

ROUND 9A

TOSS-UP

1) EARTH AND SPACE *Multiple Choice* The velocity of particles in the solar wind is closest to which of the following?

- W) 300 meters per second
- X) 3 kilometers per second
- Y) 30 kilometers per second
- Z) 300 kilometers per second

ANSWER: Z) 300 KILOMETERS PER SECOND

BONUS

1) EARTH AND SPACE *Multiple Choice* Which of the following has a shale protolith?

- W) Quartzite
- X) Serpentine **[suhr-pen-TUH-nyt]**
- Y) Gneiss **[NYS]**
- Z) Gabbro

ANSWER: Y) GNEISS

TOSS-UP

2) BIOLOGY *Multiple Choice* In a particular bird population, individuals that lay too many or too few eggs are less likely to survive and reproduce. Which of the following terms best describes this pattern of natural selection?

- W) Directional selection
- X) Stabilizing selection
- Y) Disruptive selection
- Z) Negative-frequency-dependent selection

ANSWER: X) STABILIZING SELECTION

BONUS

2) BIOLOGY *Short Answer* Spongiform encephalopathies **[en-sef-uh-LOP-uh-thees]**, such as scrapie **[SKRAY-pee]**, mad cow disease, and kuru **[KOO-roo]**, are produced after exposure to what general group of infectious agents?

ANSWER: PRIONS

TOSS-UP

3) MATH *Short Answer* How many 4-digit numbers contain the same digits as 2014?

ANSWER: 18

BONUS

3) MATH *Short Answer* Convert 120 in base 10 to hexadecimal.

ANSWER: 78

TOSS-UP

4) ENERGY *Multiple Choice* What would be the total kinetic energy of an object rolling down a ramp with no slippage?

W) $\frac{1}{2} MV^2$ [**half M-V squared**]

X) $\frac{1}{2} I \omega^2$ [**half I omega squared**]

Y) $\frac{1}{2} MV^2 + \frac{1}{2} I \omega^2$ [**half M-V- squared plus half I omega squared**]

Z) 0

ANSWER: Y) $\frac{1}{2} MV^2 + \frac{1}{2} I \Omega^2$

BONUS

4) ENERGY *Short Answer* What general type of nuclear reactor generates more fissile [**FIS-uhl**] material than it consumes?

ANSWER: BREEDER REACTOR

TOSS-UP

5) PHYSICS *Short Answer* What values in quantum systems are used to describe conserved quantities that tend to take on integer or half-integer values, examples of which are spin, azimuthal, and parity?

ANSWER: QUANTUM NUMBERS

BONUS

5) PHYSICS *Short Answer* A cannonball is shot vertically upward from ground level with an initial speed of 100 meters per second. Approximating g as 10 meters per second squared, and ignoring air resistance, what is the maximum height, in meters, that the cannonball reaches?

ANSWER: 500

TOSS-UP

6) CHEMISTRY *Multiple Choice* Which of the following acts as a Lewis acid in the presence of water to form carbonic acid?

- W) Carbon dioxide
- X) Methane
- Y) Methanol
- Z) Formic acid

ANSWER: W) CARBON DIOXIDE

BONUS

6) CHEMISTRY *Short Answer* Identify all of the following four compounds that would function as soluble electrolytes when added to water: 1) sodium chloride; 2) decane; 3) acetic acid; 4) barium sulfate.

ANSWER: 1 AND 3 (ACCEPT: SODIUM CHLORIDE AND ACETIC ACID)

TOSS-UP

7) EARTH AND SPACE *Multiple Choice* Spectroscopic binaries are easiest to detect when

- W) The stars are of the same spectral class
- X) The orbit is viewed edge-on
- Y) The orbit is wide
- Z) The orbit is viewed face-on

ANSWER: X) THE ORBIT IS VIEWED EDGE-ON

BONUS

7) EARTH AND SPACE *Multiple Choice* The largest supermassive black holes are found in

- W) Irregular galaxies
- X) Spiral galaxies
- Y) Elliptical galaxies
- Z) Lenticular galaxies

ANSWER: Y) ELLIPTICAL GALAXIES

TOSS-UP

8) ENERGY *Multiple Choice* Which of the following is an isotope that has attracted recent interest in terms of developing a new generation of cleaner, proliferation-resistant nuclear power?

- W) Uranium-235
- X) Thorium-232
- Y) Plutonium-239
- Z) Uranium-238

ANSWER: X) THORIUM-232

BONUS

8) ENERGY *Short Answer* What is the efficiency of a Carnot engine transferring heat from a reservoir at 500 Kelvin to a cold reservoir at 200 Kelvin?

ANSWER: 60%

TOSS-UP

9) MATH *Short Answer* A basketball player makes 6 baskets during a game, each worth 2 or 3 points. How many different possible values exist for the total points scored by the player?

ANSWER: SEVEN

BONUS

9) MATH *Short Answer*. In a universe with strange and unforeseen geometric relationships, the area of a circle is given by $\frac{1}{\pi}(1+r)^2$, [**open parenthesis 1 plus r close parenthesis squared, divided by pi**] with $\pi = 2$. In the universe described, what is the radius of a circle with an area of 200?

ANSWER: 19

TOSS-UP

10) PHYSICS *Short Answer* Venturi tubes measure the speed of gas flow via application of what rule or principle of fluid dynamics?

ANSWER: BERNOULLI'S PRINCIPLE

BONUS

10) PHYSICS *Short Answer* How many total degrees of freedom does a diatomic gas have?

ANSWER: FIVE

TOSS-UP

11) BIOLOGY *Multiple Choice* Which of the following would be least likely to be a life history trait of an r-selected organism?

- W) Strong competitive ability
- X) Rapid development
- Y) Early reproductive age
- Z) Found in disturbed habitats

ANSWER: W) STRONG COMPETITIVE ABILITY

BONUS

11) BIOLOGY *Short Answer* What is the term for a fluid-filled cavity formed within the mesoderm in triploblastic animals?

ANSWER: PSEUDOCOELOM

TOSS-UP

12) CHEMISTRY *Short Answer* Rank, by name or number, the following three ionic compounds in terms of increasing lattice energy, from the lowest to the highest: 1) Magnesium oxide; 2) Sodium chloride; 3) Sodium fluoride.

ANSWER: 2, 3, 1 (ACCEPT: SODIUM CHLORIDE, SODIUM FLUORIDE, MAGNESIUM OXIDE)

BONUS

12) CHEMISTRY *Short Answer* Of the nonradioactive halides found in natural abundance, which is the strongest reducing agent?

ANSWER: IODIDE (ACCEPT: I⁻ ION; DO NOT ACCEPT: IODINE OR I₂)

TOSS-UP

13) MATH *Short Answer* What is the name of the type of curve that is formed when a piece of rope is hung between two points?

ANSWER: CATENARY CURVE (ACCEPT: FUNICULAR)

BONUS

13) MATH *Short Answer* Provide all of the following three points that lie on the graph of the function $y = 2 \sin \frac{x}{2}$ [**y equals 2 sine of the quantity x divided by two**]: point 1 is (0, 2), point 2 is (π , 2), point 3 is (2π , 0)

ANSWER: 2 AND 3 (ACCEPT: (π , 2), AND (2π , 0))

TOSS-UP

14) PHYSICS *Short Answer* A truck moving at 50 meters per second begins to brake, which applies a constant force of 1000 newtons to the truck. The truck rolls 20 meters before stopping. In joules, what is the initial kinetic energy of the truck?

ANSWER: 20,000

BONUS

14) PHYSICS *Multiple Choice* Which of the following quarks does NOT have an electric charge of $+2/3$ [**plus two-thirds**]?

- W) Up
- X) Strange
- Y) Charm
- Z) Top

ANSWER: X) STRANGE

TOSS-UP

15) EARTH AND SPACE *Multiple Choice* Which of the following is not a polymorph of silica?

- W) Cristobalite [*kri-STOH-buh-lyt*]
- X) Stishovite [*STISH-uh-vyt*]
- Y) Wadsleyite [*wahd-ZLEE-ahyt*]
- Z) Quartz

ANSWER: Y) WADSLEYITE

BONUS

15) EARTH AND SPACE *Multiple Choice* Clays such as kaolinite [*KAY-uh-luh-nyt*] form when H+ [*H plus*] ions combine with which of the following?

- W) Sulfur compounds
- X) Pre-existing minerals, such as feldspars
- Y) Carbon dioxide
- Z) Primordial water emitted directly from volcanic eruptions

ANSWER: X) PRE-EXISTING MINERALS, SUCH AS FELDSPARS

TOSS-UP

16) CHEMISTRY *Multiple Choice* The solubility of a gaseous solute in a liquid solvent is typically expressed in units of concentration. Which of the following factors does NOT affect the solubility of a gas in a liquid?

- W) Volume of the liquid
- X) Temperature of the liquid
- Y) Pressure of the gas
- Z) Polarity of solvent and solute molecules

ANSWER: W) VOLUME OF THE LIQUID

BONUS

16) CHEMISTRY *Short Answer* How many moles of O₂ [*O two*] are required to completely combust 1 mole of pentane?

ANSWER: EIGHT

TOSS-UP

17) BIOLOGY *Multiple Choice* Which of the following animal respiratory pigments does not contain iron?

- W) Hemoglobin [**HEE-muh-gloh-bin**]
- X) Hemoerythrin [**hee-muh- ih-RITH-rin**]
- Y) Myoglobin [**my-uh-GLOH-bin**]
- Z) Hemocyanin [**hee-muh-SAHY-uh-neen**]

ANSWER: Z) HEMOCYANIN

BONUS

17) BIOLOGY *Multiple Choice* Which of the following functions is least important in the open circulatory system of insects?

- W) Delivery of nutrients
- X) Delivery of oxygen
- Y) Circulation of immune cells
- Z) Movement of signaling molecules

ANSWER: X) DELIVERY OF OXYGEN

TOSS-UP

18) ENERGY *Multiple Choice* In general, there are three types of compensation agreements for electricity generated using distributed generation, such as solar photovoltaic. All of the following are examples, *except*:

- W) Rate allocation
- X) Feed-in Tariff (FIT)
- Y) Net metering
- Z) Power purchase agreement

ANSWER: W) RATE ALLOCATION

BONUS

18) ENERGY *Short Answer* Quartz clocks use a crystal oscillator that generates regularly timed electric pulses to keep track of time. What is the name of the effect through which crystals such as quartz can accumulate electric charges?

ANSWER: PIEZOELECTRICITY

TOSS-UP

19) EARTH AND SPACE *Multiple Choice* Which of the following is NOT true about geothermal gradients?

W) The gradient beneath continent crust is less steep than under oceanic crust

X) They vary with tectonic environments

Y) They are largely determined by the way that pressure and temperature vary in the Earth

Z) The “normal” geothermal gradient in the upper part of Earth is 25°C/km [**twenty-five degrees Celsius per kilometer**]

ANSWER: W) THE GRADIENT BENEATH CONTINENT CRUST IS LESS STEEP THAN UNDER OCEANIC CRUST

BONUS

19) EARTH AND SPACE *Short Answer* The blue color found in a blue schist [**SHIST**] rock occurs due to what mineral?

ANSWER: GLAUCOPHANE (ACCEPT: SODIC AMPHIBOLITE OR CROSSITE)

TOSS-UP

20) MATH *Short Answer* If the equations $2x + 8 = 4$ and $ax - 30 = -22$ [**two x plus eight equals four and a x minus thirty equals negative twenty-two**] have the same solution for x , what is the value of a ?

ANSWER: -4

BONUS

20) MATH *Short Answer* What value of x satisfies the equation $27^{6-x} = 9^{x-1}$ [**27 to the power of quantity six minus x equals nine to the power of quantity x minus one**]?

ANSWER: 4

TOSS-UP

21) BIOLOGY *Multiple Choice* What is the name of the enzyme that catalyzes the formation of bicarbonate and hydronium ions from CO₂ and H₂O [**C-O two and H two O**]?

- W) Carbonic anhydrase [**an-HY-drays**]
- X) Carbonic carboxylase [**kahr-BOK-suh-layz**]
- Y) Carbonic decarboxylase
- Z) Carbonic dehydrogenase [**dee-HY-druh-juh-nays**]

ANSWER: W) CARBONIC ANHYDRASE

BONUS

21) BIOLOGY *Multiple Choice* Which of the following brain regions is incorrectly matched with its function?

- W) Medulla oblongata regulates breathing
- X) Pons regulates breath holding
- Y) Cerebellum integrates sensory systems [**ser-uh-BEL-uhm**]
- Z) Hippocampus [**hip-uh-KAM-puhs**] allows two brain hemispheres to communicate with each other

ANSWER: Z) HIPPOCAMPUS ALLOWS TWO BRAIN HEMISPHERES TO COMMUNICATE WITH EACH OTHER

TOSS-UP

22) CHEMISTRY *Multiple Choice* The standard enthalpy and entropy of a hypothetical reaction are both positive. Assuming these values are constant with temperature, which of the following statements describes the temperature dependence of the spontaneity of the reaction?

- W) Spontaneous at all temperatures
- X) Nonspontaneous at all temperatures
- Y) Spontaneous at high temperatures but nonspontaneous at low temperatures
- Z) Spontaneous at low temperatures but nonspontaneous at high temperatures

ANSWER: Y) SPONTANEOUS AT HIGH TEMPERATURES BUT NONSPONTANEOUS AT LOW TEMPERATURES

BONUS

22) CHEMISTRY *Short Answer* Identify all of the following three reactions that would result in a precipitate: 1) Addition of barium nitrate and sodium sulfate; 2) Addition of aluminum nitrate and zinc sulfate; 3) Addition of sodium hydroxide and ammonium sulfate.

ANSWER: 1 (ACCEPT: ADDITION OF BARIUM NITRATE AND SODIUM SULFATE)

TOSS-UP

23) PHYSICS *Multiple Choice* A gold leaf electroscope is negatively charged by touching it with a negatively charged conductor. You then bring a positively charged glass rod close to, but not touching, the top of the electroscope. Which of the following occurs?

- W) The leaves do not move
- X) The leaves spread further apart
- Y) The leaves get closer together
- Z) The leaves first spread further apart, then move closer together

ANSWER: Y) THE LEAVES GET CLOSER TOGETHER

BONUS

23) PHYSICS *Short Answer* Indicate, by number, all of the following four particles that are acted upon by gravity: 1) electron; 2) photon; 3) neutrino; 4) top quark.

ANSWER: 1, 2, 3 AND 4 (ACCEPT: ALL OF THEM)