AVES

RR 5

TOSS-UP

1) MATH *Short Answer* A common method in finding the rate of change of variables is to solve for the variable and differentiate. However, in equations with many complex terms, it is usually hard to solve for one of the variables, so instead, what technique is used, in which one variable is written as a function of the other and then differentiated?

ANSWER: Implicit differentiation [RG]

BONUS

1) MATH *Short Answer* Let f of n denote the sum of digits of n. For how many positive integers between 1 and 100, inclusive, is $f(n)$ odd?

ANSWER: 51 [RG]

TOSS-UP

2) BIOLOGY *Multiple Choice* The cell wall of a plant cell is exerting high turgor pressure. Which of the following would best describe the solution that the cell is immersed in?

W) Hypertonic

X) Hypotonic

Y) Isotonic

Z) Equipotential

ANSWER: X) Hypotonic [EH]

BONUS

2) BIOLOGY *Short Answer* Identify all of the following three infectious agents that would not be sorted based on the Linnaean system of classification:

1) Virus;

2) Bacteria;

3) Prion.

ANSWER: 1 and 3 [EH]

TOSS-UP

3) PHYSICS *Short Answer* A plane polarized light is subject to a polaroid sheet and is incident at an angle of 30 degrees. By what factor is the intensity changed after the light passes through the sheet?

ANSWER: 3/4 [RG]

BONUS

3) PHYSICS *Short Answer* Identify all of the following 3 conditions which would guarantee that the battery electromotive force is equal to the terminal potential difference in a circuit.

1) The total current in the circuit is 0;

2) The battery has a significant internal resistance;

3) The circuit elements are connected in parallel.

ANSWER: 1 only [RG]

TOSS-UP

4) EARTH AND SPACE *Multiple Choice* In which of the following biomes would solifluction most likely occur?

W) Tropical rainforest

X) Desert

Y) Tundra

Z) Chaparral

ANSWER: Y) Tundra [EH]

BONUS

4) EARTH AND SPACE *Multiple Choice* Which of the following is closest to the period of a typical pulsar?

W) 1 second

X) 1 hour

Y) 1 day

Z) 1 month

ANSWER: W) 1 second [PB]

TOSS-UP

5) CHEMISTRY *Short Answer* Identify all of the following three types of spectroscopy that are correctly matched with its primary function:

1) UV-Vis spectroscopy, examining electronic transitions in atoms;

2) IR spectroscopy, studying vibrational transitions in molecules;

3) Microwave spectroscopy, analyzing rotational transitions in molecules.

ANSWER: All of them [EH]

BONUS

5) CHEMISTRY *Short Answer* Rohan is combusting an unknown number of moles of propane, and he notices that 15 moles of oxygen gas were used up in the reaction. How many moles of propane were reacted?

ANSWER: 3 [RG]

TOSS-UP

6) MATH *Short Answer* Rohan expands the binomial $(ax + b)^6$ [**read as: open parenthesis ax plus b close parenthesis to the power of 6**] and notices that the sum of the coefficients of the polynomial is 64, where a and b are real numbers and x is the variable. Identify all of the following three possible ordered pairs (a, b) that satisfy this condition:

1) (2, 0);

2) (-1, 3);

3) (5, -3).

ANSWER: All of them [RG]

BONUS

6) MATH *Short Answer* How many ways are there to place the numbers from 1 through 6 inclusive in a line such that no two even integers are next to each other and no two odd integers are next to each other?

ANSWER: 72 [RG]

TOSS-UP

7) BIOLOGY *Multiple Choice* Which of the following carbohydrates would lack glycosidic linkages?

W) Galactose

X) Cellulose

Y) Lactose

Z) Maltose

ANSWER: W) Galactose [EH]

BONUS

7) BIOLOGY *Multiple Choice* Hashimoto's disease is an autoimmune disease affecting thyroid tissue. A person with Hashimoto's disease would have a decreased concentration of which of the following hormones in the bloodstream?

W) TRH

X) TSH

Y) T_3

Z) PTH

ANSWER: Y) T_3 [EH]

TOSS-UP

8) PHYSICS *Short Answer* A spring has a spring constant of 35 Newtons per meter. It is then cut into three equally sized pieces. To one of the resulting springs, an object is attached. How much force is required to stretch the object 20 meters from equilibrium?

ANSWER: 2100 [RG]

BONUS

8) PHYSICS *Short Answer* An elevator is accelerating upwards at 2 m/s^2. A person inside the elevator is standing on a bathroom scale, which reads 600 Newtons. Assuming that the acceleration due to gravity is 10 meters per second squared, what is the mass of the person?

ANSWER: 50 [GG]

TOSS-UP

9) EARTH AND SPACE *Short Answer* Gravitational waves can be observed from a kilonova, a massive burst of energy due to the merging between two of what objects?

ANSWER: Neutron stars [PB]

BONUS

9) EARTH AND SPACE *Short Answer* During the Jurassic period, Pangea split into Gondwanaland and what other supercontinent found in the northern hemisphere?

ANSWER: Laurasia [EH]

TOSS-UP

10) CHEMISTRY *Multiple Choice* Which of the following elements has an atomic radius closest to lithium?

W) Hydrogen

X) Beryllium

Y) Sodium

Z) Magnesium

ANSWER: Z) Magnesium [RG]

BONUS

10) CHEMISTRY *Short Answer* Rohan has a sample of hydrogen gas and a sample of oxygen gas. They are at the same temperature. Assuming the root mean square speed of the hydrogen gas is 12 meters per second, to the nearest integer and in meters per second, what is the root mean square speed of the oxygen gas, assuming both gasses behave ideally?

ANSWER: 3 [RG]

TOSS-UP

11) MATH *Short Answer* If Edwin plots the points (0, 0), (1, -2), and (2, -4) on a scatter plot, what would be the value of the correlation coefficient r for this set of points?

ANSWER: -1 [EH]

BONUS

11) MATH *Short Answer* At what angle theta in the interval from 0 to pi is the function sin of theta times cosine of theta maximized?

ANSWER: pi/4 [RG]

TOSS-UP

12) BIOLOGY *Short Answer* During cleavage, a zygote becomes a multicellular embryo through successive mitotic divisions without cell growth. What term describes the hollow ball formed from this process?

ANSWER: Blastula (Accept: blastocyst) [EH]

BONUS

12) BIOLOGY *Multiple Choice* Suzuko is looking at cells in the leaves of C4 plants through a light microscope. He is comparing the cells from a normal plant to one suffering from chlorosis. Which of the following cells would he notice the greatest difference in color?

W) Palisade mesophyll

X) Spongy mesophyll

Y) Bundle sheath cells

Z) Epidermal cells

ANSWER: W) Palisade mesophyll [EH]

TOSS-UP

13) PHYSICS *Short Answer* Crystal oscillator circuits sustain oscillation by taking voltage signals from a quartz resonator. To function, crystal oscillator circuits rely on what effect, which is the accumulation of charge from mechanical stress?

ANSWER: Piezoelectricity [EH]

BONUS

13) PHYSICS *Short Answer* A toy car is initially moving at 5 meters per second. A constant force of 10 newtons is applied to it in order to bring it to a stop. If it traveled a total of 10 meters before stopping, what is the toy car's mass?

ANSWER: 8 [RG]

TOSS-UP

14) EARTH AND SPACE *Short Answer* Order the following three forces from first to last to separate from the other forces immediately after the Big Bang:

1) Strong;

2) Weak;

3) Gravity.

ANSWER: 3, 1, 2 [PB]

BONUS

14) EARTH AND SPACE *Short Answer* Identify all of the following three minerals that have two planes of cleavage:

1) Muscovite;

2) Augite;

3) Hornblende.

ANSWER: 2 and 3 [EH]

TOSS-UP

15) CHEMISTRY *Multiple Choice* Rohan built a galvanic cell in which the two half-cells both have a copper electrode, but the cells contain a solution with different Cu^{2+} concentrations. Which of the following best describes what would happen to the electrode in the half cell with the lower concentration of Cu^{2+}?

W) The mass of the electrode would increase

X) The mass of the electrode would decrease

Y) The mass of the electrode would stay the same

Z) The mass of the electrode would first increase then decrease

ANSWER: X) The mass of the electrode would decrease [EH]

BONUS

15) CHEMISTRY *Short Answer* A four liter sealed container with a movable piston is flushed with a gas at 27 degrees Celsius. If the volume decreases to 2 liters at constant pressure, what is the new temperature of the container in degrees Celsius?

ANSWER: -123 [EH]

TOSS-UP

16) MATH *Multiple Choice* What is the period of the function $\sin(2x) + \cos(4x)$?

W) $\pi/2$

X) π

Y) 2π

Z) The function is not periodic

ANSWER: X) π [RG]

BONUS

16) MATH *Short Answer* Consider the set of all 3 digit positive integers such that each digit is either 1 or 3. He then removes 111 and 333 from the set. What is the sum of the remaining elements in their set?

ANSWER: 1332 [RG]

TOSS-UP

17) BIOLOGY *Short Answer* A rat is placed in a cage with a red button and a green button. Everytime the rat presses the red button, it is electrically shocked. Everytime the rat presses the green button, it is rewarded with a treat. What kind of conditioning is being demonstrated?

ANSWER: Operant conditioning [EH]

BONUS

17) BIOLOGY *Multiple Choice* Which of the following best describes the directionality of transport in the xylem and phloem?

W) The phloem transports unidirectionally while the xylem transports bidirectionally

X) The phloem transports bidirectionally while the xylem transports unidirectionally

Y) Both vascular tissues transport unidirectionally

Z) Both vascular tissues transport bidirectionally

ANSWER: X) The phloem transports bidirectionally while the xylem transports unidirectionally [EH]

TOSS-UP

18) PHYSICS *Multiple Choice* An alpha particle is traveling in the positive z-direction in a uniform magnetic field. If the magnetic force acting on the particle points in the positive y direction, in what direction does the magnetic field point?

W) Positive x

X) Negative x

Y) Negative y

Z) Negative z

ANSWER: X) Negative x [EH]

BONUS

18) PHYSICS *Short Answer* Gaurav is at a loud party and decides to measure the loudness of the music. If he measures the loudness to be 105 decibels at a distance of 4 meters from the speaker, what loudness, in decibels, would he hear at a distance of 40 centimeters from the speaker?

ANSWER: 125 decibels [GG]

TOSS-UP

19) EARTH AND SPACE *Short Answer* As new oceanic crust is formed at divergent boundaries, their elevated position causes the slabs of lithosphere to slide down. What phenomenon is occurring, which is essential in driving the motion of plate tectonics?

ANSWER: Ridge push (Do not accept: slab pull) [EH]

BONUS

19) EARTH AND SPACE *Multiple Choice* In the Hubble tuning fork diagram, the largest galaxies in the universe would typically have which of the following classifications?

W) E5

X) S0

Y) Sbc

Z) Sa

ANSWER: W) E5 [EH]

TOSS-UP

20) CHEMISTRY *Short Answer* What is the formal charge of oxygen in the compound O_2^{2-} [**read: O two two minus**]?

ANSWER: -1 [GG]

BONUS

20) CHEMISTRY *Short Answer* Reaction A + B yields C has a delta G of -1000 joules**.** If reaction 2D + 4E yields 2C has a delta G of -500 joules, what is the delta G of reaction A + B yields D + 2E in joules?

ANSWER: -750 [EH]
