TOSS UP

1. EARTH AND SPACE SCIENCE: *Short Answer:* What geological era is associated with the following descriptors: end of the formation of the Appalachian mountains, formation of Pangaea. appearance of the first life-forms with hard parts such as shells, Cambrian explosion.

ANSWER: PALEOZOIC ERA

BONUS

1. EARTH AND SPACE SCIENCE: *Short Answer:* By name or number, identify all of the following 3 unconformities that can be used as a boundary between different geological periods

1. angular unconformity

2. nonconformity

3. disconformity

ANSWER: ALL OF THEM

TOSS UP

2. PHYSICS: *Multiple Choice:* A ball of mass 1 kg is inside a spaceship traveling at 60% the speed of light. To an observer in the spaceship travelling with the ball, the ball has a relativistic mass of

W) 0 kg

X) 1 kg

Y) 1.25 kg

Z) infinity kilograms

ANSWER: W) 0 kg

BONUS

2. PHYSICS: *Short Answer:* What experiment, performed in 1887 attempted to measure the fringe shift in light cause by earth's movement through the aether , the negative results of which disproved the notion of the then-prevalent aether theory.

ANSWER: MICHAELSON-MORELY EXPERIMENT

TOSS UP

3. CHEMISTRY: *Multiple Choice:* Two solutions, A and B, of sodium chloride in water are separated by a semi permeable membrane. At time 0, the concentration NaCl in A is 0.25 M and that in B is 0.50 M. Which of the following statements best describes the solutions at some time after 0?

W) salt moves from A to B

X) salt moves from B to A

Y) water moves from A to B

Z) water moves from B to A

ANSWER: Y) WATER MOVES FROM A TO B

BONUS

3. CHEMISTRY: *Short Answer:* 1 mL of concentrated HCl is added to I L of solution containing 1kg of dissolved sodium bicarbonate. Which of the following statements is TRUE regarding the solution?  
  
W) the pH of the solution will decrease by a appreciable amount

X) the equilibrium for the bicarbonate ion will shift towards the products

Y) the amount of carbonate in the solution will increase

Z) the equilibrium constant for the bicarbonate ion will not change

ANSWER: Z) the equilibrium constant for the bicarbonate ion will not change

TOSS UP

4. BIOLOGY: *Multiple Choice:* When stained with crystal violet and saffranin, archae will stain  
  
W) gram-positive

X) gram-negative

Y) gram-variable

Z) pink

ANSWER: Y) GRAM-VARIABLE

BONUS

4. BIOLOGY: *Multiple Choice:* The increased presence of which of the following microbes can be used as an indicator of failure in water treatment and/or contamination of water with fecal material?  
  
W) gram-negative bacteria

X) gram-positive bacteria

Y) fungi  
Z) viruses

ANSWER: W) GRAM-NEGATIVE BACTERIA

TOSS UP

5. MATHEMATICS: *Multiple Choice:* What is the 15th derivative of 3sin(x)?  
  
W) 315sinx  
X) -315sinx

Y) 315cosx

Z) -315cosx

ANSWER: W) 315sinx

BONUS

5. MATHEMATICS: *Short Answer:* What curve in mathematics and physics, also known as the curve of fastest descent, is the curve between two points covered in the least time by a point-like body that starts at rest and moves under the action of gravity alone?

ANSWER: BRACHISTOCHRONE CURVE

TOSS UP

6. ENERGY: *Short Answer:* By name or number, identify all of the following 4 steps of the Otto cycle that differ from the Diesel cycle:  
1. isentropic compression of the fuel-air mixture

2. isochoric heating of the fuel-air mixture

3. isentropic power stroke

4. isochoric exhaust of the burned mixture  
  
ANSWER: 2 ONLY

BONUS

6. ENERGY: *Short Answer:* What thermodynamic cycle generates about 90% of the world's electric power and is sometimes referred to as the practical Carnot cycle. One of the main differences between this cycle and the Carnot cycle is that heat addition and rejection are isobaric, as opposed to isothermal.  
  
ANSWER: RANKINE CYCLE

TOSS UP

7. EARTH AND SPACE SCIENCE: *Short Answer:* This type of spiral galaxy has prominent and well-defined spiral arms, as opposed to multi-arm and flocculent spirals. Notable types of these galaxies include M74 and M51, the Whirlpool Galaxy. Name these galaxies, which constitute approximately 10% of all spirals.

ANSWER: GRAND DESIGN SPIRAL GALAXY

BONUS

7. EARTH AND SPACE SCIENCE: *Short Answer:* What wide-field reflecting telescope, planned to be completed in Chile in 2020 will photograph the entire available sky every few nights. Particular goals of the telescope include measure gravitational lensing, mapping NEOs and Kuiper belt objects, detecting novae and supernovae, and mapping the Milky Way.

ANSWER: LARGE SYNOPTIC SKY TELESCOPE

TOSS UP

8. PHYSICS: *Multiple Choice:* The image of an object in front of a concave mirror will appear at infinity when   
W) the object is beyond the center of curvature

X) the object is at the center of curvature

Y) the object is between the center of curvature and the focal point

Z) the object is at the focal point  
  
ANSWER: Z) THE OBJECT IS AT THE FOCAL POINT

BONUS

8. PHYSICS: *Short Answer:* Giving your answer in meters and defining the image as either "virtual" or "real", where will the image of an object placed 4 m away from a convex lens with a 5 m focal length appear?  
  
ANSWER: 1 m, VIRTUAL

TOSS UP

9. CHEMISTRY: *Multiple Choice:* Which of the following cannot act as both a Bronsted Lowry

acid and base?

W) NH4 +

X) H2O

Y) HS -  
Z) HCO3 -

BONUS

9. CHEMISTRY: *Multiple Choice:* Which of the following ions is the strongest Lewis acid?  
  
W) Na+

X) Cl-  
Y) CH3COO-

Z) Al3+

ANSWER: Z) Al3+

TOSS UP

10. BIOLOGY: *Short Answer:* What form of enzymatic inhibition is described by the following statement: impedance of enzymatic reactions by binding to a different active site than the substrate, causing the enzyme molecule to change shape so that the active site becomes less effecting at catalyzing substrate to product.

ANSWER: NONCOMPETITIVE INHIBITION

BONUS

10. BIOLOGY: *Multiple Choice:* An allosteric inhibitor  
  
W) stabilizes the inactive form of an enzyme  
X) stabilizes the active form of an enzyme  
Y) encourages oscillation between the active and inactive form of an enzyme  
Z) denatures the inactive form of the enzyme

ANSWER: W) STABILIZES THE INACTIVE FORM OF AN ENZYME

TOSS UP

11. MATHEMATICS: *Short Answer:* For what value of k is the line 8x + k tangent to the curve given by y = x^2 + 6x?  
  
ANSWER: -1

BONUS

11. MATHEMATICS: *Short Answer:* What value of x satisfies the mean value theorem for derivatives for the function f(x) = x2 - x - 1 on the closed interval [1,3]?  
  
ANSWER: 2

TOSS UP

12. ENERGY: *Multiple Choice:* Which of the following country has the largest tidal energy facility in the world?  
  
W) China  
X) United States of America

Y) Germany

Z) France

ANSWER: W) CHINA

BONUS

12. ENERGY: *Multiple Choice:* Which of the following is a disadvantage of biodiesel fuels compared to petroleum-based fuels?  
  
W) biodiesel produces more carbon dioxide

X) biodiesel produces more sulfur dioxide

Y) biodiesel produces more particulate matter

Z) biodiesel produces slightly higher amounts of nitrogen oxide  
  
ANSWER: Z) biodiesel produces slightly higher amounts of nitrogen oxide