**TOSS-UP**

1) BIOLOGY *Short Answer* Which type of hypersensitivity is mediated by IgE?  
ANSWER: TYPE 1

**VISUAL BONUS**

1) BIOLOGY *Short Answer* From Using the diagram shown, One: Name the three different types of cells labeled A, B, and C. Two: What is D, the collective name for all granulocyte and agranulocyte cells? Three: What molecule acts as the primary growth factor for the cell type labeled E?

ANSWER: ONE: A-BASOPHIL, B-EOSINOPHIL, C-NEUTROPHIL; TWO: LEUKOCYTES, THREE: THROMBOPOIETIN

**TOSS-UP**

2) EARTH AND SPACE SCIENCE *Short Answer* State by name or number all of the following statements which is or are true of earthquakes.

1: The Richter scale measures the intensity of shaking of an earthquake.   
2: The Gutenberg-Richter Law expresses the relationship between the magnitude and total number of earthquakes in a given region.   
3: The Moho is the boundary between the Earth’s crust and mantle.   
4: The P-wave is formed from alternating compressions and rarefactions in Earth’s interior.

ANSWER: 2, 3, 4

**VISUAL BONUS**

2) EARTH AND SPACE SCIENCE *Short Answer* Using the diagram, One: What is the name of the area labeled A, in which no earthquake waves are found? Two: What type of earthquake waves are represented by B and C? Three: What is the collective name given to type of waves shown in pictures B and C?

ANSWER: ONE: P-WAVE SHADOW ZONE, TWO: B= P-WAVE, C= S-WAVE, THREE: BODY WAVES

**TOSS-UP**

3) PHYSICS *Short Answer* State by name or number all of the following 3 statements which is or are true of inertial reference frames.  
1: They describe space and time homogenously.  
2: Measurements in one inertial frame obeying Newtonian physics can be converted to measurements in another by a Galilean transformation.  
3: Einstein’s theory of special relativity states that “There is no experiment observers can perform to distinguish whether an acceleration arises because of a gravitational force or because their reference frame is accelerating.”

ANSWER: 1 AND 2

**VISUAL BONUS**

3) PHYSICS *Short Answer* Observe the following diagram which shows a ball resting at the top of a 10 m tall building. There is a target (named T) which is 3 m away from the building. One: If the ball begins to roll to the right and falls off the building with a rightward velocity of 10 m/s, about how long will the ball remain in the air before hitting the ground?

Two: If the ball begins to roll to the right and falls off the building with a rightward velocity of 10 m/s, about how far away from the building will the ball land?

Three: In order for the ball to strike the target T, at what speed must the ball roll of the building?

Answers can be in radical form.

ANSWER: ONE: 1.414 SECONDS(ACCEPT: SQUARE ROOT OF TWO SECONDS), TWO: 14 METERS, THREE: 2.12 METERS PER SECOND (ACCEPT: 3 OVER SQUARE ROOT OF TWO METERS PER SECOND)

**TOSS-UP**

4) CHEMISTRY *Short Answer* The Ka value of a weak acid, HA, is 10-6. An initial solution containing 1.0 M of HA is prepared. What is the pH of the final solution at equilibrium?

ANSWER: 3

**BONUS**

4) CHEMISTRY *Short Answer* Calculate the molarity of an acetic acid solution if 30 mL of this solution are needed to neutralize 25mL of 0.10 M sodium hydroxide.

CH3COOH (aq) + NaOH (aq) -----> Na+(aq) + CH3COOH-(aq) + H2O (l)

ANSWER: 0.0833 M CH3COOH

**TOSS-UP**

5) MATH *Short Answer* Calculate the cross product between a= (3, −3, 1) and b= (4, 9, 2).

ANSWER: (-15, -2, 39)

**BONUS**

5) MATH *Short Answer* Find the volume of the solid obtained by rotating the region bounded by the lines y = x2– 2x and y = 8 about the line y = 8.

ANSWER: 1296π/5 OR 813.9

**TOSS-UP**

6) ENERGY *Multiple Choice* Which of the following statements is false regarding nuclear energy?

W) Breeder reactors use Uranium-238 to produce energy.   
X) Some thermal breeder reactors use fluoride based molten salt to achieve high operating temperatures.   
Y) Uranium-234, Uranium-238, and Plutonium-237 are the primary isotopes used as nuclear fuel in reactors.   
Z) Fusion reactors would use deuterium and tritium as fuel.

ANSWER: Y) URANIUM-234, URANIUM-238, AND PLUTONIUM-237 ARE THE PRIMARY ISOTOPES USED AS NUCLEAR FUEL IN REACTORS.

**VISUAL BONUS**

6) ENERGY *Short Answer* Using the diagram, One: What are objects B, D, and J? Two: In the fuel rods shown, about what percent, to the nearest integer, of the enriched uranium would actually be spend producing energy, before being moved into a spent fuel pool?

ANSWER: ONE- CONTROL RODS, STEAM GENERATOR, COOLING TOWER; TWO-3 %

**TOSS-UP**

7) BIOLOGY *Short Answer* State by name or number all of the following 3 statements which is or are true of double fertilization in plants.  
1. Synergids function in the attraction and guidance of the pollen tube to the embryo sac through the micropyle.  
2. The embryo sac originates from the diploid megaspore mother cell within the ovule.  
3. There are 3 polar nuclei in every embryo sac.

ANSWER: 1 and 2

**VISUAL BONUS**

7) BIOLOGY *Short Answer* Using the diagram, One: Label flower parts A, B, and C. Two: In the ABC Flower Development Model, if all A genes were missing, but B and C genes were still present, what flower parts would still develop?

ANSWER: ONE: A-OVARY, B-SEPAL, C-RECEPTACLE; TWO: STAMENS AND CARPELS

**TOSS-UP**

8) EARTH AND SPACE SCIENCE *Short Answer* Order the following 3 cloud types from lowest to highest in the atmosphere: Cirrus, Stratus, Altocumulus.

ANSWER: STRATUS, ALTOCUMULUS, CIRRUS

**VISUAL BONUS**

8) EARTH AND SPACE SCIENCE *Short Answer* Using the pictures shown, One: Classify each of the clouds A, B, and C, as either high, mid-level, or low clouds; Two: Name each cloud by type.

ANSWER: ONE: A- MID LEVEL, B-LOW, C- HIGH; TWO: A- ALTOCUMULUS, B-CUMULONIMBUS, C- CIRROCUMULUS

**TOSS-UP**

9) PHYSICS *Short Answer* A cylindrical resistor has resistance R. If its resistivity is tripled while its cross-sectional radius is doubled, what is the resistance of the final resistor, in terms of R?

ANSWER: ¾R

**VISUAL BONUS**

9) PHYSICS *Short Answer* In the diagram shown, E = 9 V, R1= 5 Ohms, R2= 5 Ohms, and R3= 20 Ohms. What are the values measured by the ammeter and the voltmeter?

ANSWER: AMMETER READS 1 AMPERE; VOLTMETER READS 4 VOLTS.

**TOSS-UP**

10) CHEMISTRY *Short Answer* State all of the following 4 which are distinct peaks in mass spectrum analysis.  
1. Metastable Peaks

2. Even-Electron Peaks  
3. Isotope Peaks  
4. Molecular Ion Peaks

ANSWER: 1, 3 and 4

**VISUAL BONUS**

10) CHEMISTRY *Short Answer* Give the name or formula of the 2 gaseous compounds whose mass spectrums are shown in the graphs.

ANSWER: ONE: SULFUR DIOXIDE, TWO: METHANAL/FORMALDEHYDE

**TOSS-UP**

11) MATH *Short Answer* What is the z score of Bob’s test if Bob scored a 95, the mean score on the test was an 80, and the standard deviation was 5.

ANSWER: 3

**BONUS**

11) MATH *Short Answer* If $1000 is placed in a savings account that pays 6% annual interest compounded semiannually, what is the total amount of money in the account at the end of 1 year, to the nearest dollar?

ANSWER: $1061.00

**TOSS-UP**

12) ENERGY *Multiple Choice* Which of the following enzymes is not correctly matched with the reaction it catalyzes?

W) (Glucose)*n* + H2O 🡪 (Glucose)*n*-2 + Maltose; Beta-amylase  
X) Glucose + ATP 🡪 Glucose-6-P + ADP; HexokinaseY) NH2CONH2+2H2O+H+ 🡪2NH4+ + HCO3-; Ammonia DehydrogenaseZ)CO2 + H2O 🡪 HCO3- + H+; Carbonic Anhydrase

ANSWER: Y) NH2CONH2+2H2O+H+ 🡪2NH4+ + HCO3-; AMMONIA DEHYDROGENASE

**VISUAL BONUS**

12) ENERGY *Short Answer* Using the reaction shown, One: What is the name of this specific type of rearrangement, A?; Two: What are the two possible transition states in this rearrangement?; Three: What type of keto-enol reaction does the intermediate undergo at B?

ANSWER: ONE- CLAISEN; TWO- CHAIR AND BOAT; THREE: TAUTOMERIZATION

**TOSS-UP**

13) BIOLOGY *Short Answer* State by name or number all of the following compounds which can be classified as glycosaminoglycans.

1: Agar

2: Chondroitins

3: Heparin

4: Hyaluronate

ANSWER: 2, 3 and 4

**VISUAL BONUS**

13) BIOLOGY *Short Answer* Using the diagram, One: Classify bacteria A and B as either gram negative or gram positive; Two: Name the part of bacteria B which is labeled C; Three: In a gram stain, which of the bacteria would retain the crystal violet? Four: Which of the bacteria would be *Bacillus anthracis*?

ANSWER: ONE- A IS GRAM POSITIVE, B IS GRAM NEGATIVE; TWO-LIPOPOLYSACCHARIDE; THREE: BACTERIA A; FOUR: BACTERIA A

**TOSS-UP**

14) EARTH AND SPACE SCIENCE *Short Answer* List by name or number all of the following 4 statements which are factors influencing the recurrence interval of floods.   
1. The climate of the region  
2. The number of tributaries.  
3. The width of the floodplain.  
4. The size of the channel.

ANSWER: 1, 3 and 4

**VISUAL BONUS**

14) EARTH AND SPACE SCIENCE *Short Answer* Using the image shown, One: Label landforms A-E; Two: Through what process that occurs in the interior of the Earth are structures D and E formed?

ANSWER: ONE- A: CONTINENTAL SHELF, B: CONTINENTAL SLOPE, C: CONTINENTAL RISE, D: VOLCANIC ISLAND ARC, E: CONTINENTAL VOLCANIC ARC; TWO- PARTIAL MELTING

**TOSS-UP**

15) PHYSICS *Short Answer* List by name or number all of the following 4 statements which is or are true of optics.  
1. The Fraunhofer diffraction equation is used to model the diffraction of waves when the diffraction pattern is viewed at a short distance from the diffracting object.  
2. Dichroism is the characteristic of a compound in which one of the polarized components is absorbed much more strongly than the other.   
3. Fresnel diffraction occurs when the point source and the screen are relatively close to the obstacle forming the diffraction pattern.   
4. Antinodal curves denote curves on which destructive interference occurs.

ANSWER: 2 and 3

**VISUAL BONUS**

15) PHYSICS *Short Answer* Using the image shown, One: What experiment is this a diagram of?; Two: What is the name of the instrument used in this experiment?; Three: What physical medium was disproved by this experiment?

ANSWER: ONE: MICHELSON-MORLEY; TWO- INTERFEROMTER; THREE- AETHER