

ROUND 12

TOSS-UP

1) PHYSICS *Short Answer* A 1 nanocoulomb charge is held 1 meter above an infinite sheet with a surface charge density of 1 nanocoulomb per meter squared. If the charge is moved to 2 meters from the sheet, then by what factor does the electric force on the charge change?

ANSWER: THERE IS NO CHANGE IN THE ELECTRIC FORCE (ACCEPT: 0)

BONUS

1) PHYSICS *Short Answer* You are in a spaceship and you bounce a ball off of a wall and catch it. The time between the instant you throw the ball and when it returns is 1.5 seconds. Another spaceship is travelling at a speed $\frac{4}{5}$ the speed of light relative to your ship. From the frame of reference of the other ship, providing your answer to the nearest tenth, how long does it take in seconds for you to throw and catch the ball?

ANSWER: 2.5

TOSS-UP

2) ENERGY *Short Answer* What is the term for the lifetime cost of generating electricity that is inclusive of initial capital cost and discount rate, as well as operation, fuel, and maintenance costs?

ANSWER: LEVELIZED COST

BONUS

2) ENERGY *Multiple Choice* When considering the total U.S. energy resources and reserves, coal represents 2.3% of the energy base. What approximate percentage does geothermal represent?

- W) 14%
- X) 23%
- Y) 39%
- Z) 51%

ANSWER: Y) 39%

TOSS-UP

3) CHEMISTRY *Multiple Choice* Which of the following properties is generally characteristic of metals?

- W) High heat conductivity
- X) Low electrical conductivity
- Y) High first ionization energies
- Z) Tendency to form negative ions

ANSWER: W) HIGH HEAT CONDUCTIVITY

BONUS

3) CHEMISTRY *Short Answer* What separation technique would effectively separate a 50:50 mixture of ethanol and water?

ANSWER: FRACTIONAL DISTILLATION (ACCEPT: DISTILLATION)

TOSS-UP

4) BIOLOGY *Multiple Choice* A man with an X-linked dominant trait has children with a female who is homozygous [***hoh-muh-ZY-guhs***] recessive for the trait. Which of the following proportions of his offspring will be affected by the trait?

- W) All of his children, male or female
- X) All his male children
- Y) All his female children
- Z) Half of his female children

ANSWER: Y) ALL HIS FEMALE CHILDREN

BONUS

4) BIOLOGY *Short Answer* Name four of the five structural characteristics shared by all Chordata at some point in their life cycle?

ANSWER: any 4 of DORSAL HOLLOW NERVE CORD (ACCEPT: DORSAL NERVE CORD), NOTOCHORD, GILL-SLITS, POST ANAL TAIL (ACCEPT: TAIL), ENDOSTYLE

TOSS-UP

5) MATH *Multiple Choice* How many two digit positive integers have at least one 6 as a digit?

- W) 17
- X) 18
- Y) 19
- Z) 20

ANSWER: X) 18

BONUS

5) MATH *Short Answer* Solve the following base-10 logarithmic equation for x :
 $\log(x^2 + 3x) + \log(5x) = 1 + \log(2x)$ [**log base 10 of open parenthesis x squared plus 3x close parenthesis plus log base 10 of 5x equals 1 plus log base 10 of 2x**].

ANSWER: 1 (DO NOT ACCEPT: -4)

TOSS-UP

6) EARTH AND SPACE *Short Answer* Which element was first discovered by observing its spectral lines in the solar atmosphere?

ANSWER: HELIUM

BONUS

6) EARTH AND SPACE *Short Answer* What are the two most massive galaxies in the Local Group?

ANSWER: MILKY WAY AND ANDROMEDA (ACCEPT: M31)

TOSS-UP

7) PHYSICS *Multiple Choice* A field emission microscope requires which of the following?

- W) A conductor with a very fine point
- X) High energy alpha particles
- Y) A light source with a wavelength shorter than the smallest observable feature size
- Z) A low amplitude, time-varying magnetic field

ANSWER: W) A CONDUCTOR WITH A VERY FINE POINT

BONUS

7) PHYSICS *Short Answer* A 2 kilogram object experiences a force with respect to time according to the relation $F = 4t$ newtons from time $t = 0$ seconds to time $t = 3$ seconds. What is the impulse that the object experiences in kilogram meters per second during these three seconds?

ANSWER: 18

TOSS-UP

8) CHEMISTRY *Multiple Choice* If an endothermic reaction is at equilibrium [*ee-kwuh-LIB-ree-uhm*], how will the equilibrium shift if the temperature is raised?

- W) Toward the reactants
- X) Toward the products
- Y) Toward both the reactants and the products
- Z) It will not shift in either direction

ANSWER: X) TOWARD THE PRODUCTS

BONUS

8) CHEMISTRY *Multiple Choice* Which of the following silver salts with the given K_{sp} values has the greatest molar solubility?

- W) Silver chloride, $K_{sp} = 1.8 \times 10^{-10}$
- X) Silver bromide, $K_{sp} = 5.0 \times 10^{-13}$
- Y) Silver iodide, $K_{sp} = 8.3 \times 10^{-17}$
- Z) Silver cyanide, $K_{sp} = 1.2 \times 10^{-16}$

ANSWER: W) SILVER CHLORIDE, $K_{sp} = 1.8 \times 10^{-10}$

TOSS-UP

9) BIOLOGY *Multiple Choice* In the lab, you engineer a gene so that it is specifically expressed in pancreatic cells. Which of the following aspects of the gene did you likely adjust?

- W) Intron sequences
- X) 5' **[5 prime]** UTR sequences
- Y) Translational start sequences
- Z) Promoter sequences

ANSWER: Z) PROMOTER SEQUENCES

BONUS

9) BIOLOGY *Multiple Choice* Which of the following is an example of a protein with quaternary structure?

- W) Myoglobin **[my-uh-GLOH-bin]**
- X) Hemoglobin
- Y) Cytochrome C **[SY-tuh-kroh-m C]**
- Z) Chymotrypsin **[ky-mo-TRIP-sin]**

ANSWER: X) HEMOGLOBIN

TOSS-UP

10) MATH *Short Answer* How many edges does a hexagonal prism have?

ANSWER: 18

BONUS

10) MATH *Short Answer* A horse is enclosed in a square field of side 100 meters. The horse eats grass along the outside edges of the field, forming a border of uniform width inside the field. If the area of the border is $\frac{9}{25}$ of the area of the field, what is the width in meters of the inside edge of the border?

ANSWER: 80

TOSS-UP

11) EARTH AND SPACE *Multiple Choice* Which of the following aberrations only occurs in refracting telescopes?

- W) Chromatic aberration
- X) Spherical aberration
- Y) Coma
- Z) Astigmatism

ANSWER: W) CHROMATIC ABERRATION

BONUS

11) EARTH AND SPACE *Multiple Choice* Which of the following is NOT true about tides?

- W) They are long-period waves that move through the oceans in response to forces exerted by the Moon and Sun
- X) They originate in the oceans and progress toward the coastlines
- Y) A horizontal movement of water often accompanies the rising and falling of the tide
- Z) The weakest currents occur before or near the time of the high and low tides

ANSWER: X) THEY ORIGINATE IN THE OCEANS AND PROGRESS TOWARD THE COASTLINES

TOSS-UP

12) PHYSICS *Short Answer* What are the units of the dielectric constant?

ANSWER: UNIT-LESS (ACCEPT: HAS NO UNIT)

BONUS

12) PHYSICS *Short Answer* A parallel plate capacitor has an area of 2 square meters and plate separation of 1 millimeter. If the electric field between the plates is 10 volts per meter, and given 9×10^{-12} coulombs squared over newtons meter squared as ϵ_0 [*epsilon naught*], providing your answer in scientific notation with one significant figure, what is the energy in joules stored by the capacitor?

ANSWER: 9×10^{-13}

TOSS-UP

13) ENERGY *Multiple Choice* Growth in the production of what commodity has resulted in an excess of glycerine **[GLIS-er-in]**?

- W) Gasoline
- X) Natural gas
- Y) Ethanol
- Z) Biodiesel

ANSWER: Z) BIODIESEL

BONUS

13) ENERGY *Multiple Choice* What is the approximate investment ratio per effective megawatt capacity for solar versus geothermally generated electricity?

- W) 2
- X) 5
- Y) 8
- Z) 10

ANSWER: Y) 8

TOSS-UP

14) CHEMISTRY *Short Answer* Give the name of the group of elements that have high melting points, are electropositive, and are frequently used in lasers and television sets.

ANSWER: LANTHANIDES

BONUS

14) CHEMISTRY *Short Answer* Given the molar mass of oxygen is 16 grams per mole and the molar mass of magnesium is 24 grams per mole, what is the empirical formula of a compound containing 48 grams of magnesium and 32 grams of oxygen?

ANSWER: MgO

TOSS-UP

15) BIOLOGY *Multiple Choice* Which of the following is NOT a common method by which ion channels are gated?

- W) Osmolarity
- X) Voltage
- Y) Mechanical
- Z) Ligand

ANSWER: W) OSMOLARITY

BONUS

15) BIOLOGY *Multiple Choice* Which of the following is NOT an energy source for active transport across a membrane?

- W) Electrochemical gradient of a different molecule
- X) Light
- Y) Ras proteins
- Z) ATP

ANSWER: Y) RAS PROTEINS

TOSS-UP

16) MATH *Short Answer* The graph of the following equation is an example of what conic section: $2x^2 = 2y^2 + 13$?

ANSWER: HYPERBOLA

BONUS

16) MATH *Short Answer* How many integers between 1 and 1000 inclusive are NOT divisible by either 2 or 5?

ANSWER: 400

TOSS-UP

17) EARTH AND SPACE *Short Answer* In hydrostatic equilibrium [*ee-kwuh-LIB-ree-uhm*], which two forces are balanced against each other?

ANSWER: PRESSURE AND GRAVITY

BONUS

17) EARTH AND SPACE *Multiple Choice* Estuaries off the coast of which of the following states demonstrate the greatest nutrient pollution?

- W) Louisiana
- X) Oregon
- Y) Maine
- Z) Texas

ANSWER: W) LOUISIANA

TOSS-UP

18) BIOLOGY *Multiple Choice* Which of the following best describes actin treadmilling?

- W) New actin polymers attach to the minus end of the actin filament
- X) The actin filament remains static with no addition or loss of subunits
- Y) One end of an actin filament has a net addition of actin polymers while the other end has a net loss of actin polymers
- Z) One end of the actin filament adds and loses polymers at an equal rate

ANSWER: Y) ONE END OF THE ACTIN FILAMENT HAS A NET ADDITION OF ACTIN POLYMERS WHILE THE OTHER END HAS A NET LOSS OF ACTIN POLYMERS

BONUS

18) BIOLOGY *Multiple Choice* When actin reaches its steady state in a cell, which of the following is occurring?

- W) The actin filament is no longer adding new subunits or losing existing subunits
- X) The actin filament is constantly adding new and losing existing subunits
- Y) The actin filament forms new disulfide bonds within itself
- Z) The actin filament forms new alpha helix structures to maintain its shape

ANSWER: X) THE ACTIN FILAMENT IS CONSTANTLY ADDING NEW AND LOSING EXISTING SUBUNITS

TOSS-UP

19) CHEMISTRY *Multiple Choice* A reaction is carried out in a constant pressure calorimeter. Appropriate measurements are taken and the energy for the change is calculated. The quantity of heat exchanged under these conditions leads to the calculation of which of the following state functions?

- W) Δq [**delta Q**]
- X) ΔE
- Y) ΔH
- Z) ΔT

ANSWER: Y) ΔH

BONUS

19) CHEMISTRY *Short Answer* Identify the number of pi bonds, respectively, in the following:
1) formaldehyde [**for-MAL-duh-hyd**], 2) sulfate ion, 3) acetylene [**uh-SET-eeen**].

ANSWER: 1) ONE, 2) TWO, 3) TWO

TOSS-UP

20) ENERGY *Multiple Choice* Which of the following materials is a common catalyst in commercial polymer electrolyte membrane fuel cells?

- W) Platinum
- X) Carbon
- Y) Copper
- Z) Silver

ANSWER: W) PLATINUM

BONUS

20) ENERGY *Short Answer* In September 2011, an experiment at CERN appeared to show neutrinos traveling at a speed faster than light. In March of 2012, these results were disproved. However, if the experiment had been accurate, it would have violated what physical principle?

ANSWER: LORENTZ INVARIANCE

TOSS-UP

21) CHEMISTRY *Multiple Choice* Assuming a temperature where the net magnetic moment is nonzero, which of the following types of magnetism will have the weakest external field?

- W) Antiferromagnetism
- X) Ferromagnetism
- Y) Paramagnetism
- Z) Diamagnetism

ANSWER: W) ANTIFERROMAGNETISM

BONUS

21) CHEMISTRY *Short Answer* Given the molar mass of silver as 107.87 grams per mole, how many moles of silver are contained in 1.806×10^{24} atoms?

ANSWER: 3

TOSS-UP

22) BIOLOGY *Multiple Choice* Which of the following is NOT an example of a human disease caused by a recessive allele that fails to produce a viable cellular protein?

- W) Turner's syndrome
- X) Tay-sachs [**tay-SAKS**]
- Y) Cystic fibrosis
- Z) Phenylketonuria [**fen-I-kee-toh-NOOR-ee-uh**]

ANSWER: W) TURNER'S SYNDROME

BONUS

22) BIOLOGY *Short Answer* What are two specific types of glycocalyx [**gly-koh-KAY-likes**] in bacteria?

ANSWER: CAPSULE, SLIME LAYER

TOSS-UP

23) MATH *Short Answer* If a family has four children, what is the probability of having exactly 3 girls?

ANSWER: $\frac{1}{4}$ (ACCEPT: 0.25 OR 25%)

BONUS

23) MATH *Short Answer* Let $a = 0.845454545\dots$ be an infinite repeating decimal with the digits 4 and 5 repeating. If a is written as a fraction in lowest terms, by how much does the denominator exceed the numerator?

ANSWER: 17

TOSS-UP

24) EARTH AND SPACE *Short Answer* What is the term for radiation emitted by an electron undergoing relativistic helical motion around a magnetic field?

ANSWER: SYNCHROTRON

BONUS

24) EARTH AND SPACE *Multiple Choice* Which of the following statements is NOT true regarding NOAA and NASA's prediction for the next solar cycle?

- W) The peak is expected in May 2013
- X) The peak will have a higher than average number of sunspots
- Y) The peak will lead to magnetic storms around Earth's poles
- Z) The peak will be associated with increases in solar radio emissions

ANSWER: X) THE PEAK WILL HAVE A HIGHER THAN AVERAGE NUMBER OF SUNSPOTS

TOSS-UP

25) PHYSICS *Multiple Choice* As an object falls to the Earth with air resistance present, what happens to the acceleration of the object?

- W) It remains a constant 9.8 meters per second squared
- X) It increases from 0 to 9.8 meters per second squared
- Y) It remains at a constant 0 meters per second squared
- Z) It decreases from 9.8 to 0 meters per second squared

ANSWER: Z) IT DECREASES FROM 9.8 TO 0 METERS PER SECOND SQUARED

BONUS

25) PHYSICS *Short Answer* Rounded to the nearest thousand, how many joules of work are done in pulling a wagon with a force of 2000 newtons over a horizontal surface of 10 meters, with a chain that makes a 45° angle with the surface?

ANSWER: 14,000