (ACCEPT FISSION, URANIUM)
TOSS-UP

17) Chemistry – Multiple Choice Consider the reaction of two moles of hydrogen gas and one mole of oxygen gas to generate two moles of steam. Which of the following statements is TRUE?

W) Delta H is greater than delta U
X) Delta H is less than delta U
Y) Delta H is equal to delta U
Z) Delta H is greater than delta U at high temperatures, but less at low temperatures

ANSWER: X) DELTA H IS LESS THAN DELTA U

BONUS

17) Chemistry – Short Answer Identify all of the following three diatomic [dye-ah-TOM-ik] molecules that MO theory predicts to be stable: 1) Li₂; 2) Be₂; 3) B₂.

ANSWER: 1 AND 3

TOSS-UP

18) Earth and Space – Multiple Choice We see the same side of the moon here on Earth all the time due to what effect?

W) Lagrange point
X) Gravitational lensing
Y) Tidal locking
Z) Asynchronous spin

ANSWER: Y) TIDAL LOCKING

BONUS

18) Earth and Space – Multiple Choice What layer of the Earth's atmosphere varies in depth with the time of day and reflects radio waves long distances?

W) Photosphere
X) Stratosphere
Y) Troposphere
Z) Ionosphere

ANSWER: Z) IONOSPHERE
19) Chemistry – Short Answer  The hormone estrogen contains five stereocenters. How many stereoisomers of estrogen are possible?

ANSWER: 32

BONUS

19) Chemistry – Short Answer  Identify all of the following three techniques that could separate enantiomers in a racemic mixture of a chiral amine: 1) Chiral chromatography; 2) Crystallization with acetic acid; 3) Crystallization with plus tartaric acid.

ANSWER: 1 AND 3 (ACCEPT: CHIRAL CHROMATOGRAPHY AND CRYSTALLIZATION WITH PLUS TARTARIC ACID)

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20) Earth and Space – Short Answer  What is the second brightest star in the night sky?

ANSWER: CANOPUS

BONUS

20) Earth and Space – Short Answer  What famous lake was formed as a result of the collapse of Mount Mazama?

ANSWER: CRATER LAKE
TOSS-UP

21) Math – Short Answer What is $6^2 - 2^6$?

ANSWER: $-28$

BONUS

21) Math – Short Answer Solve the following equation for $x$ over the negative integers: $x^3 + 5x^2 - 4x - 20 = 0$

ANSWER: $-2$ AND $-5$ (must give both answers)

TOSS-UP

22) Biology – Short Answer Rickets is caused by a deficiency of what vitamin?

ANSWER: VITAMIN D

BONUS

22) Biology – Short Answer Identify all of the following three molecules that are exocrine [EX-oh-krin] products:

1) EGF; 2) Amylase; 3) ADH.

ANSWER: 2
TOSS-UP

23) Physics – Short Answer  An engine does 15 joules of work while exhausting 35 joules of waste heat. What is the percent efficiency of the engine?

ANSWER: 30

BONUS

23) Physics – Short Answer  In classical mechanics, impulse can be calculated by finding the area under the curve on a graph of force versus what quantity?

ANSWER: TIME