**TOSS UP**

1. BIOLOGY *Multiple Choice* Which of the following white blood cell types is considered to be the hallmark of acute inflammation, is normally found in the blood stream, and is the predominant cells found in pus, giving it its white-yellow appearance?  
   W) Plasma cell

X) Neutrophil

Y) Basophil

Z) Cytotoxic T cell

ANSWER: X) Neutrophil

**BONUS**

1. BIOLOGY *Short Answer* Match the following 3 white blood cells: 1. neutrophil, 2. basophil, 3. macrophage, with their appropriate descriptorsA. mainly targets bacteria and fungi; make up the majority of leukocytes

B. are a derivative of monocytes, engulf cellular debris and pathogens

C. release histamine for inflammatory responsesANSWER: A. 1 (neutrophil) B. 3 (macrophage) C. 2 (basophil)

**TOSS UP**

1. PHYSICS *Short Answer* A particle is spinning around a circular track with radius 2 meters. If the particle makes one revolution every second, giving your answer in terms of pi, what is the centripetal acceleration of the particle?ANSWER: 8 pi squared

**BONUS**

1. PHYSICS *Multiple Choice* A light, flexible ideal rope is wrapped several times around a drum that can be approximated as a solid cylinder. The drum has radius 1 m and mass 10 kilograms. If the rope is pulled out for 3 meters while applying a constant force of 5 Newtons such that it unwinds without slipping and turns the cylinder, what is the final angular velocity of the drum?

W) sqrt (2) rad/s

X) sqrt (3) rad/s  
Y) sqrt (5) rad/s

Z) sqrt (6) rad/s

ANSWER: Z) sqrt (6) rad/s

**TOSS UP**

1. CHEMISTRY *Short Answer* In the "A" phase of this liquid crystal, molecules are oriented along the layer normal. In the C phase, they are tilted away from the layer normal. Molecules in this phase form well-defined layers that can slide over one another in a manner similar to that of slope. Name this phase of liquid crystal.  
     
   ANSWER: smectic

**BONUS**

1. CHEMISTRY *Short Answer* What is the Miller index of a plane that intercepts the x-axis at a/1, the y-axis at -b/1, and the z axis at c/2?ANSWER: (1, bar 1, 2)

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following terms refers to a wind that carries high density air from a high to low elevation under the force of gravity alone?W) Katabatic wind

X) Chinook wind

Y) Anabatic wind

Z) Advection wind

ANSWER: W) Katabatic wind

**BONUS**

EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following statements best explains why hurricanes do not develop within about 5 degrees of the equator?W) due to solar heating, surface temperatures at the equator are too warm to form hurricanes

X) the easterly trade winds prevent formation of rotating low pressure systems

Y) upwelling of cold water due to thermohaline circulation keeps surface temperatures low, retarding hurricane formation

Z) the Coriolis effect is too weak there

ANSWER: Z) the Coriolis effect is too weak there

**TOSS UP**

1. MATH *Short Answer* What is the multiplicity of the largest prime factor of 60?  
     
   ANSWER: 60

**BONUS**

1. MATH *Short Answer* In how many unique ways can the letters in the word "areas" be arranged?ANSWER: 60

**TOSS UP**

1. ENERGY *Short Answer* List the following 4 countries in order of decreasing crude oil production: Brazil, Saudi Arabia, Russia, United StatesANSWER: Saudi arabia, russia, us, brazil

**BONUS**

1. ENERGY *Short Answer* Match the following three thermodynamic cycles to their respective descriptors1. Rankine cycle

2. Bell-Coleman cycle

3. Carnot cycle

A. the most efficient cycle for converting a given amount of heat into work

B. a reversed Brayton cycle that acts as a heat pump

C. cycle that most closely describes steam-operated heat engines

ANSWER: 1. C 2. B 3. A

**TOSS UP**

1. BIOLOGY *Short Answer* What terms describes physical or chemical agents that interact with DNA in ways that cause mutations above the natural background level?  
     
   ANSWER: mutagens

**BONUS**

1. BIOLOGY *Multiple Choice* Which of the following statements about mutagens is NOT TRUE?W) Reactive oxygen species are a subset of DNA reactive chemicals, and interact directly with DNA

X) promutagens such as benzene and PAHs are not directly mutagentic, but can be metabolized to produce mutagenic compounds

Y) base analogs are chemicals that can substitute for DNA bases and cause frame shift mutations

Z) physical mutagens include ionizing radiations and radioactive decay of C14 in DNA

ANSWER: Y) base analogs are chemicals that can substitute for DNA bases and cause frame shift mutations

**TOSS UP**

1. PHYSICS *Short Answer* By name or number, identify all of the following 3 statements that are ALWAYS TRUE regarding ALL adiabatic process

1. delta S = 0

2. delta U = 0

3. delta Q = 0

ANSWER: 2 only

**BONUS**

1. PHYSICS *Short Answer* What commonly taught interpretation of quantum mechanics hold that quantum mechanics does not yield a description of an objective reality but only deals with probabilities of measuring various aspects of energy quanta? One principle of this interpretation is that any act of measurement of a wavefunction causes the set of probabilities to immediately assume only one of the possible values, in a process known as wavefunction collapse.ANSWER: COPENHAGEN INTERPRETATION

**TOSS UP**

1. CHEMISTRY *Multiple Choice* The crystal structure of diamond is equivalent to the

W) hexagonal close-packed structure

X) cesium chloride structure

Y) zincblende structure

Z) rock salt structure

ANSWER: Y) zincblende structure

**BONUS**

1. CHEMISTRY *Multiple Choice* What is the approximate percent deprotonation of a hypothetical 1.0 M monoprotic weak acid with a Ka of 4.0 x 10^-6W) 0.01%

X) 0.2%

Y) 1.0%

Z) 2.0%ANSWER: X) 0.2%

**TOSS UP**

1. EARTH AND SPACE SCIENCE *Short Answer* In the Yerkes spectral classification system, also known as the MMK system, what roman numeral is used to represent main-sequence stars? ANSWER: V

**BONUS**

1. EARTH AND SPACE SCIENCE *Short Answer* What stage of stellar evolution immediately follows the red giant branch in stars with masses similar to the suns, resulting from the changes in the stellar structure that occurs after helium flash. The changes in stellar structure. These stars are powered by helium fusion in the core and hydrogen fusion in a shell outside the core.ANSWER: Horizontal branch

**TOSS UP**

1. MATH *Short Answer* What is the smallest positive integer value of a that makes the graph of y = x^3 + ax an odd function?  
     
   ANSWER: 1

**BONUS**

1. MATH *Multiple Choice* A polar graph of the equation r^2 = 2a^2 cos 2(theta) will produce a W) lemniscate

X) cardioid

Y) spiral of archemidies

Z) polar rose

ANSWER: W) lemniscate

**TOSS UP**

1. ENERGY *Multiple Choice* According to estimates by the US energy information administration, what percentage of the 503.7 quadrillion Btu of energy consumed by the whole world came from renewable sources?W) 10%

X) 20%

Y) 30%

Z) 40%

ANSWER: W) 10%

**BONUS**

1. ENERGY *Multiple Choice* Which of the following sources accounts for the alrgest total percentage of US electricity generation?W) petroleum

X) natural gas

Y) nuclear

Z) hydropower

ANSWER: X) natural gas