

TOSS-UP

1. Chemistry *Multiple Choice* Evan is trying to determine the end point of a titration. What class of compounds would he most likely use to visualize the endpoint of his titration?

- W) Buffers
- X) Indicators
- Y) Acids
- Z) Bases

ANSWER: X) INDICATORS [YL]

BONUS

1. Chemistry *Multiple Choice* Kwanga has a sample of sodium carbonate. Addition of which of the following compounds will result in carbon dioxide evolution?

- W) Sodium hydroxide
- X) Hydrochloric acid
- Y) Distilled water
- Z) Saturated brine solution

ANSWER: X) HYDROCHLORIC ACID [YL]

TOSS-UP

2. Math *Multiple Choice* Chris is trying to learn all of HRK volume 1, which has 560 pages of content. Every day, Chris can read and learn 40 pages of the book, but overnight he forgets the last 20 pages of content he read, forcing him to reread them the next day. How many days will it take for Chris to learn the book for the first time?

- W) 26
- X) 27
- Y) 28
- Z) 29

ANSWER: X) 27 [CW]

BONUS

2. Math *Multiple Choice* Jason is going shopping. He buys a \$9.29 item using a 10 dollar bill. What is the least number of coins that he could receive as change?

- W) 5

- X) 6
- Y) 7
- Z) 8

ANSWER: W) 5 [EZ]

TOSS-UP

3. Earth and Space *Short Answer* Order the following three minerals in order of increasing hardness on the Mohs hardness scale:

- 1) Orthoclase
- 2) Apatite
- 3) Corundum

ANSWER: 2, 1, 3 [YL]

BONUS

3. Earth and Space *Short Answer* Order the following three rocks from coarsest to finest grain size:

- 1) Slate
- 2) Granite
- 3) Schist

ANSWER: 2, 1, 3 [SC]

TOSS-UP

4. Biology *Short Answer* Katherine is studying retroviruses, which have a dsDNA genome and replicate through an ssRNA intermediate. What enzyme, which converts RNA to DNA, is essential for the replication of these viruses?

ANSWER: REVERSE TRANSCRIPTASE [MS]

BONUS

4. Biology *Multiple Choice* The circulatory fluid of octopi and horseshoe crabs turns blue when oxygenated. Which of the following metals is a part of hemocyanin (*HEE-mo-SY-a-nin*), the oxygen carrier in this circulatory fluid?

- W) Manganese
- X) Iron

- Y) Copper
- Z) Zinc

ANSWER: Y) COPPER [EY]

TOSS-UP

5. Physics *Short Answer* A ball is launched at an angle on a horizontal surface and undergoes projectile motion. Identify all of the following that would necessarily decrease the horizontal distance the ball travels:

- 1) Increasing the mass of the ball
- 2) Decreasing the angle at which the ball is thrown
- 3) Increasing gravitational constant
- 4) Decreasing the initial velocity of the ball

ANSWER: 3 AND 4 [RY]

BONUS

5. Physics *Multiple Choice* Which of the following elementary particles is the carrier of the electromagnetic force?

- W) Gluon
- X) Photon
- Y) Quark
- Z) Higgs boson

ANSWER: X) PHOTON [RY]

TOSS-UP

6. Chemistry *Short Answer* Identify all of the following four thermodynamic quantities that are state functions:

- 1) Heat
- 2) Pressure
- 3) Enthalpy
- 4) Entropy

ANSWER: 2, 3, 4 [YL]

BONUS

6. Chemistry *Short Answer* Kian has a calorimeter with a heat capacity of 3000 Joules per Kelvin. He places one mole of an unknown organic compound into the calorimeter and lights it on fire, completely combusting it. The temperature of the calorimeter rises by 20 degrees. In kilojoules per mole, what is the molar enthalpy of combustion of the organic compound?

ANSWER: 60 [YL]

TOSS-UP

7. Math *Multiple Choice* Which of the following transformations would turn the function $f(x)$ into $f(x-5) + 6$?

- W) A translation of 5 units to the left and 6 units up
- X) A translation of 5 units to the left and 6 units down
- Y) A translation of 5 units to the right and 6 units up
- Z) A translation of 5 units to the right and 6 units down

ANSWER: Y) A translation of 5 units to the right and 6 units up [EZ]

BONUS

7. Math *Short Answer* Identify all of the following four binary operations that are commutative.

- 1) Addition
- 2) Subtraction
- 3) Multiplication
- 4) Division

ANSWER: 1 AND 3 [EZ]

TOSS-UP

8. Earth and Space *Multiple Choice* Which of the following best describes an occluded front?

- W) Two fast-moving warm and cold fronts collide head-on
- X) Two slow-moving warm and cold fronts collide head-on
- Y) A fast-moving warm front catches up to a cold front
- Z) A fast-moving cold front catches up to a warm front

ANSWER: Z) A FAST-MOVING COLD FRONT CATCHES UP TO A WARM FRONT [SC]

BONUS

8. Earth and Space *Short Answer* Order the following evolutionary stages for a 1.2 solar mass star in chronological order:

- 1) Horizontal branch
- 2) Asymptotic giant branch
- 3) Subgiant branch

ANSWER: 3, 1, 2 [SC]

TOSS-UP

9. Biology *Short Answer* What process describes the phenomenon in which exons from a pre-mRNA molecule can be joined in different combinations to generate different mRNA transcripts?

ANSWER: ALTERNATIVE SPLICING [MS]

BONUS

9. Biology *Short Answer* In the root nodules of a legume, a layer of sclerenchyma seals off bacteroids from oxygen so that they can carry out what process, which converts atmospheric N_2 into NH_3 ?

ANSWER: NITROGEN FIXATION [KW]

TOSS-UP

10. Physics *Short Answer* Select all of the following three thermodynamic processes where no heat is gained or lost by the system:

- 1) Adiabatic expansion
- 2) Free expansion
- 3) Isobaric expansion

ANSWER: 1 AND 2 [JY]

BONUS

10. Physics *Short Answer* Stephen is opening a door, which can be modeled as a lever with its fulcrum at its hinge. Identify all of the following four changes Stephen can make that decreases the amount of force required for him to open the door:

- 1) Pushing closer to the hinge
- 2) Pushing at an angle closer to normal to the door
- 3) Redistributing the mass of the door towards the hinge
- 4) Redistributing the mass of the door towards the handle

ANSWER: 2 AND 3 [YL]

TOSS-UP

11. Chemistry *Multiple Choice* Which of the following four elements has the highest melting point in its natural elemental form?

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

ANSWER: Z) IODINE [YL]

BONUS

11. Chemistry *Short Answer* A 0.1 molar buffer is at pH 5. By what factor does the pH change if the solution is diluted to double its initial volume?

ANSWER: 1 [YL]

TOSS-UP

12. Math *Short Answer* Kian goes to the bookstore with his 6 friends. If they stand in a line in a random order, what is the expected number of people in front of Kian?

ANSWER: 3 [EZ]

BONUS

12. Math *Short Answer* Kian has 4 shirts, 4 pants, and 4 pairs of shoes, all in the four colors red, blue, yellow, and green. How many ways can he choose an outfit consisting of 1 shirt, 1 pants, and 1 pair of shoes, if he doesn't want any two pieces to have the same color?

ANSWER: 24 [EZ]

TOSS-UP

13. Earth and Space *Short Answer* When subject to extreme heat and pressure in the cores of Jupiter and Saturn, what electrically conductive phase of hydrogen forms?

ANSWER: METALLIC HYDROGEN [YL]

BONUS

13. Earth and Space *Multiple Choice* Spaceman Fred is in a circular orbit around Earth, holding a baseball. He wants to throw the baseball in order to instantaneously decrease the energy of the baseball's orbit. What should he do?

- W) Throw it straight towards the Earth
- X) Throw it straight away from the Earth
- Y) Throw it forwards in his direction of motion
- Z) Throw it backwards against his direction of motion

ANSWER: Z) THROW IT BACKWARDS AGAINST HIS DIRECTION OF MOTION [SC]

TOSS-UP

14. Biology *Multiple Choice* A new enzyme was recently discovered that attaches a phosphate group to Evan. Which of the following is most likely the name of this enzyme?

- W) Evan Phosphatase
- X) Evan Reductase
- Y) Evan Isomerase
- Z) Evan Kinase

ANSWER: Z) EVAN KINASE [KD]

BONUS

14. Biology *Multiple Choice* The eggs of Yunyi's pet lizard hatch in front of him in the absence of their mother, causing them to believe he is their mother. Which of the following types of behavior is this an example of?

- W) Classical Conditioning
- X) Operant Conditioning
- Y) Social Learning
- Z) Imprinting

ANSWER: Z) IMPRINTING [KD]

TOSS-UP

15. Physics *Short Answer* Evan throws a pineapple at Kian with initial velocity 9.8 m/s at 15 degrees above the horizontal. Assuming the ground is flat, how far from Evan will the pineapple land?

ANSWER: 4.9 [CW]

BONUS

15. Physics *Short Answer* What is the equivalent resistance of a 10 ohm and 20 ohm resistor connected together in series, which is connected to a 30 ohm resistor in parallel?

ANSWER: 15 [EY]

TOSS-UP

16. Chemistry *Short Answer* What law, often used in spectrophotometry, can be used to calculate the concentration of a particular species in a solution given its absorbance?

ANSWER: BEER-LAMBERT LAW (ACCEPT: BEER'S LAW) [YL]

BONUS

16. Chemistry *Multiple Choice* Which of the following compounds will metallic sodium not react with?

- W) Steam
- X) Strong acid
- Y) Mineral oil
- Z) Water

ANSWER: Y) MINERAL OIL [AY]

TOSS-UP

17. Math *Short Answer* What is the ratio between the area and circumference of a circle with a radius of 10?

ANSWER: 5 [EZ]

BONUS

17. Math *Multiple choice* Which of the following numbers has the most factors?

- W) 240
- X) 252

Y) 264

Z) 276

ANSWER: W) 240 **[EZ]**

TOSS-UP

18. EARTH AND SPACE *Short Answer* Phytoplankton blooms are indicative of what climate pattern, in which temperatures are warmer than normal in the Southern US but cooler than normal in the Northern US?

ANSWER: LA NINA **[ZG]**

BONUS

18. Earth and Space *Short Answer* In addition to Earth, which planet in our solar system was found to have barchan dunes?

ANSWER: MARS **[ZG]**

TOSS-UP

19. Biology *Short Answer* Turner's syndrome is characterized by a female having only one of what structure in her cells, leading to no Barr Body formation?

ANSWER: X CHROMOSOME **[KD]**

BONUS

19. Biology *Multiple Choice* Which of the following phyla has members that are NOT coelomates (*SEE-lum-ates*)?

W) Chordata

X) Platyhelminthes

Y) Mollusca

Z) Echinodermata

ANSWER: X) PLATYHELMINTHES **[KD]**

TOSS-UP

20. Physics *Short Answer* A block is placed in a vat of a mysterious liquid, which has a density of 2500 kilograms per cubic meter. If 40% of the mass is above the surface of the liquid, in kilograms per cubic meter what is the density of the block?

ANSWER: 1500 **[W: CW]**

BONUS

20. Physics *Short Answer* Identify all of the following that would increase the orbital period of a planet:

- 1) Increasing the semi-major axis of the orbit
- 2) Reducing the mass
- 3) Increasing the mass of the star it orbits around

ANSWER: 1 ONLY **[W: CW]**