

ROUND 15A

TOSS-UP

1) CHEMISTRY *Multiple Choice* Which of the following ionic salts has the LARGEST lattice dissociation energy?

- W) Sodium chloride
- X) Magnesium oxide
- Y) Magnesium chloride
- Z) Lithium fluoride

ANSWER: X) MAGNESIUM OXIDE

BONUS

1) CHEMISTRY *Short Answer* If 30 milliliters of 0.10 molar sulfuric acid is titrated with 0.03 molar sodium hydroxide, how many milliliters of sodium hydroxide are required to reach the equivalence point?

ANSWER: 200

TOSS-UP

2) MATH *Short Answer* In a group of 16 students, 12 take science and 8 take math. One student takes neither science nor math. How many students take both?

ANSWER: 5

BONUS

2) MATH *Short Answer* If $a * b = ab \div (a + b)$ [**a star b equals a times b divided by the quantity a plus b**], then find the value of $4 * (4 * 4)$ [**four star open parenthesis four star four close parenthesis**]

ANSWER: 4/3 (ACCEPT: 1 1/3)

TOSS-UP

3) PHYSICS *Multiple Choice* An electromagnetic wave goes into a block of glass with an index of refraction of $n = 1.1$. In terms of the speed of light C , which of the following is closest to the speed at which the wave propagates inside the glass medium?

- W) C
- X) $0.1C$
- Y) $0.9C$
- Z) $1.1C$

ANSWER: Y) $0.9C$

BONUS

3) PHYSICS *Multiple Choice* Water is warmed by an immersed coil that generates 1000 joules of heat per second when an electric potential difference of 10 volts is applied across its ends. What is the resistance, in ohms, of the heater wire?

- W) 0.1
- X) 1
- Y) 10
- Z) 100

ANSWER: W) 0.1

TOSS-UP

4) EARTH AND SPACE *Short Answer* If a galaxy is observed to have a recessional velocity of 150 km/s, what is its distance, in megaparsecs, to one significant figure?

ANSWER: 2

BONUS

4) EARTH AND SPACE *Multiple Choice* Which of the following best represents the maximum possible change in thickness of a single clay particle between its condition during hydration compared to dehydration?

- W) Less than 20%
- X) Approximately 50%
- Y) Approximately 70%
- Z) Nearly 100%

ANSWER: Z) NEARLY 100%

TOSS-UP

5) CHEMISTRY *Multiple Choice* Which of the following statements does NOT describe a molecule in an octahedral arrangement?

- W) Two-fold, three-fold, and four-fold rotation axes can all be found
- X) Two different types of improper rotations can be found
- Y) Exactly eight different mirror planes can be found
- Z) An inversion center is present

ANSWER: Y) EXACTLY EIGHT DIFFERENT MIRROR PLANES CAN BE FOUND

BONUS

5) CHEMISTRY *Short Answer* An airtight chamber contains 4 moles of nitrogen and an unknown amount of oxygen. If the partial pressure of oxygen is 150 torr, and the total pressure is 350 torr, how many moles of oxygen are present?

ANSWER: 3

TOSS-UP

6) BIOLOGY *Multiple Choice* Which of the following is an example of commensalism?

- W) A hummingbird drinking from a flower
- X) A tapeworm living in a host intestine
- Y) A clown fish living in a sea anemone [*uh-NEM-uh-nee*]
- Z) Egrets foraging among cattle fields

ANSWER: Z) EGRETS FORAGING AMONG CATTLE FIELDS

BONUS

6) BIOLOGY *Multiple Choice* You are walking in July when you come across a hedgehog. The animal does not stir when you pick it up; it is breathing and is not injured. What is the best explanation for the animal's lack of responsiveness?

- W) It is hibernating
- X) It is in a state of torpor
- Y) It is estivating
- Z) It is in a state of suspended animation

ANSWER: Y) IT IS ESTIVATING

TOSS-UP

7) ENERGY *Multiple Choice* Which of the following is NOT an oil product?

- W) Gasoline
- X) Syngas
- Y) Kerosene
- Z) Asphalt

ANSWER: X) SYNGAS

BONUS

7) ENERGY *Short Answer* The battery in your laptop is 4 volts and has a resistance of 10 ohms. In amp-hours, if your laptop charges to 100 percent in an 8 hour workday, what is the initial capacity, assuming perfect efficiency?

ANSWER: 3.2

TOSS-UP

8) EARTH AND SPACE *Multiple Choice* Which of the following volcanoes in the Cascade Volcanic Arc is a shield volcano?

- W) Mt Rainier
- X) Mt St Helens
- Y) Newberry Volcano
- Z) Glacier Peak

ANSWER: Y) NEWBERRY VOLCANO

BONUS

8) EARTH AND SPACE *Short Answer* What is the name of the graben that has the highest recorded temperature on Earth?

ANSWER: DEATH VALLEY

TOSS-UP

9) MATH *Multiple Choice* For the expression $5^x = 4^z$, **[five to the power of x equals four to the power of z]** if x and z are positive, which of the following is true?

W) $x^z = \log_{\frac{5}{4}}$ **[x to the power of z equals log of five-fourths]**

X) $\frac{z}{4} = \log_5(x)$ **[z divided by four equals log base five of x]**

Y) $z < x$

Z) $\frac{x}{z} < 1$ **[x divided by z is less than one]**

ANSWER: Z) $\frac{x}{z} < 1$

BONUS

9) MATH *Short Answer* Evaluate the following definite integral: $\int_{-3}^0 \sqrt{(9 - x^2)} dx$ **[the integral from negative three to zero of the square root of open parenthesis nine minus x squared close parenthesis d x]**

ANSWER: $\frac{9\pi}{4}$

TOSS-UP

10) BIOLOGY *Multiple Choice* If the average fur thickness of wild foxes in the northern hemisphere increased with increasing latitude, this variation would be an example of which of the following.

W) Directional selection

X) Genetic drift

Y) Balancing selection

Z) Polymorphism

ANSWER: W) DIRECTIONAL SELECTION

BONUS

10) BIOLOGY *Multiple Choice* Compared to a seawater acclimated fish, a freshwater acclimated fish would be expected to have which of the following?

W) Higher glomerular filtration rates **[gloh-MER-you-lur]**

X) Increased drinking rates

Y) Decreased water gain

Z) Increased ion loss

ANSWER: W) HIGHER GLOMERULAR FILTRATION RATES

TOSS-UP

11) CHEMISTRY *Short Answer* How many sigma and pi bonds, respectively, are in ethyne [*ETH-yn*], commonly known as acetylene [*uh-SET-I-een*]?

ANSWER: 3 SIGMA AND 2 PI

BONUS

11) CHEMISTRY *Multiple Choice* Consider an arbitrary acid HA [*H- A*], where A can be any group. Which of the following facts would allow one to directly infer that it is a stronger acid than acetic acid?

- W) H-A has the ability to protonate water in high yield
- X) Acetic acid has the ability to protonate H-A in high yield
- Y) H-A has the ability to protonate acetate in high yield
- Z) Acetic acid has the ability to protonate A⁻ in high yield

ANSWER: Y) H-A HAS THE ABILITY TO PROTONATE ACETATE IN HIGH YIELD

TOSS-UP

12) PHYSICS *Short Answer* What physical quantity does the reciprocal of the square root of the product of vacuum magnetic permeability and electric susceptibility represent?

ANSWER: THE SPEED OF LIGHT

BONUS

12) PHYSICS *Multiple Choice* The compressibility of an object's volume is dependent on which of the following?

- W) Young's modulus
- X) Bulk modulus
- Y) Volume stress
- Z) Tensile stress

ANSWER: X) BULK MODULUS

TOSS-UP

13) EARTH AND SPACE *Short Answer* What competing model lost out to the Big Bang theory in the 1960s due to the discovery of the cosmic microwave background?

ANSWER: STEADY-STATE (ACCEPT: STEADY-STATE MODEL, STEADY-STATE THEORY, STEADY-STATE UNIVERSE)

BONUS

13) EARTH AND SPACE *Multiple Choice* If the atmosphere contained fewer salt crystals and dust particles than it does now, what would be true of clouds?

- W) Clouds would form less readily
- X) Clouds would form more readily
- Y) Cloud formation would not be affected
- Z) Clouds would form, but precipitation development would be affected

ANSWER: W) CLOUDS WOULD FORM LESS READILY

TOSS-UP

14) BIOLOGY *Multiple Choice* Electroporation of a cell enables which of the following?

- W) Polar molecules to pass through the plasma membrane
- X) Glucose to escape the plasma membrane
- Y) Polar molecules to intercalate into the plasma membrane [*in-TUR-kuh-layt*]
- Z) Non-polar molecules to escape the plasma membrane

ANSWER: W) POLAR MOLECULES TO PASS THROUGH THE PLASMA MEMBRANE

BONUS

14) BIOLOGY *Multiple Choice* Which of the following processes would be least similar in terms of ATP production between normal adipose tissue and brown adipose tissue?

- W) Glycolysis [*gly-KOL-uh-sis*]
- X) Glycogenolysis [*gly-KUH-juh-NOL-i-sis*]
- Y) Electron transport chain
- Z) Citric acid cycle

ANSWER: Y) ELECTRON TRANSPORT CHAIN

TOSS-UP

15) CHEMISTRY *Multiple Choice* Each of the following pairs of chemicals are dissolved in aqueous **[AK-wee-uhs]** solution at concentrations of 1 molar. Which pair would form a buffer solution?

- W) Sodium formate and formic acid
- X) Sodium nitrate and ammonia
- Y) Sodium hydroxide and nitric acid
- Z) Sodium chloride and hydrochloric acid

ANSWER: W) SODIUM FORMATE AND FORMIC ACID

BONUS

15) CHEMISTRY *Short Answer* Identify the oxidation number of carbon in each of the following: dimethyl ether (CH_3OCH_3), methylamine (CH_3NH_2), and formaldehyde **[fore-MAL-duh-hyd]** (H_2CO).

ANSWER: DIMETHYL ETHER: -2; METHYLAMINE: -2; FORMALDEHYDE: 0

TOSS-UP

16) ENERGY *Short Answer* What type of device is used to quantitatively measure the heat released by chemical reactions and physical changes at constant volume?

ANSWER: BOMB CALORIMETER (DO NOT ACCEPT: CALORIMETER)

BONUS

16) ENERGY *Multiple Choice* Which of the following is closest to the correct global warming potential factor for nitrous oxide (N_2O)?

- W) 3
- X) 30
- Y) 100
- Z) 300

ANSWER: Z) 300

TOSS-UP

17) MATH *Short Answer* Express the base twelve numeral ET [**E T**] in base 10.

ANSWER: 142

BONUS

17) MATH *Short Answer* A 10 X 10 [**ten by ten**] grid contains 100 unit squares with vertical and horizontal sides. How many squares with vertical and horizontal sides can be drawn whose 4 vertices are also vertices of the unit squares?

ANSWER: 385

TOSS-UP

18) BIOLOGY *Multiple Choice* Which of the following terms is used to describe the center of the field of vision?

- W) Optic nerve
- X) Fovea [**FOH-vee-uh**]
- Y) Pupil
- Z) Blind spot

ANSWER: X) FOVEA

BONUS

18) BIOLOGY *Multiple Choice* Injury to cranial nerve III would result in an inability to do which of the following?

- W) Smell
- X) Chew food
- Y) Move eyes to the left
- Z) Feel pain in the eye area

ANSWER: Y) MOVE EYES TO THE LEFT

TOSS-UP

19) PHYSICS *Multiple Choice* What must be the capacitance in farads of a capacitor storing 10 joules of energy and having 1 volt potential difference between its plates?

- W) 2
- X) 20
- Y) 200
- Z) 2000

ANSWER: X) 20

BONUS

19) PHYSICS *Short Answer* A necessary condition for a standard laser is that a population of atoms or molecules must have more members in an excited metastable state than in a lower energy state. What is the term for this scenario?

ANSWER: POPULATION INVERSION

TOSS-UP

20) ENERGY *Multiple Choice* Which of the following compounds is an additive to natural gas that serves as an odorant?

- W) Hydrogen sulfide
- X) tert-Butylthiol [*turt-byoo-til-THY-ol*]
- Y) Acetylsalicylate [*uh-seet-l-suh-LIS-uh-layt*]
- Z) Methylamine [*meth-uhl-a-MEEN*]

ANSWER: X) TERT-BUTYLTHIOL

BONUS

20) ENERGY *Short Answer* Calculate the number of air changes per hour in a 10' x 10' x 20' [**10 feet by 10 feet by 20 feet**] apartment given a leakage rate of 10 cubic feet per minute.

ANSWER: 0.3

TOSS-UP

21) MATH *Short Answer* On an average day, Kedar receives 10 spam emails. However, on some days he receives more, and on some days he receives less. What probability distribution best represents the probability that he will receive a certain number of spam emails on a given day?

ANSWER: POISSON DISTRIBUTION

BONUS

21) MATH *Multiple Choice* The tangent line to the graph $y = e^{2-x}$ [**y equals e to the power of the quantity two minus x**] at the point (1, e) [**one, e**] intersects both coordinate axes. What is the area of the triangle formed by this tangent line and the coordinate axes?

W) $2e$

X) $e^2 - 1$ [**e squared minus one**]

Y) e^2 [**e squared**]

Z) $4e$ [**four e**]

ANSWER: W) $2e$

TOSS-UP

22) CHEMISTRY *Multiple Choice* In the Haber process, one mole of nitrogen gas reacts with three moles of hydrogen gas to produce two moles of ammonia. The process is exothermic. If a particular Haber synthesis is at equilibrium [**ee-kwuh-LIB-ree-uhm**], which of the following changes to the reaction's conditions are predicted by Le Chatelier's principle to INCREASE the yield of ammonia?

W) Adding a catalyst

X) Increasing the temperature

Y) Increasing the pressure of the reaction mixture

Z) Increasing the volume of the reaction vessel

ANSWER: Y) INCREASING THE PRESSURE OF THE REACTION MIXTURE

BONUS

22) CHEMISTRY *Short Answer* Nitrogen monoxide reacts with hydrogen gas to form water vapor and nitrogen gas. A 1 liter vessel contains an equilibrium [**ee-kwuh-LIB-ree-uhm**] mixture of 28 moles of N_2 , 10 moles of H_2O , 2 moles of NO , and 1 mole of H_2 . Calculate K_c for this reaction.

ANSWER: 700

TOSS-UP

23) BIOLOGY *Short Answer* Pluripotent [**ploor-uh-POHT-nt**] cells develop from what type of connective tissue?

ANSWER: MESENCHYME (ACCEPT: MESENCHYMAL)

BONUS

23) BIOLOGY *Multiple Choice* In 1937, a medicinal elixir produced by a pharmaceutical company killed 71 adults and 34 children because the solvent for the drug was diethylene [**dy-E-thi-leen**] glycol, a chemical used now as antifreeze. Diethylene glycol is toxic because it is converted to oxalic acid by alcohol dehydrogenase [**dee-HY-druh-juh-nays**] and other enzymes, which damages the kidneys and brain. If given early enough, ethanol is a treatment for this poisoning. Which of the following reasons is the most likely explanation for why ethanol is an effective treatment?

- W) Ethanol is an allosteric inhibitor of alcohol dehydrogenase
- X) Ethanol is a more competitive substrate for alcohol dehydrogenase than diethylene glycol
- Y) Diethylene glycol has a stronger affinity for ethanol than for alcohol dehydrogenase
- Z) Ethanol cleaves the diethylene glycol molecule through an electrophilic attack on the alpha-carbon of diethylene glycol

ANSWER: X) ETHANOL IS A MORE COMPETITIVE SUBSTRATE FOR ALCOHOL DEHYDROGENASE THAN DIETHYLENE GLYCOL