TOSS UP

1. BIOLOGY: *Multiple Choice:* Which of the following is considered to be the basic unit of DNA packaging and appears as "beads" strung upon a string of unfolded chromatin under an electron microscope?  
  
W) nucleosome  
X) histone

Y) looped domain  
Z) 30 nanometer fiber

ANSWER: W) NUCLEOSOME

BONUS

1. BIOLOGY: *Short Answer:* What "restriction point" in mammalian cells seems to be the most important checkpoint, after which many cells stop the cell cycle and enter into G0, a nondividing resting stage? Cells that pass this checkpoint will usually complete all other phases of the cycle, including mitosis.

ANSWER: G1 CHECKPOINT

TOSS UP

2. EARTH AND SPACE SCIENCE: *Short Answer:* Order the following three ocean-floor features in order of increasing steepness: abyssal plain, continental slope, continental rise

ANSWER: ABYSSAL PLAIN, CONTINENTAL RISE, CONTINENTAL SLOPE

BONUS

2. EARTH AND SPACE SCIENCE: *Multiple Choice:* Which of the following statements best explains why although they are found in all oceans of the world, the Atlantic Ocean has the most extensive abyssal plains?

W) the Atlantic ocean's pattern of turbidity currents distributes sediment more equally

X) more sediment flows into the Atlantic Ocean from rivers and streams than other oceans

Y) the Atlantic Ocean has relatively fewer oceanic trenches to act as sediment traps

Z) volcanic activity at the Mid-Atlantic Ridge helps replenish sediment lost to turbidity currents

ANSWER: Y) the Atlantic Ocean has fewer oceanic trenches to act as traps of sediment

TOSS UP

3. CHEMISTRY: *Short Answer:* What is the specific gravity of a block of wood that has 80% of its volume under the surface when floating in a tub of water?  
  
ANSWER: 4/5

BONUS

3. CHEMISTRY: *Short Answer:* Identify if q, the reaction quotient, is less than, greater than, or equal to k, the equilibrium constant, in the following three situations:  
1. A reaction that is proceeding towards the right

2. A reaction in which a catalyst has been added

3. The reaction N2O4 gas is in equilibrium with 2NO2 gas immediately after increasing the concentration of N2O4 in the container

ANSWER: less than, equal to, less than

TOSS UP

4. PHYSICS: *Short Answer:* By name or number, identify all of the following 4 frequencies that would be impossible to produce in a pipe open at one end but closed at the other with a fundamental frequency of 300 Hz.

1. 150 Hz

2. 300 Hz

3. 600 Hz

4. 900 Hz

ANSWER: 1, 3

BONUS

4. PHYSICS: *Short Answer:* What is the wavelength of the fundamental frequency of a pipe that is 1 meter long and open at both ends?  
  
ANSWER: 2 METERS

TOSS UP

5. MATHEMATICS: *Short Answer:* Evaluate the following improper integral: the integral from 0 to infinity of e to the -x, dx

ANSWER: 1

BONUS

5. MATHEMATICS: *Multiple Choice:* Using the squeeze principle, fin the limits as x goes to infinity of (2-cosx) / (x+3)  
  
W) - infinity

X) zero  
Y) one  
Z) infinity  
  
ANSWER: X) zero

TOSS UP

6.ENERGY: *Short Answer:* What thermoelectric effect, named after its French discoverer, is used in thermoelectric cooling devices. The phenomenon consists of the presence of heat at an electrified junction of two different metals. Stated differently, when a current is made to flow through a junction composed of materials A and B, heat is generated at one junction, and absorbed in the lower junction. Name this effect.   
  
ANSWER: PELTIER EFFECT

BONUS

6. ENERGY: *Short Answer:* By name or number, identify all of the following 4 statements that are benefits of using a thermoelectric cooling device over a conventional vapor-compression system  
  
1. no moving parts, fluid, or refrigerants

2. small and compact size

3. ability to dissipate large amounts of heat flux

4. higher coefficient of performance than vapor compression systems

ANSWER: 1, 2

TOSS UP

7. BIOLOGY: *Multiple Choice:* Which of the following methods is the best choice for separating nucleic acids or proteins that differ in size, electrical charge, or other physical properties?  
  
W) Southern blotting

X) Northern blotting  
Y) Polymerase chain reaction

Z) Gel electrophoresis

ANSWER: Z) GEL ELECTROPHORESIS

BONUS

7. BIOLOGY: *Short Answer:* What term describes former genes that have accumulated mutations over a long period of time and thus have become nonfunctional?  
  
ANSWER: PSEUDOGENES

TOSS UP

8. EARTH AND SPACE SCIENCE: *Short Answer:* What limit, analogous to the Chandrasekhar limit for white dwarves, gives the upper bound to the mass of a star composed entirely of degenerate neutrons? Stars that exceed this limit will collapse into a denser form, either becoming a black hole or changing composition and becoming a quark star.

ANSWER: TOLMAN-OPPENHEIMER-VOLKOFF LIMIT

BONUS

8. EARTH AND SPACE SCIENCE: *Short Answer:* By name or number, identify all of the following 4 sources that could produce a "long" gamma ray burst:  
1. collapse of a star into a black hole

2. collapse of a star into a neutron star

3. merging of binary neutron star

4. starquakes on the surface of a magnetar

ANSWER: 1 and 2

TOSS UP

9. CHEMISTRY: *Multiple Choice:* In which of the following titration situations would the indicator used not be suitable for the acids and bases used?

W) titration of HCl with NaOH using litmus as an indicator

X) titration of LiOH with HNO3 using litmus as an indicator

Y) titration of HCN with NaOH using phenolphthalein as an indicator

Z) titration of NH3 with HCl using Cresol Red as an indicator

ANSWER: Z) titration of NH3 with HCl using Cresol Red as an indicator

BONUS

9. CHEMISTRY: *Short Answer:* What volume of 1.0 M calcium hydroxide is needed to reach the equivalence point when titrating a 0.5 L solution of 2.0 M hydrochloric acid? Give your answer in liters.  
  
ANSWER: 0.5 L

TOSS UP

10. PHYSICS: *Short Answer:* Using proper sign notation, what is the angular velocity, in radians per minute, of the second hand on a clock?  
  
ANSWER: -2 pi rad/min

BONUS

10. PHYSICS: *Short Answer:* A flywheel of a prototype car engine is being tested The angular position theta of the flywheel is given by theta = 2.0 rad/s cubed times t to the third. If the diameter of the flywheel is 1 m, find the distance in meters that a particle on the edge of the flywheel moves between time t = 1s and t = 2s

ANSWER: 7 m

TOSS UP

11. MATHEMATICS: *Multiple Choice:* Which of the following defines a function f for which f(-x) = -f(x)?

W) f(x) = sin x  
X) f(x) = x^2

Y) f(x) = ln x  
Z) f(x) = cos x

ANSWER: W) f(x) = sin x

BONUS

11. MATHEMATICS: *Multiple Choice:* If f(x) = the interval from 0 to x of the function 1 over the quantity square root of t squared closed quantity dt, then which of the following is NOT TRUE?

W) f (0) = 0

X) f ' (2) = 1/2

Y) f is continuous at x for all x is greater than 0

Z) f (1) is greater than 0

ANSWER: X) f ' (2) = 1/2

TOSS UP

12. ENERGY: *Short Answer:* What precursor to coal, found in histosoils, is an accumulation of partially decayed vegetation found in wetland conditions such as bogs and mires. It is a soft an easily compressed material and when dried, can be used as fuel.

ANSWER: PEAT

TOSS UP

12. ENERGY: *Short Answer:* What country, in addition to holding 22.6% of the world's total known coal reserves, also contains the largest anthracite and bituminous deposits, with more than double that of the next country.

ANSWER: 'MURICA