TOSS-UP

1) MATH *Multiple Choice* In 2014, January 1st fell on a Wednesday. What is the next year that January 1st will fall on a Wednesday?

W) 2015
X) 2019
Y) 2020
Z) 2025

ANSWER: Y) 2020

BONUS

1) MATH *Short Answer* The sums of three whole numbers taken in pairs are 11, 13, and 16. What is the product of these three numbers?

ANSWER: 252

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TOSS-UP

2) BIOLOGY *Multiple Choice* During which of the following phases of an action potential do voltage-gated sodium channels begin to close?

W) Rising phase
X) Falling phase
Y) After hyperpolarization
Z) Refractory period

ANSWER: X) FALLING PHASE

BONUS

2) BIOLOGY *Multiple Choice* In humans, in addition to transferring antibodies, colostrum also stimulates the development of the neonatal gut through the transference of which of the following?

W) Pheromones
X) Non-heritable mutations
Y) Beta-galactose
Z) Growth factors

ANSWER: Z) GROWTH FACTORS

TOSS-UP

3) CHEMISTRY *Multiple Choice* Halogenation *[hal-uh-juh-NAY-shuhn]* will occur fastest between methane and the radical of which of the following elements?

W) Chlorine
X) Iodine
Y) Fluorine
Z) Bromine

ANSWER: Y) FLUORINE

BONUS

3) CHEMISTRY *Short Answer* In terms of the ideal gas constant R, what is the constant-pressure heat capacity, per mole, of a monatomic ideal gas?

ANSWER: 5/2 R (ACCEPT: 2.5 R)

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TOSS-UP

4) PHYSICS *Multiple Choice* An antihydrogen atom is made of what two components?

W) An antiproton and a positron
X) An antiproton and an electron
Y) A proton and a positron
Z) A proton and a neutrino

ANSWER: W) AN ANTIPROTON AND A POSITRON

BONUS

4) PHYSICS *Multiple Choice* A capillary tube with an inner radius of 0.1 millimeter is partially dipped in a liquid with a surface tension of 0.1 newtons per meter, with approximately 0 degrees of contact angle. The density of the liquid is approximately the same as that of water. Calculate the liquid rise in the tube.

W) 2 millimeter
X) 2 centimeter
Y) 20 centimeter
Z) 2 meter

ANSWER: Y) 20 cm

TOSS-UP

5) EARTH AND SPACE *Multiple Choice* At a latitude of 45 degrees, which of the following is closest to the percentage of astronomical sources that are circumpolar?

W) 0%
X) 30%
Y) 50%
Z) 100%

ANSWER: X) 30%

BONUS

5) EARTH AND SPACE *Multiple Choice* A poikiloblastic *[poi-kil-uh-BLAS-tik]* texture is characterized by which of the following?

W) Idioblasts embedded within a fine matrix
X) Homogeneously *[hoh-muh-JEE-nee-uhs-li]* xenoblastic with little to no evidence of additional alteration minerals
Y) Fine, phyllitic *[fi-LIT-ik]* foliation accompanied by porphyroblasts *[por-FI-roh-blasts]*
Z) Inclusions from other minerals enveloped during porphyroblast growth

ANSWER: Z) INCLUSIONS FROM OTHER MINERALS ENVELOPED DURING PORPHYROBLAST GROWTH

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TOSS-UP

6) BIOLOGY *Multiple Choice* Which of the following phases of meiosis *[my-OH-sis]* is longest?

W) Prophase I
X) Prophase II
Y) Metaphase I
Z) Anaphase II

ANSWER: W) PROPHASE I

BONUS

6) BIOLOGY *Short Answer* Arrange the following three steps of cell respiration from lowest to highest in terms of net NADH molecules produced per one molecule of glucose entering respiration: 1) glycolysis *[gly-KOL-uh-sis]*, 2) electron transport chain, 3) Krebs cycle.

ANSWER: 2, 1, 3 (ACCEPT: ELECTRON TRANSPORT CHAIN, GLYCOLYSIS, KREBS CYCLE)

7) ENERGY *Multiple Choice* What major rock type is the medium for fracking?

W) Schist **[SHIST]**
X) Shale
Y) Basalt
Z) Limestone

ANSWER: X) SHALE

BONUS

7) ENERGY *Multiple Choice* What substance was the primary fuel source for NASA space shuttles?

W) Propane
X) Helium gas
Y) Liquid hydrogen
Z) Methane

ANSWER: Y) LIQUID HYDROGEN

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TOSS-UP

8) CHEMISTRY *Multiple Choice* Which of the following is the full list of products produced by the mild heating of sodium bicarbonate at temperatures of about 80 degrees Celsius?

W) Sodium oxide and carbon dioxide
X) Sodium peroxide and carbon dioxide
Y) Sodium carbonate, water, and carbon dioxide
Z) Sodium carbonate and carbon dioxide

ANSWER: Y) SODIUM CARBONATE, WATER, AND CARBON DIOXIDE

BONUS

8) CHEMISTRY *Short Answer* What rule is used to predict the aromaticity of conjugated alkenes?

ANSWER: HUCKEL'S RULE

TOSS-UP

9) PHYSICS *Multiple Choice* Which of the following does not interact with a magnetic field?

W) A magnet at rest
X) Moving electric charges
Y) A moving magnet
Z) Electric charges at rest

ANSWER: Z) ELECTRIC CHARGES AT REST

BONUS

9) PHYSICS *Multiple Choice* The closest distance at which Gina can properly focus is 100 cm from her eye. The distance of normal vision is 0.25 m. Find the power in diopters *[dy-OP-ters]* of the converging lens for her eyeglass.

W) -3
X) -0.03
Y) 0.03
Z) 3

ANSWER: Z) 3

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TOSS-UP

10) BIOLOGY *Multiple Choice* Which of the following structures would have been most likely absent from the last shared common ancestor of osteichthyans *[os-tee-IK-thee-uhns]* and chondrichthyans *[kan-DRIK-thee-ez]*?

W) Teeth
X) Gills
Y) Scales
Z) Swim bladder

ANSWER: Z) SWIM BLADDER

BONUS

10) BIOLOGY *Short Answer* Place the following four animals in order of lowest to highest energy cost per unit body weight for regulation of body temperature: python, canary, human, poodle.

ANSWER: PYTHON, HUMAN, POODLE, CANARY

TOSS-UP

11) EARTH AND SPACE *Multiple Choice* Which of the following composes most of the insoluble residues of limestones?

W) Calcite matrix
X) Crystalline quartz
Y) Chert nodules *[churt]*
Z) Clay minerals

ANSWER: Y) CHERT NODULES

BONUS

11) EARTH AND SPACE *Multiple Choice* Long-term preservation of deep sea carbonates is rare because of which of the following?

W) Most ocean crust and overlying sediments are subducted
X) Carbonates readily dissolve along the ocean floor when exposed to seawater
Y) There is little carbonate-forming material occurring in ocean water
Z) Carbonates react with silicates in the deep ocean, reducing the occurrence of carbonates along the ocean floor

ANSWER: W) MOST OCEAN CRUST AND OVERLYING SEDIMENTS ARE SUBDUCTED

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TOSS-UP

12) CHEMISTRY *Short Answer* The van der Waals equation is an equation of state for real gases that contains two gas-dependent parameters, *a* and *b*. What state function from the ideal gas equation does the *a* parameter modify in the van der Waals equation?

ANSWER: PRESSURE (ACCEPT: P)

BONUS

12) CHEMISTRY *Multiple Choice* Which of the following statements concerning the particle-in-a-box model is false?

W) The potential well is approximated to be infinitely deep
X) The ground state energy increases with the length of the box
Y) The energy levels are quantized
Z) The energy of level *n* is proportional to *n* squared

ANSWER: X) THE GROUND STATE ENERGY INCREASES WITH THE LENGTH OF THE BOX

TOSS-UP

13) MATH *Multiple Choice* If $\frac{2x}{3} - \frac{x}{6}$ *[two x divided by three minus x divided by six]* is an integer, which of the following MUST be true regarding x?

W) x is negative
X) x is a multiple of two
Y) x is a multiple of three
Z) x is odd

ANSWER: X) x IS A MULTIPLE OF TWO

BONUS

13) MATH *Short Answer* What is the smallest positive integer that can be added to 2500 to get a perfect square?

ANSWER: 101

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TOSS-UP

14) ENERGY *Multiple Choice* A 100 mile 765 kilovolt line carrying 1000 megawatts of energy can have losses ranging from 1.1% to 0.5%. Which of the following best approximates the losses as a ratio to the 1.0% of a 345 kilovolt line carrying the same load across the same distance?

W) 1/10
X) 1/4
Y) 4/1
Z) 10/1

ANSWER: Y) 4/1

BONUS

14) ENERGY *Short Answer* If a single electric distribution line has a resistance of 1 ohm per 1000 meters and current at 50 amps, what will be the voltage reduction over a 10 kilometer run?

ANSWER: 500

TOSS-UP

15) BIOLOGY *Short Answer* Identify all of the following three neurotransmitters that are considered to have only excitatory actions: 1) acetylcholine *[uh-seet-l-KOH-leen]*, 2) GABA, 3) glutamate.

ANSWER: 3 (ACCEPT: GLUTAMATE)

BONUS

15) BIOLOGY *Short Answer* What specific cell type in the stomach is responsible for production of hydrochloric acid in response to stimulation by gastrin?

ANSWER: PARIETAL CELLS

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TOSS-UP

16) CHEMISTRY *Multiple Choice* Which of the following organic functional groups does NOT exhibit sp^2 *[s-p-2]* hybridization?

W) Ketones
X) Aldehydes *[AL-duh-hyds]*
Y) Amides
Z) Amines

ANSWER: Z) AMINES

BONUS

16) CHEMISTRY *Multiple Choice* Which of the following statements is true regarding the chemistry of the alkaline earth elements?

W) Compounds of beryllium have the most covalent character
X) Melting point increases as you go down the group
Y) Atomic radius decreases as you go down the group
Z) Barium has a distinct red flame test color

ANSWER: W) COMPOUNDS OF BERYLLIUM HAVE THE MOST COVALENT CHARACTER

TOSS-UP

17) MATH *Multiple Choice* Which of the following statements is TRUE?

W) -7 is not a prime number
X) $e^{i\pi} = -e^{-i\pi}$ *[e to the power of quantity I times pi equals negative e to the power of quantity negative I times pi]*
Y) All pairs of perpendicular lines in the Cartesian plane have slopes that are negative reciprocals of each other
Z) There is no number a such that $\log(-a)$ *[log of negative a]* exists.

ANSWER: W) -7 IS NOT A PRIME NUMBER

BONUS

17) MATH *Short Answer* If a circle is divided into 8 sectors whose central degree angles are integers that form an arithmetic sequence with first term 3, what is the common difference for the sequence?

ANSWER: 12

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TOSS-UP

18) PHYSICS *Short Answer* Assuming the heat of fusion for water is 80 calories per gram, what is the increase in entropy, in calories per Kelvin, for a 273 gram block of ice at 0 degrees Celsius when it melts?

ANSWER: 80

BONUS

18) PHYSICS *Multiple Choice* An α-particle *[alpha particle]* and a proton, both initially at rest, are accelerated through a potential difference of 10^5 kilovolts. Find the ratio (K_α/K_p) *[k alpha over k proton]* of their final kinetic energies.

W) 1/4
X) 1/2
Y) 2
Z) 4

ANSWER: Y) 2

TOSS-UP

19) EARTH AND SPACE *Multiple Choice* What will occur if a white dwarf in a binary exceeds its Roche *[ROSH]* lobe?

W) Its companion will transfer mass to it until it shrinks below its Roche lobe
X) It will form a planetary nebula
Y) It will continue to expand and ablate onto its companion
Z) It will transfer matter to its companion until it shrinks below its Roche lobe

ANSWER: Z) IT WILL TRANSFER MATTER TO ITS COMPANION UNTIL IT SHRINKS BELOW ITS ROCHE LOBE

BONUS

19) EARTH AND SPACE *Multiple Choice* Which of the following describes the carbonate compensation depth (CCD)?

W) Occurring between 2,000-3,000 m
X) Varying by latitude: deeper near the equator, shallower near the poles
Y) Restricted to waters near the poles in both hemispheres
Z) The depth at which carbonates start to form at nearly two times the rate of formation in shallower water

ANSWER: X) VARYING BY LATITUDE: DEEPER NEAR THE EQUATOR, SHALLOWER NEAR THE POLES

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TOSS-UP

20) CHEMISTRY *Multiple Choice* Which of the following best describes the elementary kinetic step where a proton is transferred directly between an ammonium ion and water?

W) Unimolecular
X) Bimolecular
Y) Trimolecular
Z) Tetramolecular

ANSWER: X) BIMOLECULAR

BONUS

20) CHEMISTRY *Short Answer* One liter of a saturated solution of silver chromate contains 0.0002 moles of the silver cation *[KAT-eye-uhn]* and 0.00003 moles of the chromate ion. To two significant figures and in scientific notation, what is the Ksp of silver chromate?

ANSWER: 1.2×10^{-12}

TOSS-UP

21) BIOLOGY *Multiple Choice* Which of the following vitamin deficiencies causes the condition known as "Pellagra"?

W) Vitamin B_3
X) Vitamin B_6
Y) Vitamin B_2
Z) Vitamin B_1

ANSWER: W) VITAMIN B_3

BONUS

21) BIOLOGY *Short Answer* How many molecules of ATP are needed to synthesize two glucose molecules in the Calvin cycle?

ANSWER: 36 ATP

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TOSS-UP

22) ENERGY *Multiple Choice* Energy radiates from a surface as a function of temperature to what power?

W) 1
X) 3
Y) 2
Z) 4

ANSWER: Z) 4

BONUS

22) ENERGY *Multiple Choice* Which of the following rare earth elements is used to produce magnets for wind turbines?

W) Europium
X) Gadolinium *[gad-l-IN-ee-uhm]*
Y) Scandium
Z) Neodymium

ANSWER: Z) NEODYMIUM

23) EARTH AND SPACE *Short Answer* A torus of sulfur and sodium has been detected along the orbit of which of Jupiter's moons?

ANSWER: IO

BONUS

23) EARTH AND SPACE *Multiple Choice* Telescope A has an aperture with diameter 1 meter and telescope B has an aperture with diameter 2 meters. Both take diffraction-limited images to the same depth. What is the relationship between the smallest resolved angle and integration time of the two telescopes?

W) Smallest resolved angle of A is twice that of B and integration time is four times that of B
X) Smallest resolved angle of A is half that of B and integration time is four times that of B
Y) Smallest resolved angle of A is half that of B and integration time is twice that of B
Z) Smallest resolved angle of A is twice that of B and integration time is half that of B

ANSWER: W) SMALLEST RESOLVED ANGLE OF A IS TWICE THAT OF B AND INTEGRATION TIME IS FOUR TIMES THAT OF B