ROUND 17

TOSS-UP

1) CHEMISTRY *Multiple Choice* L-alanine and D-alanine are BEST classified as what type of isomers:

W) cis
X) trans
Y) structural
Z) optical

ANSWER: Z) OPTICAL

BONUS

1) CHEMISTRY *Short Answer* How many sigma and pi bonds, respectively, are there in a molecule with the following formula: [read slowly] $CH_3CHCHCH_2CH_3$

ANSWER: SIGMA 14; PI = 1

TOSS-UP

2) BIOLOGY *Multiple Choice* Which of the following BEST explains how cyclic AMP can cause so many different intracellular responses in a mammalian cell:

W) it is produced in large quantities
X) it migrates to the DNA where it binds to a variety of histones
Y) it activates a wide variety of specific protein kinases
Z) it prevents the activation of other hormonal signals

ANSWER: Y) IT ACTIVATES A WIDE VARIETY OF SPECIFIC PROTEIN KINASES

BONUS

2) BIOLOGY *Multiple Choice* Which of the following BEST describes the function of a spliceosome (read as: SPLY-see-oh-zome):

W) splicing DNA together during replication
X) splicing out mutations
Y) joining multiple copies of structural genes
Z) removing introns

ANSWER: Z) REMOVING INTRONS

TOSS-UP

3) PHYSICS *Multiple Choice* Which of the following BEST explains how a radium isotope with a half-life of about 1,600 years can be found in the crust of the Earth that was formed millions of years ago:

W) its decay is slowed by the pressure of the Earth
X) the radium is replenished by decay of longer lived radioactive elements
Y) the radium was replenished by meteors and asteroids over the millennia
Z) the radium is recycled from the Earth's core where magnetic fields slow the decay

ANSWER: X) THE RADIUM IS REPLENISHED BY DECAY OF LONGER LIVED RADIOACTIVE ELEMENTS

BONUS

3) PHYSICS *Multiple Choice* Which of the following is probably the most significant limitation for PET scans being used in remote rural hospital sites:

W) lack of properly trained personnel
X) the proximity to production facilities for short-lived radioisotopes
Y) the high level of radiation requiring special training and increased radiation risk
Z) difficulty in PET radiotracers binding to receptors when imaging certain human tissues

ANSWER: X) THE PROXIMITY TO PRODUCTION FACILITIES FOR SHORT-LIVED RADIOISOTOPES

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TOSS-UP

4) MATH *Multiple Choice* Which of the following is TRUE about any two successive terms in the Fibonacci sequence:

W) their product is a Fibonacci number
X) they are either both odd or both even
Y) they are relatively prime
Z) their quotient is the golden ratio

ANSWER: Y) THEY ARE RELATIVELY PRIME

BONUS

4) MATH *Short Answer* Find the inverse of the 2-by-2 matrix whose rows are 3, 5 and 7, –2. Give your answer in rows.

ANSWER: $\dfrac{2}{41}, \dfrac{5}{41}, \dfrac{7}{41}, -\dfrac{3}{41}$

5) EARTH SCIENCE *Multiple Choice* Most terrestrial plants grow best in soil with a pH range of:

W) 4.5 to 5.5
X) 6.0 to 7.0
Y) 7.0 to 8.0
Z) 7.5 to 8.5

ANSWER: X) 6.0 TO 7.0

BONUS

5) EARTH SCIENCE *Multiple Choice* Which of the following is a problem that affects most plants growing in very acidic soil:

W) iron deficiency
X) accumulation of excess salt in their foliage
Y) aluminum toxicity to their roots
Z) excess calcium and magnesium ion uptake

ANSWER: Y) ALUMINUM TOXICITY TO THEIR ROOTS

TOSS-UP

6) GENERAL SCIENCE *Multiple Choice* Which of the following best illustrates a limitation of a supercapacitor, or electric double-layer capacitor, versus an electrochemical battery:

W) virtually unlimited cycle life
X) rapid recharging
Y) low impedance
Z) high self-discharge rate

ANSWER: Z) HIGH SELF-DISCHARGE RATE

BONUS

6) GENERAL SCIENCE *Short Answer* If it is 7:47 AM, Tuesday September 23rd in Beijing China at 116º east longitude, what day and time, respectively, would it be in London, England?

ANSWER: TUESDAY; 12:47 AM

TOSS-UP

7) ASTRONOMY *Multiple Choice* Which of the following would astronomers most likely consider emission nebula:

W) Population III (read as: 3) regions
X) Population II (read as: 2) regions
Y) glowing H II (read as: H, 2) regions
Z) active regions

ANSWER: Y) GLOWING H II REGIONS

BONUS

7) ASTRONOMY *Multiple Choice* In which of the following locations would there typically be more Population Two stars than Population One stars:

W) in globular clusters
X) in spiral arms of galaxies
Y) in planetary nebula
Z) in regions actively forming stars

ANSWER: W) IN GLOBULAR CLUSTERS

TOSS-UP

8) CHEMISTRY *Multiple Choice* Which of the following are the units of the rate constant for a 2nd order reaction given that concentration is measured in molarity and time in seconds:

W) $M^{-2}s^{-1}$
X) $M^{-1}s^{-1}$
Y) Ms^{-1}
Z) $M^{-2}minutes^{-1}$

ANSWER: X) $M^{-1}s^{-1}$
(Solution: units relationship is $M^{1-order} \times time^{-1}$)

BONUS

8) CHEMISTRY *Short Answer* 1.0 gram of an unknown organic molecule is dissolved in 50.0 grams of benzene. Determine the molecular mass of the unknown if this solution freezes at 4.5ºC. Assume the freezing point constant of benzene is 5.0ºC per molal, and the freezing point of benzene is 5.5ºC. Give your answer to the nearest whole number in grams per mole.

ANSWER: 100
(Solution: $\Delta T_f = 5.5° – 4.5° = 1.0°C$; $m = \Delta T_f / K_f = 1.0°/5.0° = 0.2m$ or 0.2mol/kg;
(1.0g unkn/0.05 kg benz)(1kg benz/0.2 mol unkn) = 100 g/mol)

9) BIOLOGY *Multiple Choice* Which of the following is the target tissue of the hormone leptin where it binds with LepRB (read as: L, E, P, R, B) receptors:

W) hypothalamus
X) pancreas
Y) adipose tissue
Z) kidney

ANSWER: W) HYPOTHALAMUS

BONUS

9) BIOLOGY *Multiple Choice* Which of the following types of fatty acids would alpha linolenic or *all cis*-9,12,15-Octadecatrienoic (read as: octa-deca-tri-en-oh-ick) acid most commonly be classified:

W) an alpha 9 fatty acid
X) an alpha 9,12,15 fatty acid
Y) an omega 3 fatty acid
Z) an omega 6 fatty acid

ANSWER: Y) AN OMEGA 3 FATTY ACID

TOSS-UP

10) PHYSICS *Short Answer* Name all of the following 3 sub-atomic particles that interact with all 4 of the fundamental forces: electron; quarks; neutrino

ANSWER: QUARKS

BONUS

10) PHYSICS *Short Answer* Until the Large Hadron Collider came on-line at CERN, what accelerator was generally believed to be the only one energetic enough to produce top quarks?

ANSWER: TEVATRON (ACCEPT: FERMILAB ACCELERATOR)

11) MATH *Multiple Choice* Which of the following is the equation for the tangent line for $y = x^4$ at the point (1, 1):

W) $y = 4x - 3$
X) $y = 4x - 1$
Y) $y = 4x + 1$
Z) $y = 4x + 3$

ANSWER: W) $y = 4x - 3$

(Solution: using the derivative, $y' = 4x^3$, the slope of the tangent line at $x = 1$ is 4. The line must pass through (1, 1) so $y - 1 = 4(x - 1)$)

BONUS

11) MATH *Short Answer* What are the coordinates of the hole in the graph of the function,
$g(x) = \dfrac{(2x^2 - 8)}{(x - 2)}$?

ANSWER: (2, 8)

(Solution: simplifies to $2(x + 2)$; graph looks like a line except at the indicated hole)

TOSS-UP

12) EARTH SCIENCE *Multiple Choice* According to the discontinuous side of Bowen's reaction series, which of the following is likely to first crystallize as basaltic magma cools:

W) quartz
X) olivine
Y) pyroxene
Z) hornblende

ANSWER: X) OLIVINE

BONUS

12) EARTH SCIENCE *Short Answer* Of the 3 basic types of magma on Earth, which one generally has a chemical composition intermediate in iron, magnesium, and calcium?

ANSWER: ANDESITIC (ACCEPT: ANDESITE)

(Solution: 3 basic types: basaltic, andesitic, rhyolitic)

13) GENERAL SCIENCE *Multiple Choice* Which of the following age groups would have the most brown fat per kilogram of body weight:

W) infant
X) adolescent
Y) middle age
Z) elderly

ANSWER: W) INFANT

BONUS

13) GENERAL SCIENCE *Multiple Choice* Which of the following physiological processes generates most of the heat needed to keep an infant warm:

W) digestion of food in the gut
X) oxidative metabolism
Y) inspiration of air
Z) bacterial activity in the gut

ANSWER: X) OXIDATIVE METABOLISM

TOSS-UP

14) ASTRONOMY *Short Answer* What element makes up the innermost core of a type II (read as: type 2) supernova just before core collapse?

ANSWER: IRON

BONUS

14) ASTRONOMY *Short Answer* What is the magnification of a telescope with an objective lens that has a focal length of 250 centimeters and an eyepiece with a focal length of 0.50 centimeters?

ANSWER: 500X (ACCEPT: 500 or 500 TIMES)

(Solution: $M = F_o \div F_e = 250/0.50 = 500$)

TOSS-UP

15) CHEMISTRY *Multiple Choice* Consider the following equilibrium reaction, $FeO_{(solid)} + CO_{(gas)} \leftrightarrow Fe_{(solid)} + CO_{2(gas)}$, where ΔH (read as: delta H) equals –10 kilojoules. Which of the following would have a similar effect on the equilibrium position as lowering the temperature:

W) adding iron
X) increasing pressure
Y) removing carbon dioxide
Z) removing carbon monoxide

ANSWER: Y) REMOVING CARBON DIOXIDE

(Solution: shifts to the right)

BONUS

15) CHEMISTRY *Short Answer* In the electrolysis of water, if a very small amount of sodium sulfate is added to the water, give the equation for the half reaction that occurs at the ANODE. Make sure to indicate proper charges and the state of each substance, such as solid, liquid, aqueous, or gas:

ANSWER: $2H_2O_{(liquid)} \rightarrow O_{2(gas)} + 4H^+_{(aqueous)} + 4e^-$

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TOSS-UP

16) BIOLOGY *Short Answer* From what specific biological molecule are Barbara McClintock's transposons (read as: trans-POE-zons) made?

ANSWER: DNA

BONUS

16) BIOLOGY *Short Answer* Name all of the following 4 organisms in which transposons (read as: trans-POE-zons) are found: humans; maize; fruit fly; bacteria

ANSWER: ALL

TOSS-UP

17) PHYSICS *Multiple Choice* Which of the following BEST describes how one would compute the speed for a sound wave through a liquid:

W) the square of the density of liquid divided by its bulk modulus
X) the square of the bulk modulus of the liquid divided by its density
Y) the square root of the density of liquid divided by its bulk modulus
Z) the square root of the bulk modulus of the liquid divided by its density

ANSWER: Z) THE SQUARE ROOT OF THE BULK MODULUS OF THE LIQUID DIVIDED BY ITS DENSITY

BONUS

17) PHYSICS *Short Answer* Name all the leptons that are produced during beta minus decay?

ANSWER: ELECTRONS AND ANTINEUTRINOS (ACCEPT: ELECTRON ANTINEUTRINO FOR NEUTRINO)

TOSS-UP

18) MATH *Short Answer* How many solutions are there for the equation, cosine $4x = \dfrac{1}{2}$, for the interval $0 \le x < 2\pi$?

ANSWER: 8

(Solution: 4 cycles, 2 solutions per cycle)

BONUS

18) MATH *Short Answer* Cards numbered 1 through 10 lie on a table. If two cards are picked at random, without replacement, what is the probability, as a fraction in lowest terms, that the two cards will have values within one of each other?

ANSWER: 1/5

(Solution: 9/(10 nCr 2) = 9/45 = 1/5)

19) EARTH SCIENCE *Short Answer* In the southern hemisphere, Ekman transport generated by trade winds over the equatorial Pacific Ocean is how many degrees to the left of the prevailing winds?

ANSWER: 90

BONUS

19) EARTH SCIENCE *Multiple Choice* Which of the following BEST describes an air mass that originates in northern Mexico, moves into the Great Plains and stagnates, resulting in severe drought:

W) continental tropical
X) continental polar
Y) maritime tropical
Z) maritime polar

ANSWER: W) CONTINENTAL TROPICAL

TOSS-UP

20) GENERAL SCIENCE *Multiple Choice* Which of the following is NOT true regarding the burning of biodiesel versus gasoline in automobile engines:

W) biodiesel combustion does not emit SO_2
X) biodiesel contains more oxygen than gasoline
Y) the CO_2 released when biodiesel is burned is the same CO_2 the plants removed from the atmosphere as they grew
Z) the energy content per gallon of biodiesel is approximately 28% lower than that of ethanol

ANSWER: Z) THE ENERGY CONTENT PER GALLON OF BIODIESEL IS APPROXIMATELY 28% LOWER THAN THAT OF ETHANOL

BONUS

20) GENERAL SCIENCE *Short Answer* A physician orders 0.1 gram of a drug be administered to a patient. If it is only available as 20 milligrams per 5 milliliters, how many milliliters needs to be administered?

ANSWER: 25

(Solution: (100mg/20mg)(5mL) = 25 mL)

21) ASTRONOMY *Short Answer* From the LEAST to the MOST, what are the 3 most abundant elements in a G-type star?

ANSWER: HYDROGEN; HELIUM; CARBON

BONUS

21) ASTRONOMY *Short Answer* If a supernova with an apparent magnitude of –2.0 was observed for the first time in the year 2,000 at 35.00 kiloparsecs from Earth, how many years before observation, rounded to the nearest whole number, did the supernova most likely occur?

ANSWER: 114

(Solution: $3.26 \times 35.00 = 114.1$)

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TOSS-UP

22) BIOLOGY *Short Answer* What is the specific intermediate informational molecule for human retrotransposons (read as: rhet-tro-trans-POE-zons):

ANSWER: RNA (ACCEPT: RIBONUCLEIC ACID or mRNA or MESSENGER RNA)

BONUS

22) BIOLOGY *Short Answer* Order the following 4 processes from the one to typically occur the EARLIEST to the one to occur the LATEST in the production of collagen:
(read slowly) spliceosome (read as: SPLY-see-oh-zome); transcription; translation; golgi modification

ANSWER: TRANSCRIPTION; SPLICEOSOME; TRANSLATION; GOLGI MODIFICATION

23) CHEMISTRY *Short Answer* What is the overall reaction order for the following rate law:
rate = k[NH_4^+][NO_2^-]   (read as: k times the concentration of NH_4^+ times the concentration of NO_2^-)

ANSWER: 2 (ACCEPT: 2nd ORDER)

(Solution: exponents 1 + 1 = 2)

BONUS

23) CHEMISTRY *Short Answer* Calculate the one-atmosphere boiling point elevation, in degrees Celsius to the 2nd decimal place, for a solution made by dissolving 1 gram of solute in 0.1 kilograms of water. Assume the formula weight of the solute is 300 and the boiling point depression constant is 2.0°C per molal..

ANSWER: 0.07 (ACCEPT: 0.06)

(Solution: moles solute = 1g/300g/mol = 0.003m; m = 0.0033 moles solute /0.1kg = 0.033m;
ΔT_b = K_b(m) = (2.0°C/m)(0.033m) = 0.066°C)

TOSS-UP

24) PHYSICS *Short Answer* What boson is the only particle predicted by the Standard Model of Particle Physics that had not yet been observed as of June 2008?

ANSWER: HIGGS BOSON (ACCEPT: HIGGS)

BONUS

24) PHYSICS *Short Answer* Through what two particles is most of the energy released by a star like our Sun?

ANSWER: PHOTONS AND NEUTRINOS

25) BIOLOGY *Short Answer* From what amino acid is the vasodilator histamine primarily synthesized?

ANSWER: HISTIDINE

BONUS

25) BIOLOGY *Short Answer* What is the typical reported initial threshold value, in millivolts, of a human peripheral nerve axon?

ANSWER: –45 (ACCEPT: –50 TO –40)