**TOSS UP**

1. BIOLOGY *Multiple Choice* What protein is mainly responsible for the neurotoxicity associated with HIV?
W) rev
X) pol
Y) tat
Z) env
ANSWER: Y) tat

**BONUS**

1. BIOLOGY Multiple Choice The env gene codes for the protein known as gp160. gp160 is further cleaved into gp41 and gp120. gp120 is responsible for binding to what receptor on helper T-cells?
W) CCR5
X) MHC II
Y) CD4
Z) CD8
Answer: Y) CD4

**TOSS-UP**

2. MATH *Short Answer* Adam is standing at a point such that if he takes a single step exactly to the north or south, he will die. He is currently facing north. He now picks a random integer between 0 and 360, inclusive, and rotates that amount of degrees counterclockwise. Finally, he takes a single step. What is the probability that he dies?

ANSWER: $\frac{358}{361}$

**BONUS**

2. MATH *Short Answer* Adam is once again facing north. He chooses a random number between 0 and 360, rotates that amount of degrees counterclockwise, and then walks for 1 meter in that direction. He then repeats this entire process again. What is the probability that he is now within a meter of where he started?

ANSWER: $\frac{1}{3}$

**TOSS-UP**

3. EARTH SCIENCE *Short Answer* What type of boundary is the boundary between the Indian plate and the Eurasian plate?

ANSWER: CONVERGENT

**BONUS**

3. EARTH SCIENCE *Multiple Choice* By the start of which of the following epochs was the supercontinent Pangea fully assembled?

W) Ordovician
X) Permian
Y) Triassic
Z) Jurassic

ANSWER: X) PERMIAN

**TOSS-UP**

4. MATH *Multiple Choice* Which of the following constructions is impossible with a straightedge and compass?

W) Constructing a line parallel to a given line through a specific point
X) Constructing a line perpendicular to a given line through a specific point
Y) Constructing a triangle's centroid (intersection of all three medians)
Z) All of these are possible

ANSWER: Z) ALL OF THESE ARE POSSIBLE

**BONUS**

4. MATH *Multiple Choice* Which impossible geometrical construction problem can be used to prove that it is impossible to construct a nonagon?

W) Angle trisection
X) Squaring the circle

Y) Doubling the cube
Z) None of the above

Answer: W) ANGLE TRISECTION

**TOSS-UP**

5. EARTH SCIENCE *Short Answer* What metal impurity found in rubies is attributed to their red color?

ANSWER: IRON

**BONUS**

5. EARTH SCIENCE *Short Answer* What metal impurity found in sapphires is attributed to their blue color?

ANSWER: TITANIUM

**TOSS UP**

6. BIOLOGY *Short Answer* Certain humans are resistant to HIV infection due to a 32 nucleotide deletion in a certain gene that codes for a co-receptor. What is this co-receptor?

ANSWER: CCR5

**BONUS**

6. BIOLOGY *Multiple Choice* In HIV, there exists a certain myristoylated protein that can easily be detected following infection. What is this protein?
W) vif
X) pol
Y) gag
Z) nef

ANSWER: Z) nef

**TOSS-UP**

7. PHYSICS *Short Answer* Identify all of the following forces that act on a block sliding down an inclined plane: 1) Frictional force, 2) Normal force, 3) Gravitational force.

ANSWER: 1, 2, and 3 (ACCEPT: ALL OF THEM)

**BONUS**

7. PHYSICS *Short Answer* An inclined plane of 45 degrees has a block on it that is not moving. What is the minimum coefficient of static friction?

ANSWER: 1/sqrt2

**TOSS-UP**

8. CHEMISTRY *Multiple Choice* Which chromium-containing species is a main component of the Jones reagent?

W) Pyridinium chlorochromate
X) Chromium trioxide
Y) Potassium dichromate
Z) Potassium chromate

ANSWER: X) CHROMIUM TRIOXIDE

**BONUS**

8. CHEMISTRY *Short Answer* What compound is produced by the oxidation of phenol?

ANSWER: QUINONE

**TOSS-UP**

9. BIOLOGY *Short Answer* What ecological term describes groups of initially-isolated individuals of the same species that eventually could interact on some level? These groups often prevent total extinction of a species, although various subgroups may become extinct from time to time.

ANSWER: METAPOPULATION

**BONUS**

9. BIOLOGY *Multiple Choice* Which of the following best characterizes a grassland ecosystem?

W) The temperature rarely dips below 0 degrees Celsius.
X) Rain of approximately 30 cm a year.
Y) Grasslands include savannahs, steppes, and boreal meadows.
Z) Grasslands are stable climates and often do not experience natural disasters.

ANSWER: X) RAIN OF APPROXIMATELY 30 CM A YEAR.

**TOSS-UP**

10. MATH *Short Answer* For the Platonic solid has the same number of vertices and faces, what is the sum of its edges, vertices, and faces?

ANSWER: 14

**BONUS**

10. MATH *Multiple Choice* A certain polyhedra is such that every equilateral triangle is has is surrounded by exactly three octagons. How many faces does it have at least?

W) 14
X) 24
Y) 34
Z) 44

ANSWER: W) 14

**TOSS-UP**

11. PHYSICS *Multiple Choice* A sled has a mass of 5 kg. Someone pulls the sled at a constant 20 m/s for 5 seconds. How much work has the person done on the sled over these 5 seconds?

W) 500
X) 100
Y) 25
Z) 0

ANSWER: Z) 0

**BONUS**

11. PHYSICS *Short Answer* A block with mass 5 kg moving 3 m/s east collides with a block with mass 3kg moving 5 m/s west. The collision is completely elastic and lasts 0.1 seconds. During the collision, what is the first block's acceleration? Assume that east is positive and west is negative.

ANSWER: -60 m/s^2

**TOSS-UP**

12. EARTH SCIENCE *Multiple Choice* Which of the following rocks is an extrusive ultramafic rock?

W) Komatiite
X) Peridotite
Y) Andesite
Z) Basalt

ANSWER: W) KOMATIITE

**BONUS**

12. EARTH SCIENCE *Multiple Choice* Which of the following minerals is classified as an inosilicate?

W) Amphibole

X) Plagioclase feldspar
Y) Olivine
Z) Mica

ANSWER: W) AMPHIBOLE

**TOSS-UP**

13. MATH *Short Answer* If $f(x) = x^2 - 5x + 6$, order the following from least to greatest: $f(2) + f(3), f(1) + f(4), f(0) + f(5)$

ANSWER: $f(0) + f(5), f(1) + f(4), f(2) + f(3)$

**BONUS**

13. MATH *Short Answer* A recursive sequence is defined by $a_0 = 1, a_1 = 2$and $a_n = 3a_{n-1} + 4a_{n-2}$for $n >= 2$. Compute $a_4$.

ANSWER: 233

**TOSS-UP**

14. BIOLOGY *Short Answer* By name or number, which of the following parts of the brain are a component of the Forebrain?

1) Cerebral cortex
2) Thalamus
3) Hypothalamus
4) Epithalamus

Answer: 1, 2, 3, 4 (All)

**BONUS**

14. BIOLOGY *Multiple Choice* This network of the brain is responsible for regulating arousal and sleep. What is this part?

W) Reticular formation
X) Suprachiasmatic nucleus
Y) Limbic system

Z) Amygdala

Answer: W) Reticular formation

**TOSS-UP**

15. EARTH SCIENCE *Short Answer* Shiprock in New Mexico rises high above the surrounding desert in New Mexico. Which of the following geologic features is Shiprock?

W) Stratovolcano
X) Caldera
Y) Laccolith
Z) Volcanic neck

ANSWER: Z) VOLCANIC NECK

**BONUS**

15. EARTH SCIENCE *Multiple Choice* Which of the following minerals is most resistant to chemical weathering?

W) Calcite
X) Quartz
Y) Halite
Z) Sylvite

ANSWER: QUARTZ

**TOSS-UP**

16. BIOLOGY *Short Answer* The drug sarin binds to a specific amino acid within the active site of acetylcholinesterase. What amino acid is this?

Answer: Serine

**BONUS**

16. BIOLOGY *Short Answer* When looking at the molecular weight of amino acids, these two amino acids cannot be distinguished. Other methods of analyses are typically used. What are these two amino acids?

Answer: Leucine and Isoleucine

**TOSS-UP**

17. PHYSICS *Short Answer* A ball of mass 5 kg is being swung in a circle of radius 4 m. If its angular velocity is 3 rad/s, what is the centripetal force on the ball?

ANSWER: 180 NEWTONS

**BONUS**

17. PHYSICS *Short Answer* A solid sphere, ring, and disk, all with the same radius, roll down an incline. State the order in which they reach the bottom.

ANSWER: SPHERE, DISK, RING

**TOSS-UP**

18. EARTH SCIENCE *Short Answer* Which of the following minerals is not a polymorph of calcium carbonate?

W) Calcite
X) Dolomite
Y) Aragonite
Z) Vaterite

ANSWER: DOLOMITE

**BONUS**

18. EARTH SCIENCE *Multiple Choice* Which of the following rocks have thin bands in its structure?

W) Schist
X) Shale

Y) Conglomerate
Z) Granite

ANSWER: W) SCHIST

**TOSS-UP**

19. BIOLOGY *Multiple Choice* This type of fluorescent protein is red and excites at 583nm. What protein is this?

W.) GFP
X.) mCherry
Y.) mRasberry
Z.) OFP

ANSWER: X) mCherry

**BONUS**

19. BIOLOGY *Short Answer* What common drug is used after transfecting human cell lines in order to select for transfected cells?

Answer: Purimycin

**TOSS-UP**

20. CHEMISTRY *Short Answer* What is the term that describes a substituted oxirane, or a cyclic ether containing a three-membered ring system?

ANSWER: EPOXIDE

**BONUS**

20. CHEMISTRY *Multiple Choice* Which of the following reducing agents reduces aldehydes and ketones to alcohols, but not esters and carboxylic acids?

W) $LiAl(OR)_3H$
X) $NaBH_4$

Y) LAH
Z) DIBAH

ANSWER: X) $NaBH_4$

**TOSS-UP**

21. MATH *Multiple Choice* Which of the following numbers cannot be expressed as the sum of two squares?

W) 13
X) 33
Y) 53
Z) 73

ANSWER: X) 33

**BONUS**

21. MATH *Multiple Choice* Which of the following numbers cannot be expressed as the sum of three squares?

W) 19
X) 39
Y) 59
Z) All of the above can be expressed in this manner.

ANSWER: X) 39

**TOSS-UP**

22. EARTH SCIENCE *Short Answer* What is the name for a failed arm of a triple junction of a plate tectonics rift system?

ANSWER: AULACOGEN

**BONUS**

22. EARTH SCIENCE *Short Answer* What is the name of the process that describes the opening and closing of ocean basins caused by movement of the Earth's plates?

ANSWER: WILSON CYCLE

**TOSS-UP**

23. PHYSICS *Multiple Choice* A conducting sphere with positive charge is grounded. Which of the following will happen?

W) Protons flow out of the conducting sphere, making it neutral
X) Electrons flow into the conducting sphere, making it neutral
Y) The sphere will retain its positive charge
Z) The sphere will gain a negative charge greater than its initial positive charge in magnitude

ANSWER: X) ELECTRONS FLOW INTO THE CONDUCTING SPHERE, MAKING IT NEUTRAL

**BONUS**

23. PHYSICS *Short Answer* Two capacitors A and B, are such that A has twice as much charge as B currently. Both capacitors are connected in parallel in a circuit with a 9-volt battery and no resistors. Ignoring the risks associated with this experiment, if capacitor B has a capacitance of 3 F, how much charge does A have at the moment?

ANSWER: 54 COULOMBS