**TOSS-UP 1**

CHEMISTRY *Multiple Choice* Which of the following choices gives the correct units for the rate constant of a second order reaction?

W) 1/s

X) L/s

Y) L/(mol\*s)

Z) L/(mol2\*sec)

ANSWER: Y) L/(mol\*s)

**BONUS 1**

CHEMISTRY *Short Answer* Give by name or number all of the following four choices is or are correct regarding the collision theory of reactions?

1. Collision frequency is dependent on the cross section of the collision.
2. Collision frequency is most directly dependent on the acceleration of the molecules before impact.
3. The mean relative frequency decreases with respect to the square root of the temperature.
4. If a reaction is endothermic in the forward direction, the activation energy is lower for the reverse reaction than the forward reaction.

ANSWER: 1, 4

**TOSS-UP 2**

BIOLOGY *Short Answer* Give by name or number all of the following three choices that are true regarding the growth of plants.

1. C3 Plants grow better in hot, arid conditions than do CAM Plants.
2. CAM plants grow better in cold, moist conditions than do C3 plants.
3. CAM plants and C4 plants both grow better in hot arid conditions than do C3 plants.

ANSWER: 3 Only

**BONUS 2**

BIOLOGY *Short Answer Short Answer* Classify the following 3 organisms as photoautotrophs, chemoautotrophs, photoheterotrophs or chemoheterotrophs.

1. Rhodobacter
2. Fungi
3. Cyanobacteria

ANSWER: Photoheterotroph, chemoheterotroph, photoautotroph

**TOSS-UP 3**

PHYSICS *Short Answer* Find the volume of water that can pass through a tube with a cutaway area of 20 pi, if you know that earlier in the pipe, where the cutaway area was 10 pi, the speed of the flow was 0.2 m/s and the volume of the flow was 50L.

ANSWER: 25 L

**BONUS 3**

PHYSICS *Short Answer* This phenomenom is the scattering of a photon by a free charged particle. It results in a decrease in the energy of the photon. Conversely, the inverse of this process can also occur.

ANSWER: Compton Scattering

**TOSS-UP 4**

EARTH AND SPACE SCIENCE *Short Answer* Give by name or number, give all of the following choices that are correct, regarding how, compared to normal years, El Nino affects the water levels in Asia compared to the Americas.

1) higher water levels in Asia than usual

2) higher water levels in the Americas than usual

3) roughly equal water levels between Asia and the Americas

4) overall higher water levels in the Americas than in Asia

ANSWER: 2, 3

**BONUS 4**

EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following is false regarding the impact of La Nina?

W) La Nina is always preceded by El Nino.

X) In India, La Nina would have a beneficial impact on the monsoons.

Y) La Nina corresponds to an average warming of ocean temperatures by about 0.5 degrees Celsius.

Z) Other impacts of La Nina are increased precipitation in the Rockies, but lower precipitation in the American Southwest.

ANSWER: W) La Nina is always preceded by El Nino.

**TOSS-UP 6**

ENERGY *Short Answer* This substance is later converted to its hexafluoride form right before its primary substituent is purified. Give the name for the substance into which uranium ore is converted into, valued due to its stability and compact area.

ANSWER: Yellowcake

**BONUS 6**

ENERGY *Short Answer* Which of the following 4 is or are not major advantages of algae based fuels over fossil fuels?

1) It is relatively harmless to the environment if spilled

2) It is a relatively cost efficient fuel source

3) The growth rate is extremely short

4) It can produce much more fuel per area of crop than other competing crops

ANSWER: 3) It is a relatively cost efficient fuel source

**TOSS-UP**

CHEMISTRY *Short Answer* This equation can be derived directly from statistical mechanics. This equation can determine the Boyle Temperature from the van der Waals equation of state. Name this equation of state that utilizes coefficients to represent the interactions between pairs, triplets and other groups of molecules.

ANSWER: Virial Equation of State

**BONUS 7**

CHEMISTRY *Short Answer Short Answer* Identify the molecularity of the following two reactions.

1. C2N2-> CN+ CN
2. NO2+NO2->NO+NO3

ANSWER: 1- Unimolecular 2- bimolecular

**TOSS-UP 8**

BIOLOGY *Multiple Choice* The region of the plant in which the parenchyma cells are located that is involved in photosynthesis is called the

W) Vascular Cylinder

X) Mesophyll

Y) Xylem

Z) Phloem

ANSWER: X) Mesophyll

**BONUS 8**

BIOLOGY *Multiple Choice* Which of the following 4 does not occur in a signal conduction pathway?

1) Stimulation of receptor by relay molecule

2) Production of secondary messenger such as cGMP

3) Activation of protein kinases

4) Phosphorylation of protein kinases

ANSWER: 1) Stimulation of receptor by relay molecule

**TOSS-UP 9**

PHYSICS *Multiple Choice* Which of the following is not a part of the Carnot Cycle, when it is acting as part of a heat engine?

W) Isentropic expansion of gas, leading to the gas’s temperature decreasing

X) Reversible isothermal expansion of the gas

Y) Reversible adiabatic compression of the gas

Z) Reversible adiabatic expansion of the gas

ANSWER: Y) Reversible adiabatic compression of the gas

**BONUS 9**

PHYSICS *Short Answer* Give by name or number all of the following four statements that are true regarding fluid motion?

1) Swiftly moving fluids exert more pressure than slower moving fluids

2) When a fluid is at rest, all portions of the fluid are in static equilibrium with each otherwith respect to the observer

3) In Newtonian fluids, stress and strain are linearly related.

4) A pressure applied to an enclosed fluid will decrease as the distance from the source increases

ANSWER: 2, 3

**TOSS-UP 10**

EARTH AND SPACE SCIENCE Supernova remnants can merge to form these objects. Often hundreds of parsecs across, these objects can spew hot gas high above the galactic plane in a galactic fountain.

ANSWER: Superbubble

**BONUS 10**

EARTH AND SPACE SCIENCE *Short Answer* In this theory, scientists point to large, sudden changes in the fossil record as evidence. The older version of this theory claims that the Earth’s features are primarily shaped by large events, such as volcanoes. Give the name for this theory, first introduced by Cuvier.

ANSWER: Catastrophism

**TOSS-UP 12**

ENERGY *Short Answer* In this class of nuclear reactor, the water which passes over the reactor core acts as a moderator. Coolant does not flow to the turbine, but is contained in a pressurized primary loop, which produces steam in the secondary loop, driving the turbine. Its advantage is that a fuel leak in the core would not pass any radioactive contaminants to the turbine and condenser.

ANSWER: Pressurized Water Reactors

**BONUS 12**

ENERGY *Short Answer* A problem regarding nuclear power sometimes occurs via this event, in which the core of a nuclear reactor is shut down temporarily due to the buildup of short lived nuclear poisons. Give the name for this event, in which the natural decay of Iodine 135 into Xenon 135 acts as a strong neutron absorber, shutting down fission.

ANSWER: Xenon poisoning, Iodine pit, xenon pit, reactor slagging

**TOSS-UP 13**

CHEMISTRY *Short Answer* Commonly, these materials are composed of kaolinite, a form of aluminum aluminosilicates. Typically, they are inorganic materials that have been hardened by heating to high temperatures. Give the name for these materials that are characterized by electrical resistance and are formed by heating clay in a kiln.

ANSWER: Ceramics

**BONUS 13**

CHEMISTRY *Short Answer* In the reaction 2NO (g) + O2 (g) -> 2NO2, the reaction rate increases by a factor of 4 when the NO concentration is doubled. When both O2 and NO are doubled, the reaction rate increases by a factor of 8. What are the reaction orders, and the units of the rate constant k for the overall reaction in terms of L, mol, and seconds?

ANSWER: Second order to NO, first order in O2, L2 mol-2 s-1

**TOSS-UP 14**

BIOLOGY *Short Answer* An example of this occurrence is a population of birds who either have small or large bills. Evolution has made intermediate sized bills inefficient, and has removed them from the population. Give the name for this type of natural selection when conditions favor individuals at extremes of a phenotypic range.

ANSWER: Disruptive Selection

**BONUS 14**

BIOLOGY *Short Answer* Give by name or number, all of the following four choices that is or are true regarding homologous chromosomes.

1. They behave independently in mitosis.
2. They synapse during the S phase of meiosis.
3. They travel together to the metaphase plate in prometaphase of meiosis I.
4. Crossing over between non-sister chromatids of homologous chromosomes is indicated by the presence of chiasma.

ANSWER: 1, 3, 4

**TOSS-UP 15**

PHYSICS Short Answer: The focal length of a concave mirror is 2 meters. An object is

positioned 8 meters in front of the mirror. Give the magnitude of the distance where the image is formed.

ANSWER: 8/3 Meters

**BONUS 15**

PHYSICS *Short Answer* Pipe B, with length L, and pipe A, with length 2 L have two open ends. What harmonic of pipe B will have the same frequency of the fundamental of pipe A?

ANSWER: Second harmonic

**TOSS-UP 16**

EARTH AND SPACE SCIENCE *Short Answer* These objects exhibit broad emission lines of highly ionized atoms. At visual wavelengths, these objects appear to have small highly luminous nuclei. Name these objects that are thought to have extremely high velocities in the gases within their nuclei, and possibly a supermassive black hole at their centers.

ANSWER: Seyfert Galaxies

**BONUS 16**

EARTH AND SPACE SCIENCE *Short Answer* Calculate the redshift of a quasar to three significant digits, if you know that the change in its wavelength due to redshift is 300 nm, and that its unshifted wavelength is 900 nm.

ANSWER: 0.333

**TOSS-UP 18**

ENERGY *Multiple Choice* Which of the following is false regarding geothermal energy?

W) Unrestricted use of geothermal energy in a specific location is sustainable for centuries.

X) Geothermal sources of energy are relatively low emitting sources compared to their green counterparts.

Y) If geothermal energy sources are spread out over a large area, it is more sustainable.

Z) Geothermal energy is primarily used along fault lines.

ANSWER: W) Unrestricted use of geothermal energy in a specific location is sustainable for centuries

**BONUS 18**

ENERGY *Short Answer* Give all of the flowing three choices that is or are true regarding wind energy.

1. The energy from a single turbine is highly stable.
2. Typically, solar energy is built alongside wind as a complementary source of energy.
3. Hydroelectric dams can be built as alternating complementary sources of energy.

ANSWER: 2, 3

**TOSS-UP 19**

CHEMISTRY *Short Answer* This type of industrial catalyst are commonly composed of aluminosilicates. Name this microporous catalyst that has a three dimensional structure riddled with hexagonal channels that allow the products to only grow to a certain size.

ANSWER: Zeolites

**BONUS 19**

CHEMISTRY *Short Answer Short Answer* Calculate the distance between two layers of a crystal lattice, if you are given that constructive interference occurs at 60 degrees and x-ray of wavelength 200 pm is used in the experiment.

ANSWER: 200 pm

**TOSS-UP 20**

BIOLOGY *Multiple Choice* Which of the following is an example of an early vertebrate that had prominent eyes, and barbed hooks formed from mineralized dental tissues. They were so plentiful, that geologists use their fossilized teeth as a guide for the rock layer in which they search for oil.

W) Gnathostomes

X) Lampreys

Y) Conodonts

Z) Lancelets

ANSWER: Y) Conodonts

**BONUS 20**

BIOLOGY *Multiple Choice* Muscle cell contraction occurs via

W) Contraction of the I band

X) Contraction of the A band

Y) The contraction of the sarcoplasmic reticulum

ANSWER: Z) Sliding of thin filaments by thick filaments

**TOSS-UP 21**

PHYSICS Multiple Choice: For an electromagnetic wave traveling in a vacuum, if the magnitude

of the intensity of the E field is zero, the magnitude of the intensity of the B field is:

W) the square root of 2 times the positive maximum

X) the negative maximum

Y) the positive maximum

Z) zero

ANSWER: Z) zero

**BONUS 21**

PHYSICS *Short Answer* In lasers, voltages can sometimes be used to put more electrons in the excited state rather than the ground state. In this process, stimulated emission will occur before spontaneous emission.

ANSWER: Population Inversion

**TOSS-UP 22**

EARTH AND SPACE SCIENCE *Short Answer* Give the name for a specialized form of concordant igneous intrusion that is characterized by a dome in the country rock and a nearly planar floor.

ANSWER: Laccolith

**BONUS 22**

EARTH AND SPACE SCIENCE *Short Answer* This term is given to the region of water that is neither close to the bottom nor near the shore. It is affected by light intensity, pressure, temperature, salinity and the supply of dissolved oxygen and nutrients. Derived from the Greek for “open water”, life here decreases with depth.

ANSWER: Pelagic Zone

**TOSS-UP 24**

ENERGY *Short Answer* Give all of the following four choices that is or are a significant advantage of breeder reactors.

1. Theoretically, they have 100% energy extraction efficiency from uranium.
2. Thermal breeder reactors are feasible with any fuel source.
3. They produce lower levels of actinide level nuclear waste.
4. They are much cheaper to build than water cooled reactors.

ANSWER: 1, 3

**BONUS 24**

ENERGY Short Answer Give by name or number, all of the following four statements that are true of hydroelectric power.

1. Sand bars and riverbanks downstream of a dam commonly show signs of rapid erosion, due to cyclic discharges from the dam.

2. In tropical regions, dam reservoirs are a major emitter of methane, due to the anaerobic decomposition of plant material in the reservoir.

3. Plants can quickly ramp up production in order to meet fluctuating demands.

4. The major advantage of hydroelectric power is the elimination of fuel needs and the quick payoff that it can make.

ANSWER: All 4

**TOSS-UP 25**

CHEMISTRY *Short Answer* Estimate the solubility of silver chloride in 1.0\*10-4M NaCl at 25 degrees Celsius, if you are given that the Ksp is 1.6\*10-10.

ANSWER: 1.6\*10-6.

**BONUS 25**

CHEMISTRY *Short Answer* Identify the class of colloid that the following three examples belong to.

1. Muddy Water
2. Styrofoam
3. Mayonaise

ANSWER: 1- Sol 2- foam 3- emulsion