AVES



RR 4

TOSS-UP

1) MATH *Multiple Choice* Which of the following decimals is closest to 8/27?

W) 0.1

X) 0.2

Y) 0.3

Z) 0.4

ANSWER: Y) 0.3 [RG]

BONUS

1) MATH *Short Answer* The position of a particle is given parametrically by <5t, $2t^2$> **[read as: 5t comma 2t squared]** at time t. What is the speed of the particle at time t = 3?

ANSWER: 13 [RG]

TOSS-UP

2) BIOLOGY *Short Answer* What enzyme contradicts the central dogma of molecular biology by synthesizing double stranded DNA from a RNA template strand?

ANSWER: Reverse transcriptase [EH]

BONUS

2) BIOLOGY *Multiple Choice* Which of the following types of selection would lead to the greatest increase in genetic variation?

W) Directional

X) Disruptive

Y) Stabilizing

Z) Balancing

ANSWER: X) Disruptive [EH]

TOSS-UP

3) PHYSICS *Short Answer* Entropy is decreased when mass is lost in a black hole. However, black holes do not violate the second law of thermodynamics because they increase entropy through the release of what type of radiation?

ANSWER: Hawking radiation [RG]

BONUS

3) PHYSICS *Multiple Choice* A ring of uniform charge is in the xy plane centered at the origin and a point is placed at z = -1. The point is then slowly moved along the z-axis to z=1. Which of the following describes how the magnitude of the electric potential at the point changes as it is moved?

W) Increases

X) Decreases

Y) Increases then decreases

Z) Decreases then increases

ANSWER: Y) Increases then decreases [RG]

TOSS-UP

4) EARTH AND SPACE *Short Answer* Order the following three mountainous structures from youngest to oldest:

1) Himalayas;

2) Australian shield

3) Appalachians.

ANSWER: 1, 3, 2 [EH]

BONUS

4) EARTH AND SPACE *Multiple Choice* Samarth is measuring the density of seawater. Under which of the following conditions would Samarth find the densest seawater?

W) High salinity; high temperature

X) High salinity; low temperature

Y) Low salinity; high temperature

Z) Low salinity; low temperature

ANSWER: X) High salinity; low temperature [EH]

TOSS-UP

5) CHEMISTRY *Multiple Choice* The K_{sp} of a compound with formula AB, where A and B are elements, is 9 times 10^{-8}. Which of the following is closest to the molar solubility of A?

W) 6 times 10^{-8}

X) 2 times 10^{-6}

Y) 3 times 10^{-4}

Z) 4 times 10^{-2}

ANSWER: Y) 3 times 10^{-4} [RG]

BONUS

5) CHEMISTRY *Short Answer* Identify all of the following three thermodynamic state functions that a catalyst could change for a reaction:

1) delta S;

2) delta G;

3) delta H.

ANSWER: None of them [RG]

TOSS-UP

6) MATH *Short Answer* A polynomial equation with real coefficients with degree 7 has the complex number 1 + 2i as a root. What is the minimum number of distinct roots it could have?

ANSWER: 3 [RG]

BONUS

6) MATH *Short Answer* For how many positive integers n does n^2 have exactly 4 digits?

ANSWER: 68 [RG]

TOSS-UP

7) BIOLOGY *Short Answer* The cell body of a typical neuron is studded with numerous high branched extensions that receive signals from other neurons. What are these extensions called?

ANSWER: Dendrites [EH]

BONUS

7) BIOLOGY *Multiple Choice* At which of the following temperatures would the addition of cholesterol mainly contribute by decreasing membrane fluidity?

W) High temperature

X) Low temperature

Y) Cholesterol always decreases membrane fluidity

Z) Cholesterol never decreases membrane fluidity

ANSWER: W) High temperature [EH]

TOSS-UP

8) PHYSICS *Short Answer* Identify all of the following 3 quantities that must be zero in a system that is in static equilibrium:

1) Net torque;

2) Net force;

3) Velocity.

ANSWER: All [RG]

BONUS

8) PHYSICS *Short Answer* A circuit consists of a 5 ohm and 10 ohm resistor with a 12 volt battery. What is the ratio of the power dissipated by the circuit if the resistors were connected in series to the power dissipated by the circuit if the resistors were connected in parallel?

ANSWER: 2/9 [RG]

TOSS-UP

9) EARTH AND SPACE *Multiple Choice* Axions and WIMPS are proposed explanations for which of the following phenomena?

W) Black holes

X) Dark matter

Y) Dark energy

Z) Gamma ray bursts

ANSWER: X) Dark matter [PB]

BONUS

9) EARTH AND SPACE *Short Answer* What type of vents usually found on the flanks of volcanoes only emit hot volcanic gases and vapors without accompanying liquids or solids?

ANSWER: Fumaroles [EH]

TOSS-UP

10) CHEMISTRY *Short Answer* In the non-elementary reaction, A + B yields C, the concentration of B is held constant while the concentration of A is doubled, leading the rate of the reaction to double**.** When the concentration of A is quadrupled and the concentration of B is doubled, the rate of the reaction increases sixteen fold**.** What is the order of the reaction?

ANSWER: Third order (Accept: 3) [EH]

BONUS

10) CHEMISTRY *Multiple Choice* Gaurav wants to increase the percent ionization of an acid**.** Which of the following actions should he take to increase percent ionization in his 2 molar solution of acetic acid?

W) Dilute the solution with water

X) Increase the concentration of the conjugate base

Y) Increase the concentration of acetic acid

Z) Introduce a catalyst of the ionization reaction

ANSWER: W) Diluting the solution with water [EH]

TOSS-UP

11) MATH *Multiple Choice* How many units must the parabola $x^2 + 6x + 7$ be shifted up so that it is tangent to the x-axis?

W) 1

X) 2

Y) 3

Z) 4

ANSWER: X) 2 [RG]

BONUS

11) MATH *Short Answer* Consider pens being stacked in a pyramid with 1 in the top layer, 8 in the second layer, 27 in the third layer, and so on**.** How many pens in total are needed to form a pyramid with 7 layers?

ANSWER: 784 [RG]

TOSS-UP

12) BIOLOGY *Short Answer* Identify all of the following three model organisms that would not share the same domain as humans:

1) C. elegans;

2) D. melanogaster;

3) E. coli.

ANSWER: 3 only [EH]

BONUS

12) BIOLOGY *Short Answer* Identify all of the following three tissues that could develop into the phloem:

1) Procambium;

2) Vascular cambium;

3) Cork cambium.

ANSWER: 1 and 2 [EH]

TOSS-UP

13) PHYSICS *Multiple Choice* Rohan has an Atwood machine, with the first block having a greater mass than the second block. He increases the mass of the first block without bound. Which of the following describes how the magnitude of the acceleration of the two blocks changes as he does this?

W) Always increases

X) Always decreases

Y) Increases then decreases

Z) Decreases then increases

ANSWER: W) Always increases [RG]

BONUS

13) PHYSICS *Short Answer* A particle experiences a force in 3 dimensions described by $3\mathbf{i} + 4\mathbf{j} - 2\mathbf{k}$. If the particle has a displacement of $2\mathbf{i} + 2\mathbf{j} - 3\mathbf{k}$, what is the work done on the particle by the force?

ANSWER: 20 [RG]

TOSS-UP

14) EARTH AND SPACE *Short Answer* Order the following three moons by increasing albedo:

1) Enceladus;

2) Callisto;

3) Europa.

ANSWER: 2, 3, 1 [RG]

BONUS

14) EARTH AND SPACE *Multiple Choice* The Hayashi track describes the movement of stars along an H-R diagram at which of the following points in their evolution?

W) Pre-main sequence

X) Main sequence

Y) Red giant branch

Z) Horizontal branch

ANSWER: W) Pre-main sequence [PB]

TOSS-UP

15) CHEMISTRY *Short Answer* Order the following 3 substances in terms of increasing standard molar entropy:

1) Water;

2) Graphite;

3) Diamond.

ANSWER: 3, 2,1 [RG]

BONUS

15) CHEMISTRY *Multiple Choice* A molecule with which of the following geometries must be polar?

W) Linear

X) Square planar

Y) Trigonal bipyramidal

Z) Square pyramidal

ANSWER: Z) Square pyramidal [RG]

TOSS-UP

16) MATH *Multiple Choice* January 1st of a certain year was a Monday**.** Which of the following dates of the same year must also be a Monday?

W) January 7th

X) January 27th

Y) February 5th

Z) February 13th

ANSWER: Y) February 5th [RG]

BONUS

16) MATH *Short Answer* A rhombus has diagonals with length 120 and x, where x is an integer**.** If the area is a perfect square, what is the smallest possible value of x?

ANSWER: 15 [RG]

TOSS-UP

17) BIOLOGY *Short Answer* Pepsinogen is activated to pepsin through its contact with what strong acid in the stomach?

ANSWER: Hydrochloric acid (Accept: HCl) [EH]

BONUS

17) BIOLOGY *Short Answer* The motor protein kinesin transports vesicles from the Golgi apparatus to the plasma membrane on specialized tracks**.** What cytoskeletal element makes up these tracks?

ANSWER: Microtubules (Accept: tubulin) [EH]

TOSS-UP

18) PHYSICS *Short Answer* Time dilation is the phenomenon in which the elapsed time for two observers is different due to a relative velocity between them. What quantity, calculated based on the relative velocity, can be used to calculate the ratio of the elapsed times for the two observers?

ANSWER: Lorentz factor [RG]

BONUS

18) PHYSICS *Short Answer* A planet travels in an elliptical orbit around a star and the closest distance it has to the star is 2 AU and the farthest distance it has to the star is 6 AU. What is the eccentricity of the orbit?

ANSWER: 1/2 [RG]

TOSS-UP

19) EARTH AND SPACE *Short Answer* Mafic rocks typically contain high concentrations of what type of feldspar, which consists of a solid solution between calcium-rich and sodium-rich endmembers?

ANSWER: Plagioclase [PB]

BONUS

19) EARTH AND SPACE *Multiple Choice* The white regions of Pluto's surface are thought to be glaciers composed of what typically gaseous molecule?

W) Carbon dioxide

X) Methane

Y) Nitrogen

Z) Oxygen

ANSWER: Y) Nitrogen [PB]

TOSS-UP

20) CHEMISTRY *Multiple Choice* Which of the following isomerisms is not a type of stereoisomerism?

W) Cis-trans isomerism

X) Enantiomerism

Y) Constitutional isomerism

Z) Diastereomers

ANSWER: Y) Constitutional isomerism [EH]

BONUS

20) CHEMISTRY *Multiple Choice* In a balloon at atmospheric pressure and 300 Kelvin, the following reaction is at equilibrium: $3H_2$ (g) + N_2 (g) yields $2NH_3$ (g). Helium gas is added to the balloon, maintaining it at atmospheric pressure and thus, increasing volume. Which of the following would occur, assuming that the temperature remains constant?

W) The reaction will shift towards the reactants

X) The reaction will shift towards the products

Y) The reaction will not be affected

Z) It is not possible to predict the direction of the reaction

ANSWER: W) The reaction will shift towards the reactants [GG]
