


# RR3

**TOSSUP**

1) Biology - *Multiple Choice* Joel is studying mutated DNA replication in bacteria. The bacteria he is observing can temporarily separate the two DNA strands, but they quickly re-anneal before the complementary strand can begin synthesis. Which of the following replication machinery components is likely mutated in this bacteria?

W) Helicase
X) Primase
Y) Single-Stranded Binding Protein
Z) Topoisomerase

ANSWER: Y) Single-Stranded Binding Protein [HL]

**BONUS**

1) Biology - *Short Answer* Order the following four intermediates from first to last in the progression of the Krebs cycle after the creation of citrate:

1) Alpha Ketoglutarate
2) Fumarate
3) Isocitrate
4) Succinate

ANSWER: 3, 1, 4, 2 (ACCEPT: Isocitrate, Alpha Ketoglutarate, Succinate, Fumarate [HL]

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**TOSSUP**

2) Chemistry - *Short Answer* Order the following three types of solids in order of increasing melting point:

1) Molecular
2) Ionic
3) Network Covalent

ANSWER: 123 [SO]

**BONUS**

2) Chemistry - *Multiple Choice* 1 mole of which of the following hydrocarbons requires exactly 6 moles of O2 to achieve complete combustion?

W) C3H6
X) C4H8
Y) C5H10
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Z) C6H12

ANSWER: X) C4H8 [SO]

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**TOSSUP**

3) Earth and Space - *Short Answer* Order the following three types of volcanoes from lowest to highest viscosity of their magma:

1) Stratovolcano
2) Shield volcano
3) Cinder cone

ANSWER: 2, 3, 1 [JY]

**BONUS**

3) Earth and Space - *Short Answer* What equation describes the discharge of groundwater by multiplying the hydraulic conductivity, hydraulic gradient, and cross-sectional area of the flow path?

ANSWER: Darcy's Law [JY]

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**TOSSUP**

4) Math - *Short Answer* Normal distribution X has a mean of 10 and a standard deviation of 5. Normal distribution Y has a mean of 15 and standard deviation 5. To the nearest integer, what is the standard deviation of the distribution X - Y?

ANSWER: 7

**BONUS**

4) Math - *Short Answer* A shop sells balls, bats and gloves. 1 ball, 1 bat, and 1 glove costs $8. 1 ball, 2 bats, and 4 gloves costs $16, 1 ball, 3 bats and 9 gloves costs $28. In dollars, how much does 1 ball, 5 bats, and 25 gloves cost.

ANSWER: 64

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**TOSSUP**

5) Physics - *Short Answer* A force acts 3 N north and 4 N to the east. What is the magnitude of the acceleration this force causes on a 1 kg object?

ANSWER: 5 $m/s^2$

**BONUS**

5) Physics - *Short Answer* Identify all of the following quantities that are conserved:

1) Integral of torque with respect to time
2) Derivative of force with respect to time
3) Integral of force with respect to time

ANSWER: 13

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**TOSSUP**

6) Biology - *Short Answer* When a seedling is placed in a dark environment, pallor and elongated stems can be observed as a result of increased auxin production. What is the name for this phenomenon?

ANSWER: Etiolation [HL]

**BONUS**

6) Biology - *Short Answer* What term refers to a type of maternal effect gene that sets up concentration gradients across the egg's cytoplasm that determine the axes of offspring?

ANSWER: Egg Polarity Genes (DO NOT ACCEPT: Cytoplasmic Determinants) [HL]

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**TOSSUP**

7) Chemistry - *Multiple Choice* In an acid base titration, an erlenmeyer flask is often used to store the analyte for the reaction. To store the titrant, which of the following pieces of glassware is most commonly used?

W) Buchner flask
X) Graduated Cylinder
Y) Burette
Z) Pipette

ANSWER: Y) Burette [SO]

**BONUS**

7) Chemistry - *Short Answer* Identify all of the following three statements that are true of phase diagrams:

1) As pressure decreases, it becomes easier for a substance to evaporate
2) The slope of the solid-liquid boundary depends on the relative density of the phases
3) Above the critical temperature, no amount of pressure can liquefy a gas

ANSWER: All [SO]

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**TOSSUP**

8) Earth and Space - *Short Answer* Order the following three marine zones from closest to farthest from a continent:

1) Continental rise
2) Continental slope
3) Continental shelf

ANSWER: 3, 2, 1 [JY]

**BONUS**

8) Earth and Space - *Multiple Choice* Which of the following best explains the differences in ozone distribution throughout the atmosphere?

W) Most atmospheric ozone is in the stratosphere
X) Most atmospheric ozone is in the troposphere
Y) Most atmospheric ozone is in the mesosphere
Z) Atmospheric ozone is distributed evenly throughout each layer

ANSWER: W) Most atmospheric ozone is in the stratosphere [JY]

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**TOSSUP**

9) Math - *Short Answer* Arjun is standing at the position (3, 4) on the coordinate plane. In how many ways can he reach the origin if he can only move 1 unit down or to the left at a time?

ANSWER: 35

**BONUS**

9) Math - *Short Answer* How many of the first 100 positive integers are not divisible by either 5 or 7?

ANSWER: 68

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**TOSSUP**

10) Physics - *Short Answer* What term describes a process with no heat lost or gained from the surroundings?

ANSWER: Adiabatic

**BONUS**

10) Physics - *Short Answer* What is the kinetic energy of a charge of 1 C when it moves from x=0 to x=2 meters in an electric field given by E(x) = ax^2 where a is 5 N/C*m2 (read 5 newtons per coulomb meter squared).

ANSWER: 40/3 J

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**TOSSUP**

11) Biology - *Short Answer* Order the following three components of the animal vascular system in order of increasing cumulative cross sectional area:

1) Aorta
2) Capillaries
3) Venules

ANSWER: 1, 3, 2 [AD]

**BONUS**

11) Biology - *Multiple Choice* Praneel discovers a mystery species that produces very few offspring across multiple reproductive seasons, displays a high degree of parental care and lives close to carrying capacity. This species most likely displays what kind of survivorship curve?

W) Type I
X) Type II
Y) Type III
Z) Staircase

ANSWER: W [AD]

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**TOSSUP**

12) Chemistry - *Short Answer* Monoprotic acid HA has a pKa of 5. In a solution, 1 mole of HA is mixed with 0.5 moles of NaOH. What is the pH of this solution?

ANSWER: 5 [SO]

**BONUS**

12) Chemistry - *Multiple Choice* Which of the following statements is the best explanation for why atomic radius decreases across a period going to the right?

W) Increase in ionization energy in the valence shell
X) Increase in polarizability in the valence shell
Y) Increase in effective nuclear charge in the valence shell
Z) Increase in electron affinity in the valence shell

ANSWER: Y) Increase in effective nuclear charge in the valence shell [SO]

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**TOSSUP**

13) Earth and Space - *Short Answer* Rank the following 3 objects by increasing magnetic field strength:

1) Venus
2) Saturn
3) Earth

ANSWER: 1, 3, 2

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**BONUS**

13) Earth and Space - *Multiple Choice* Which of the following best explains why larger stars do not have a helium flash?

W) The helium core is non-degenerate, allowing it to expand gradually as helium fusion begins
X) The helium core is degenerate, causing the onset of fusion to proceed explosively
Y) Larger stars never reach core temperatures high enough for helium fusion
Z) Energy from hydrogen shell burning is insufficient to ignite helium fusion in larger stars

ANSWER: W) he helium core is non-degenerate, allowing it to expand gradually as helium fusion begins

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**TOSSUP**

14) Math - *Short Answer* In a triple elimination tournament with 32 teams, what is the minimum number of games to be played in order to guarantee a winner?

ANSWER: 95

**BONUS**

14) Math - *Multiple Choice* Which of the following expressions is equivalent to the number of ways that 2025 identical marbles can be split between 67 distinct boxes?

W) 2091 choose 66
X) 2091 choose 67
Y) 2092 choose 66
Z) 2099 choose 67

ANSWER: W) 2091 CHOOSE 66

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**TOSSUP**

15) Physics - *Multiple Choice* Which of the following is closest to the total mass of a gluon at rest in electron volts per $c^2$?

W) 0
X) 1
Y) 100
Z) 1000

ANSWER: W

**BONUS**

15) Physics - *Short Answer* A speaker plays a sound and a person standing 1 m away hears it at 100 dB. What is the new decibel count 100 meters away?

ANSWER: 60 dB

**TOSSUP**

16) Biology - *Multiple Choice:* Which of the following mutant plant types occurs when a kinase responsible for de-activating ethylene transduction pathways involved in the triple response is dysfunctional?

W) etr mutant
X) eto mutant
Y) ein mutant
Z) ctr mutant

ANSWER: Z) ctr mutant [HL]

**BONUS**

16) Biology - *Short Answer* What Eukaryotic supergroup, whose notable members include diatoms, Plasmodium, and amoebas, is named for its three main clades: Stramenopiles, Alveolates, and Rhizarians?

ANSWER: SAR [HL]

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**TOSSUP**

17) Chemistry - *Multiple Choice* Which of the following terms best describes the relationship between 2-methylbutane and 3-methylbutane?

W) Structural isomers
X) Enantiomers
Y) Diastereomers
Z) Same compound

ANSWER: Z) Same compound [SO]

**BONUS**

17) Chemistry - *Short Answer* What is the enthalpy of sublimation of water to 3 significant figures and in KJ/mol, given that the enthalpy of vaporization for water is 40.7 KJ/mol, and the enthalpy of fusion for water is 6.0 KJ/mol?

ANSWER: 46.7 KJ/mol [SO]

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**TOSSUP**

18) Earth and Space - *Short Answer* Identify which 2 of the following 4 regions of the electromagnetic spectrum that are commonly used to identify pulsars:

1) Radio
2) Microwave
3) Visible
4) X-Ray

ANSWER: 14

**BONUS**

18) Earth and Space - *Short Answer* Due to gravitational interactions with early planetesimals and asteroids, all the Gas Giants except for what Planet experienced an increase in orbital radius?

ANSWER: Jupiter

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**TOSSUP**

19) Math - *Short Answer* What is the interior angle of a regular polygon with 20 sides?

ANSWER: 162 (ACCEPT: 9pi/10)

**BONUS**

19) Math - *Short Answer* What is the sum of the geometric sequence with first term 2 and third term 1?

ANSWER: 4 + 2sqrt(2)

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**TOSSUP**

20) Physics - *Short Answer* CDs and DVDs often have tiny grooves. When light is shined onto the CD, these grooves allow light to be bent around them and split into its component colors. What is the term for this effect?

ANSWER: Diffraction

**BONUS**

20) Physics - *Short Answer* A dumbbell is in orbit vertically where 1 weight is facing toward the Earth and the other is facing towards space. Identify all of the following 3 actions that would increase the tidal force experienced by the dumbbell:

1) Increase the length of the of dumbbell
2) Increase the width of the dumbbell
3) Replacing the weights on the dumbbell with identical weights that are twice as heavy

ANSWER: 1 and 3 only