


# RR4

**TOSSUP**

1) Biology - *Short Answer:* The PQ interval on an ECG is caused by a delay between the depolarization of the atria, and that of the ventricles. What structure within the intraventricular septum is responsible for this delay of about 0.1 seconds in humans?

ANSWER: AV node (ACCEPT: atrioventricular node) [AD]

**BONUS**

1) Biology - *Short Answer:* Glomerular filtration rate is the rate at which plasma is filtered into the Bowman's capsule of nephrons. Which of the following three conditions will result in an increase in GFR?

1) Vasoconstriction of afferent arteriole
2) Contraction of mesangial cells
3) Vasoconstriction of efferent arteriole

ANSWER: 3 [AD]

**TOSSUP**

2) Chemistry - *Multiple Choice* Which of the following compounds acts as the reducing agent in the reaction between a strip of zinc metal and hydrochloric acid?

W) Zinc
X) Hydrochloric acid
Y) Water
Z) There is no reaction

ANSWER: W) Zinc [SO]

**BONUS**

2) Chemistry- *Multiple Choice* In the typical titration of a weak acid, such as 0.1 molar acetic acid, with a strong base, such as 0.1 molar sodium hydroxide, which of the following is the best description of the characteristic titration curve?

W) At the equivalence point, the pH is primarily controlled by the acetate ion
X) At the equivalence point, the pH drops dramatically
Y) The second equivalence point is primarily controlled by the hydroxide ion
Z) The pH at the equivalence point is almost always 7

ANSWER: W) At the equivalence point, the pH is primarily controlled by the acetate ion

**TOSSUP**

3) Earth and Space - *Multiple Choice* Which of the following, in degrees celsius per kilometer, is closest to the value of the dry adiabatic lapse rate?

W) 9
X) 10
Y) 11
Z) 12

ANSWER: X) 10 [JY]

**BONUS**

3) Earth and Space - *Short Answer* What are the two main microscopic marine organisms responsible for the formation of calcareous ooze on the ocean floor?

ANSWER: Cocclithophores and foraminifera (ACCEPT: in any order and “forams” in place of foraminifera) [JY]

**TOSSUP**

4) Math - *Short Answer* Among all real values of x, what is the minimum value of x^6+4x^3+100?

ANSWER: 96

**BONUS**

4) Math - *Short Answer* What is the determinant of a matrix with first row 2, 8, and second row -4, -5?

ANSWER: 22

**TOSSUP**

5) Physics - *Short Answer* A particle's position is defined by the function x(t) = 3e^t + 6t^2. Find the acceleration of the particle at t=0.

ANSWER: 15

**BONUS**

5) Physics - *Short Answer* A planet has an escape velocity of v. Another planet has double the radius and double the density. What is the new escape velocity?

ANSWER: 2sqrt2v

**TOSSUP**

6) Biology - *Short Answer* What form of incomplete cleavage, which results in the formation of only two layers of cells at the animal pole in most birds, is characteristic of animals whose eggs have a large amount of yolk?

ANSWER: meroblastic (ACCEPT: meroblastic cleavage) [AD]

**BONUS**

6) Biology - *Short Answer* Chef Grace is preparing an octopus soup for the competitors at SCB. To create the most harmonious dish possible, she must add organisms that are more closely related to octopi before adding organisms that are more distantly related. Order the following three organisms in the order that they would be added in the recipe:

1) earthworms
2) sheep
3) nematodes

ANSWER: 1, 3, 2 [AD]

**TOSSUP**

7) Chemistry - *Short Answer* If the temperature of a 4L piston at constant pressure is increased from 200K to 500K, then in liters, what is the new volume of the piston?

ANSWER: 10 L [SO]

**BONUS**

7) Chemistry - Short Answer - *Short Answer* Identify all of the following 3 species which are paramagnetic in its ground state:

1) CO
2) $F_2$
3) $He_2$

ANSWER: NONE [SO]

**TOSSUP**

8) Earth and Space - *Short Answer* What is the term for the moraine after a series of recessional moraines representing a glacier's furthest advance?

ANSWER: Terminal moraine (DO NOT ACCEPT: End moraine or recessional moraine) [JY]

**BONUS**

8) Earth and Space - *Short Answer* In sedimentary rocks, finer grain sizes generally correspond to a reduction in what property, which refers to the ability of a rock body or group of sediment to allow water to flow through or within it?

ANSWER: Permeability [JY]

**TOSSUP**

9) Math - *Short Answer* What is the sum of the z-scores of the list of numbers 1, 2, 3, 6, 7, 8.

ANSWER: 0

**BONUS**

9) Math - *Short Answer* Equilateral triangle SCB has an inradius of 4, what is it's area?

ANSWER: 48sqrt3

**TOSSUP**

10) Physics - *Short Answer* Gauss's law of magnetism prohibits the existence of what type of object which has a net magnetic flux?

ANSWER: Magnetic Monopole

**BONUS**

10) Physics - *Short Answer* A circular wire of radius 1 is placed in a magnetic field of 2 milli teslas. Over a period of 5 seconds, the magnetic field uniformly decreases to 0. If the wire has a resistance of 5 ohms, what is the current in the wire in terms of pi during this period?

ANSWER: 8 pi * $10^{-5}$ Amps

**TOSSUP**

11) Biology - *Short Answer* Arjun notices a similarity between the lateral lines of fish and the semicircular canals of humans. What gelatinous structures, in which the stereocilia of hair cells are embedded, are present in both of these examples?

ANSWER: cupula (ACCEPT: cupulae)

**BONUS**

11) Biology - *Multiple Choice* A population of mice in Hardy-Weinberg equilibrium have coat color controlled by one gene, where the dominant allele confers dark color and the recessive allele confers light color. If the frequency of light individuals in the population is 0.64, what is the frequency of heterozygotes?

ANSWER: 0.32 [AD]

**TOSSUP**

12) Chemistry - *Short Answer* For the reduction of the permanganate ion, $MnO_4^-$, in acidic solution, $Mn^{2+}$ is produced. In this reduction reaction, how many electrons are transferred between the reactants and products?

ANSWER: 5 [SO]

**BONUS**

12) Chemistry - *Short Answer* If Helium and Sulfur Dioxide gases both effuse through a small opening in a gas tank, what is the ratio of the rate of effusion for Helium to that of Sulfur Dioxide?

ANSWER: 4 [SO]

**TOSSUP**

13) Earth and Space - *Short Answer* Identify all of the following three spectral classes that solely belong to brown dwarfs:

1) M
2) T
3) Y

ANSWER: 2 and 3

**BONUS**

13) Earth and Space - *Multiple Choice* As the Sun ages, it is theorized to lose significant mass. Which of the following best describes the orbits of planets such as Mars and Jupiter ignoring drag?

W) Orbital radius increases, orbital speed decreases
X) Orbital radius increases, orbital speed increases
Y) Orbital radius decreases, orbital speed decreases
Z) Orbital radius decreases, orbital speed increases

ANSWER: W) Orbital radius increases, orbital speed decreases

**TOSSUP**

14) Math - *Short Answer* The Lucas numbers are very similar to the fibonacci numbers, where each term is the sum of the last two. However the first two terms of the Lucas numbers are 2 and 1 in that order. What constant does the ratio of two consecutive terms approach as the sequence continues to infinity?

ANSWER: The Golden Ratio (ACCEPT: (1+sqrt5)/2)

**BONUS**

14) Math - *Short Answer* Given that all angles are in degrees, identify all of the following that are equivalent to sin(15).

1) sin(345)
2) cos(75)
3) cos(105)

ANSWER: 2 ONLY

**TOSSUP**

15) Physics - *Short Answer* Identify all of the following 3 particles that can interact with gravity:

1) Photon
2) Neutrino
3) Positron

ANSWER: ALL

**BONUS**

15) Physics - *Multiple Choice* Heidi is standing next to a lake. The sun is shining onto the lake at a certain angle, theta. For which of the following angles theta is the light reflected off the lake most polarized? Assume the water has a refractive index of 1.33?

W) 30 degrees
X) 40 degrees
Y) 50 degrees
Z) 60 degrees

ANSWER: Y

**TOSSUP**

16) Biology - *Multiple Choice:* The removal of which of the following ions from NMDA receptors is crucial for long term potentiation?

W) Ca2+
X) K+
Y) Na+
Z) Mg2+

ANSWER: Z [AD]

**BONUS**

16) Biology - *Short Answer:* Identify all of the following three features shared exclusively by charophytes and plants that are not present in chlorophytes?

1) Rosette cellulose synthesizing complexes
2) Flagellated sperm
3) Use of sporopollenin to avoid dessication

ANSWER: 1, 3 [AD]

**TOSSUP**

17) Chemistry - *Multiple Choice* Which of the following formulas is NOT correctly matched to its type of compound?

W) $C_5H_{11}CHO$, Aldehyde
X) $C_5H_{10}$, Noncyclic Alkane
Y) $C_5H_{11}COOH$, Carboxylic Acid
Z) $C_5H_{11}NH_2$, Amine

ANSWER: X) $C_5H_{10}$, Noncyclic Alkane [SO]

**BONUS**

17) Chemistry - *Short Answer* Identify all of the following three molecules that have a trigonal bipyramidal VSEPR geometry:

1) $ClF_5$
2) $PCl_5$
3) $XeOF_4$

ANSWER : 2 only [SO]

**TOSSUP**

18) Earth and Space - *Short Answer* Star A has a peak wavelength of lambda. Star B has a peak wavelength of lambda/2. Assuming Star A and Star B both have the same radius, what is the ratio of the luminosities between Star A and Star B?

ANSWER: 1/16

**BONUS**

18) Earth and Space - *Multiple Choice* Pluto's Sputnik Planitia has relatively few craters compared to its surroundings. Which of the following is the primary reason for this phenomenon?

W) Impactor flux is lower at the location of Sputnik Planitia due to Pluto's orientation
X) Past glacial flow and volatile transport may have smoothed or erased older craters
Y) Frequent sublimation–condensation cycles hide craters under seasonal frost layers
Z) The surface is geologically young due to convective overturning and resurfacing of nitrogen ice

ANSWER: Z

**TOSSUP**

19) Math - *Multiple Choice* In a certain movie theatre, children get in for half price. If 7 adult tickets and 4 child tickets cost 28 dollars and 8 cents, how much does each adult ticket cost?

W) 3 dollars and 2 cents
X) 3 dollars and 12 cents
Y) 3 dollars and 22 cents
Z) 3 dollars and 32 cents

ANSWER: X) 3 dollars and 12 cents

**BONUS**

19) Math - *Short Answer* Game theory deals with the study of games and optimal strategies. A zero-sum game in game theory is a game where one player's win correlates to another player's loss. Identify all of the following three games that are **not** zero sum:

1) Prisoner's Dilemma
2) Poker
3) Tennis

ANSWER: 1 only

**TOSSUP**

20) Physics - *Multiple Choice* In classical mechanics, two charged particles orbiting each other will have their orbits slowly decay. Which of the following best explains why this occurs?

W) They are destabilized by magnetic interactions between their orbital currents
X) They emit gravitational radiation as they orbit
Y) They radiate electromagnetic waves
Z) They experience increasing Coulomb repulsion that destabilizes their orbit

Answer: Y) They radiate electromagnetic waves

**BONUS**

20) Physics - *Short Answer* A liquid has a surface tension of 2 N/m and forms a droplet with radius of 2 cm. Find the energy needed to spread all the molecules an infinite distance away from each other in terms of pi.

ANSWER: $3.2\pi * 10^{-3}$