AVES



RR 3

TOSS-UP

1) MATH *Short Answer* What is the ratio of the volume of a cylinder to a cone with the same height and radius?

ANSWER: 3 (ACCEPT: 3 to 1) [RG]

BONUS

1) MATH *Multiple Choice* Rohan has three positive numbers x, y, and z which can form the sides of a non-degenerate triangle. Which of the following must be true about the triangle with the side lengths being x + 1, y + 1, and z + 1?

W) The triangle must be non-degenerate

X) The triangle may be non-degenerate

Y) The triangle must be degenerate

Z) No conclusion may be made about the triangle

ANSWER: W) The triangle must be non-degenerate [RG]

TOSS-UP

2) BIOLOGY *Short Answer* In animal cells, a cleavage furrow forms during cytokinesis, contracting to split one cell into two. For plant cells, what structure forms instead that splits the plant cell?

ANSWER: Cell plate (Accept: phragmoplast) [EH]

BONUS

2) BIOLOGY *Short Answer* Lost blood elements that leak from the capillaries into the interstitial fluid are recovered through the functions of what organ system?

ANSWER: Lymphatic system [EH]

TOSS-UP

3) PHYSICS *Short Answer* A fluid is moving through three pipes of different radii. It flows through the first pipe of radius 4 at velocity v. It then enters a second pipe of radius 8 and a few minutes later, enters a third pipe of radius 16. What is the fluid's final velocity in terms of v?

ANSWER: v/16 [RG]

BONUS

3) PHYSICS *Multiple Choice* Which of the following functions for the force of a particle in terms of its position x would indicate that the particle is undergoing simple harmonic motion?

W) $f(x) = -\sin(x)$

X) $f(x) = 2x$

Y) $f(x) = -x^2$

Z) $f(x) = -4x$

ANSWER: Z) $f(x) = -4x$ [RG]

TOSS-UP

4) EARTH AND SPACE *Multiple Choice* Which of the following processes is primarily responsible for the initial creation of Valles Marineris, the largest canyon in the solar system?

W) Meteor impact

X) Water erosion

Y) Ice wedging

Z) Seismic activity

ANSWER: Z) Seismic activity [RA]

BONUS

4) EARTH AND SPACE *Multiple Choice* Which of the following best explains how rocks with a pyroclastic texture form?

W) Various minerals crystallizing under different environmental conditions

X) Ejected magma cooling rapidly when exposed to a cold atmosphere

Y) Consolidation of individual rock fragments during explosive volcanic eruptions

Z) Gas bubbles escaping as lava solidifies

ANSWER: Y) Consolidation of individual rock fragments during explosive volcanic eruptions [EH]

TOSS-UP

5) CHEMISTRY *Multiple Choice* For a sodium atom, electrons in which of the following subshells would be the most important in determining its chemical properties?

W) 1s

X) 2s

Y) 2p

Z) 3s

ANSWER: Z) 3s [EH]

BONUS

5) CHEMISTRY *Multiple Choice* Which of the following elements when ionically bonded to a sulfate ion will result in a compound soluble in water?

W) Magnesium

X) Calcium

Y) Strontium

Z) Barium

ANSWER: W) Magnesium [EH]

TOSS-UP

6) MATH *Short Answer* Triangle ABC has all angles having integer measure in degrees. If angle A is 89 degrees, identify all of the following three classifications of ABC that are possible:

1) Acute;

2) Right;

3) Obtuse.

ANSWER: 1 and 2 [RG]

BONUS

6) MATH *Short Answer* Rohan has 5 bottles of water and he chooses two of them at random. 3 of the 5 bottles are blue. What is the probability he chooses at least one blue bottle?

ANSWER: 9/10 [RG]

TOSS-UP

7) BIOLOGY *Short Answer* In the roots of monocots, ground tissue can also be found in the center of the root along with outside the vascular cylinder. What is the name of the ground tissue found at the center?

ANSWER: Pith [EH]

BONUS

7) BIOLOGY *Short Answer* The diffusion of oxygen into the cell is driven by the establishment of a concentration gradient from high cellular consumption. Identify all of the following three organelles whose functions increase the rate of oxygen transport into the cell:

1) Mitochondria;

2) Chloroplasts;

3) Peroxisomes.

ANSWER: 1 and 3 [EH]

TOSS-UP

8) PHYSICS *Multiple Choice* Which of the following fundamental forces has the smallest range?

W) Electromagnetic force

X) Weak force

Y) Strong force

Z) Gravitational force

ANSWER: X) Weak force [EH]

BONUS

8) PHYSICS *Short Answer* Rohan holds two objects at a distance of 3 meters away and the gravitational force between them is F. He doubles the masses of the two objects. At what distance in meters must he keep the objects away from each other to make the force 9F?

ANSWER: 2 [RG]

TOSS-UP

9) EARTH AND SPACE *Short Answer* What structure is formed when unconsolidated sediments are carried off a subducting plate and plastered against the edge of the overriding plate?

ANSWER: Accretionary wedge (Accept: accretionary prism) [EH]

BONUS

9) EARTH AND SPACE *Short Answer* What term describes a highly powerful active galactic nucleus that is extremely bright as observed on Earth because its relativistic jets are pointed at our planet?

ANSWER: Blazar [PB]

TOSS-UP

10) CHEMISTRY *Short Answer* Around a certain central atom, a molecule has bent geometry. Identify all of the following four hybridizations that this central atom can possess:

1) sp^2;

2) sp^3;

3) sp^3d;

4) sp^3d^2.

ANSWER: 1 and 2 [RG]

BONUS

10) CHEMISTRY *Short Answer* Order the following three elements by the maximum number of covalent bonds they can form in increasing order:

1) Carbon;

2) Nitrogen;

3) Sulfur.

ANSWER: 2, 1, 3 [RG]

TOSS-UP

11) MATH *Short Answer* The probability a weighted coin lands on heads is ⅔. What is the expected number of times someone has to flip the coin to get tails?

ANSWER: 3 [RG]

BONUS

11) MATH *Multiple Choice* Rohan is tired of rolling dice. So instead, he flips coins. If he flips 5 fair coins, what is the probability that at most 1 of them show heads?

W) 1/16

X) 3/32

Y) 5/32

Z) 3/16

ANSWER: Z) 3/16 [RG]

TOSS-UP

12) BIOLOGY *Short Answer* In addition to its single chromosome, a typical prokaryotic cell may also have much smaller rings of independently replicating DNA molecules. What is the name of these genetic structures?

ANSWER: Plasmids [EH]

BONUS

12) BIOLOGY *Multiple Choice* Which of the following nitrogenous bases would be the largest in size?

W) Adenine

X) Uracil

Y) Thymine

Z) Cytosine

ANSWER: W) Adenine [EH]

TOSS-UP

13) PHYSICS *Short Answer* A light ray hits a mirror with an incident angle of 88 degrees. What is the angle measure between the direction vectors of the incident and reflected ray in degrees?

ANSWER: 176 [RG]

BONUS

13) PHYSICS *Short Answer* A heat engine inputs 10 kilojoules of heat at 500 Kelvin and outputs 3 kilojoules of heat**.** What is the maximum temperature, in Kelvin, that the heat engine could output at?

ANSWER: 150 Kelvin [RG]

TOSS-UP

14) EARTH AND SPACE *Short Answer* Unlike Earth's magnetic field which is a result of the rotating iron-nickel core, Jupiter's magnetic field is caused by electrical currents through a core made of what element, found in its highly conductive metallic phase?

ANSWER: Hydrogen (Accept: Metallic hydrogen) [RA]

BONUS

14) EARTH AND SPACE *Short Answer* When an end moraine is forming, braided meltwater streams emerge from the glacier, layering deposits of sand and gravel over a broad area**.** What is the name of this feature?

ANSWER: Outwash plain (Accept: glacial outwash) [EH]

TOSS-UP

15) CHEMISTRY *Short Answer* Identify all of the following three properties that generally increase down a column on the Periodic Table:

1) Ionization energy;

2) Polarizability;

3) Metallic character.

ANSWER: 2 and 3 [GG]

BONUS

15) CHEMISTRY *Short Answer* Order the following three hydrocarbons by increasing number of sigma bonds:

1) Ethane;

2) Propene;

3) Butyne.

ANSWER: 1, 2, 3 [EH]

TOSS-UP

16) MATH *Short Answer* Rohan has a line which is not parallel to any of the coordinate axes. Identify all of the following 4 numbers that could be the number of quadrants his line passes through:

1) 1;

2) 2;

3) 3;
4) 4.

ANSWER: 2 AND 3 [RG]

BONUS

16) MATH *Short Answer* A ball is dropped from a height of 100 meters. Every time it hits the ground, it bounces back up to half its previous height. What is the total distance the ball travels assuming it bounces indefinitely?

ANSWER: 300 [RG]

TOSS-UP

17) BIOLOGY *Short Answer* Due to high death rates at a young age, most fishes follow what type of survivorship curve?

ANSWER: Type 3 [EH]

BONUS

17) BIOLOGY *Short Answer* Based on the cohesion-tension hypothesis, water transportation through the xylem exerts strong negative pressure. To prevent the xylem from collapsing, sclerenchyma cells contain what structural polysaccharide hardening their secondary cell walls?

ANSWER: Lignin [EH]

TOSS-UP

18) PHYSICS *Short Answer* Below a critical temperature, certain superconductive materials expel all magnetic fields from their interior. What is the name of this effect?

ANSWER: Meissner effect [RG]

BONUS

18) PHYSICS *Short Answer* Rohan and Edwin want to move an object 10 meters. Rohan applies a force of 100 newtons at a 60° angle in the direction of motion and Edwin applies a force of 50 newtons at a 30° angle in the direction of motion. What is the ratio of the work done by Edwin to the work done by Rohan?

ANSWER: $\sqrt{3}/2$ [RG]

TOSS-UP

19) EARTH AND SPACE *Short Answer* Batholiths are commonly surrounded by a ring of hornfels or quartzite due to the action of what type of metamorphism?

ANSWER: Contact [PB]

BONUS

19) EARTH AND SPACE *Multiple Choice* Which of the following terms is defined as the deviation of an interstellar body from a perfect sphere?

W) Eccentricity

X) Oblateness

Y) Axial precession

Z) Obliquity

ANSWER: X) Oblateness [RA]

TOSS-UP

20) CHEMISTRY *Short Answer* Resonance is the phenomenon in which several different structures are possible for an atom and the overall structure resembles a blend of these structures. How many major structures contribute to the resonance hybrid of the nitrate ion?

ANSWER: 3 [RG]

BONUS

20) CHEMISTRY *Multiple Choice* In which of the following compounds would hydrogen not have an oxidation number of +1?

W) LiOH

X) Al_2H_6

Y) H_3PO_4

Z) H_2S

ANSWER: X) Al_2H_6 [EH]
