AVES



RR 2

TOSS-UP

1) MATH *Short Answer* Rohan has a bag with 200 marbles, 2 of each color for 100 different colors. What is the minimum number of marbles he must pick out to have at least one marble of each color?

ANSWER: 199 [RG]

BONUS

1) MATH *Short Answer* The area of a rectangle is 36 centimeters squared and it has integer side lengths. The length and width of the rectangle are each increased by 1. What is the maximum possible area of the new rectangle?

ANSWER: 74 [RG]

TOSS-UP

2) BIOLOGY *Short Answer* Gel electrophoresis separates nucleic acid fragments by size through an electric field. The electric field attracts the DNA's negative charge which is mainly attributed to the presence of what functional group in its backbone?

ANSWER: Phosphate [EH]

BONUS

2) BIOLOGY *Multiple Choice* Which of the following correctly matches the chamber of the heart with its function?

W) Left atrium pumps blood into the aorta

X) Right atrium pumps blood into the pulmonary vein

Y) Left ventricle pumps blood into the vena cava

Z) Right ventricle pumps blood into the pulmonary artery

ANSWER: Z) Right ventricle pumps blood into the pulmonary artery [EH]

TOSS-UP

3) PHYSICS *Multiple Choice* A ball with mass 3 kilograms is dropped from the top of a building vertically with a constant force of 15 newtons acting on it horizontally for its entire fall**.** The trajectory of the ball resembles which of the following types of graphs?

W) Linear

X) Parabolic

Y) Hyperbolic

Z) Exponential

ANSWER: W) Linear [RG]

BONUS

3) PHYSICS *Short Answer* An object in uniform circular motion is experiencing a centripetal force of 50 newtons while rotating about a fixed point at 5 meters per second**.** If the object speeds up and now experiences a centripetal force of 128 newtons, what is the object's new velocity in meters per second, assuming its mass and distance to the fixed point stay constant?

ANSWER: 8 [EH]

TOSS-UP

4) EARTH AND SPACE *Short Answer* The upper mantle can be divided into the stiff lithosphere and what weaker layer, which is mobile due to its composition of partially melted rock?

ANSWER: Asthenosphere [EH]

BONUS

4) EARTH AND SPACE *Short Answer* Identify all of the following three characteristics of oceanic crust that differs from continental crust:

1) Thickness;

2) Density;

3) Composition.

ANSWER: All of them [EH]

TOSS-UP

5) CHEMISTRY *Short Answer* In the reaction with ammonium sulfide and calcium chloride, ammonium chloride and calcium sulfide are produced. The ammonium and chloride ions still exist as ions, so they do not play a role in the reaction. What is the name for these ions?

ANSWER: Spectator ions [RG]

BONUS

5) CHEMISTRY *Short Answer* Rohan performs an analysis on a substance and determines the percentage by mass of each element. Identify all of the following three properties he can determine about the substance:

1) Mass;

2) Empirical formula;

3) Molecular formula.

ANSWER: 2 only [RG]

TOSS-UP

6) MATH *Multiple Choice* How many factors of 12 are not multiples of 2?

W) 1

X) 2

Y) 3

Z) 4

ANSWER: X) 2 [RG]

BONUS

6) MATH *Short Answer* Rohan has recently discovered a new coin, the dollar coin! He realizes he can't actually use it, so he wants to trade it in exchange for some pennies, nickels, dimes, and quarters, so that the amount he receives is exactly 1 dollar**.** What is the minimum number of coins he can receive in exchange for his dollar coin, given that he must receive each coin at least once?

ANSWER: 11 [RG]

TOSS-UP

7) BIOLOGY *Short Answer* Dendritic cells, neutrophils, and macrophages destroy pathogens primarily through what process in which cells extend cytoplasmic projections to engulf large particles?

ANSWER: Phagocytosis [EH]

BONUS

7) BIOLOGY *Short Answer* Identify all of the following four phases of mitosis in which chromosomes are condensed for its entirety:

1) Prophase;

2) Metaphase;

3) Anaphase;

4) Telophase.

ANSWER: 2 and 3 [EH]

TOSS-UP

8) PHYSICS *Short Answer* In certain microscopy techniques, a voltage is applied to allow electrons to pass through a vacuum. What phenomenon does this demonstrate, in which a particle crosses a supposedly impassable potential energy barrier?

ANSWER: Quantum tunneling [RG]

BONUS

8) PHYSICS *Short Answer* Rohan is trying to lift his car using a hydraulic lift. The input piston is a square with side length 3 meters and the output piston is a square with side length 9. If Rohan applies 200 newtons of force on the input piston, what is the maximum weight of the car he can lift in newtons?

ANSWER: 1800 [RG]

TOSS-UP

9) EARTH AND SPACE *Multiple Choice* If an earthquake released 1000 times more energy than another earthquake, about how much greater in magnitude is the first earthquake compared to the second on the Richter scale?

W) 1

X) 2

Y) 3

Z) 4

ANSWER: X) 2 [EH]

BONUS

9) EARTH AND SPACE *Multiple Choice* At which of the following temperatures in Celcius would a set volume of air require the least amount of water vapor to be saturated?

W) 5 degrees

X) 15 degrees

Y) 30 degrees

Z) 40 degrees

ANSWER: W) 5 degrees [EH]

TOSS-UP

10) CHEMISTRY *Short Answer* Rohan is given the enthalpy of vaporization and enthalpy of fusion for a substance. Using this information, he figures out the enthalpy of sublimation. He does this by applying what law, which states that the total enthalpy change during the complete course of a chemical reaction is independent of the sequence of steps taken?

ANSWER: Hess's Law [RG]

BONUS

10) CHEMISTRY *Short Answer* Order the following 3 interactions in terms of increasing strength:

1) Dipole-dipole interactions;

2) London dispersion forces;

3) Ion-dipole.

ANSWER: 2, 1, 3 [RG]

TOSS-UP

11) MATH *Multiple Choice* If a quadratic equation has a vertex at a minimum, which of the following must be true about the quadratic?

W) It has 2 real roots

X) It has 2 complex roots

Y) The leading coefficient is positive

Z) The leading coefficient is negative

ANSWER: Y) The leading coefficient is positive [RG]

BONUS

11) MATH *Short Answer* If a triangle has two side lengths of length 11 and 7, how many possibilities are there for the final side length of the triangle assuming the last side length is also an integer?

ANSWER: 13 [RG]

TOSS-UP

12) BIOLOGY *Short Answer* To increase the surface area for oxidative phosphorylation, the mitochondria has many infoldings in its inner membrane. What is the name of these structures?

ANSWER: Cristae [EH]

BONUS

12) BIOLOGY *Short Answer* Carbon dioxide in the bloodstream diffuses into the lungs to be expelled during expiration. Order the following three parts of the respiratory system from first to last carbon dioxide will pass through as it leaves the body:

1) Trachea;

2) Alveolus;

3) Bronchus.

ANSWER: 2, 3, 1 [EH]

TOSS-UP

13) PHYSICS *Short Answer* Identify all of the following three situations in which work is positive:

1) Work done lowering a block at a constant velocity;

2) Work done lifting a block up at a constant velocity;

3) Work done moving a ball around a circular track once at varying velocities.

ANSWER: 2 only [RG]

BONUS

13) PHYSICS *Short Answer* Identify all of the following 3 changes that must increase the intensity of a wave:

1) Increasing the frequency;

2) Decreasing the frequency;

3) Increasing the wavelength.

ANSWER: None of them [RG]

TOSS-UP

14) EARTH AND SPACE *Short Answer* How many planets in the Solar System have an atmosphere primarily composed of nitrogen?

ANSWER: 1 [PB]

BONUS

14) EARTH AND SPACE *Short Answer* Rohan is looking through a telescope which seems to be distorting the color of the image when it cannot focus all wavelengths of light to a single point. What phenomenon is the lens of the telescope experiencing?

ANSWER: Chromatic aberration [RG]

TOSS-UP

15) CHEMISTRY *Multiple Choice* A perfect crystal is said to have zero entropy at absolute zero. Which of the following laws of thermodynamics does this demonstrate?

W) Zeroth

X) First

Y) Second

Z) Third

ANSWER: Z) Third [RG]

BONUS

15) CHEMISTRY *Multiple Choice* For a first order reaction, which of the following best describes the relationship that the half life of the reaction has with the initial concentration of the reactant?

W) Directly proportional

X) Inversely proportional

Y) Inversely proportional to the square of initial concentration

Z) There is no relationship between half life and initial concentration of reactant

ANSWER: Z) There is no relationship between half life and initial concentration of reactant [EH]

TOSS-UP

16) MATH *Multiple Choice* Rohan has 3 linear equations in 2 variables. Which of the following could not be the number of solutions to the three equations?

W) 0

X) 1

Y) 2

Z) Infinitely many

ANSWER: Y) 2 [RG]

BONUS

16) MATH *Short Answer* Rohan rolls a fair 6 sided dice 3 times**.** What is the probability the sum of the numbers on top of the 3 dice sum up to a value that is greater than 16?

ANSWER: 1/54 [RG]

TOSS-UP

17) BIOLOGY *Multiple Choice* Cyclic AMP acts as a secondary messenger in what stage of cellular signaling?

W) Reception

X) Transduction

Y) Propagation

Z) Response

ANSWER: X) Transduction [EH]

BONUS

17) BIOLOGY *Short Answer* Identify all of the three mechanisms that can change allele frequencies of a population over time:

1) Natural selection;

2) Gene flow;

3) Genetic drift.

ANSWER: All of them [EH]

TOSS-UP

18) PHYSICS *Short Answer* A projectile is launched from the ground directly up at an initial velocity v and reaches a height of 34 feet before falling down. The projectile is then launched again at the same velocity,

but at some angle between 0 and 90 degrees. In feet, what is the maximum horizontal range the projectile can have in the second launch?

ANSWER: 68 [RG]

BONUS

18) PHYSICS *Multiple Choice* Which of the following explains why the acceleration due to gravity varies across different parts of the world?

W) The mass of the objects subject to gravity changes

X) Disruptions in Earth's magnetic field

Y) Differences in altitude

Z) Variations in the strength of the Coriolis effect

ANSWER: Y) Differences in altitude [RG]

TOSS-UP

19) EARTH AND SPACE *Short Answer* Because of the mutual attraction involved in a binary system, a satellite does not orbit the center of its parent object. Instead, it orbits what point, the center of mass between the two bodies?

ANSWER: Barycenter [RA]

BONUS

19) EARTH AND SPACE *Multiple Choice* The orbit of an extrasolar comet is most likely to follow which of the following trajectories?

W) Circular

X) Elliptical

Y) Parabolic

Z) Hyperbolic

ANSWER: Z) Hyperbolic [PB]

TOSS-UP

20) CHEMISTRY *Short Answer* The pressure of a gas is 10 atmospheres. The gas contains 5 moles of gases total. If there are 1.5 moles of oxygen gas, what is the partial pressure of oxygen gas in atmospheres?

ANSWER: 3 [RG]

BONUS

20) CHEMISTRY *Short Answer* Identify all of the following 3 acids which are polyprotic:

1) Sulfuric acid;

2) Nitric acid;

3) Phosphoric acid.

ANSWER: 1 and 3 [RG]
