

ROUND 15

TOSS-UP

1) PHYSICS *Multiple Choice* Which of the following best describes mesons:

- W) a subgroup of leptons
- X) a subgroup of hadrons
- Y) hadronic leptons
- Z) particles with a spin of 1

ANSWER: X) A SUBGROUP OF HADRONS

BONUS

1) PHYSICS *Multiple Choice* Which of the following most directly describes the de Broglie wavelength:

- W) wavelength equals Planck's constant over the quantity mass times velocity
- X) wavelength equals mass times velocity over Planck's constant
- Y) energy equals Planck's constant times frequency
- Z) Planck's constant equals mass times the speed of light over the frequency

ANSWER: W) WAVELENGTH EQUALS PLANCK'S CONSTANT OVER THE QUANTITY MASS TIMES VELOCITY

TOSS-UP

2) BIOLOGY *Multiple Choice* Species similarity is partly based on DNA hybridization studies that determine:

- W) similarity in where restriction enzymes cleave
- X) determining exact nucleotide sequences
- Y) generating a restriction enzyme map
- Z) degree of base pairing between DNA strands

ANSWER: Z) DEGREE OF BASE PAIRING BETWEEN DNA STRANDS

BONUS

2) BIOLOGY *Short Answer* In the Calvin cycle, for each 6 CO₂ fixed how many PGAL are typically formed?

ANSWER: 12

TOSS-UP

3) CHEMISTRY *Multiple Choice* A fermentation reaction and a saponification reaction are similar in that they both can produce:

- W) a soap
- X) an ester
- Y) an alcohol
- Z) an acid

ANSWER: X) AN ESTER

BONUS

3) CHEMISTRY *Short Answer* What is the degree of unsaturation for a ring chain of the molecule C_9H_{16} , assuming it contains only sigma bonds?

ANSWER: 2

(Solution: $(2n + 2 - m)/2$; $= (2 \times 9 + 2 - 16) / 2$; $= 2$)

TOSS-UP

4) ASTRONOMY *Short Answer* If it were to be renamed today based on what constellation the sun is in on December 22nd, what would the new name be for the Tropic of Capricorn?

ANSWER: TROPIC OF SAGITTARIUS (ACCEPT: SAGITTARIUS)

BONUS

4) ASTRONOMY *Short Answer* How many arc-seconds wide, rounded to the nearest whole number, would Galileo have been able to resolve with his telescope, if one assumes that its 1.7 inch diameter lens was free of optical aberrations?

ANSWER: 3

(Solution: For radiation to which our eyes are most sensitive, then $= 0.25 (0.55 \mu m) / 0.04318 m$; $= 3.2$)

TOSS-UP

5) MATH *Multiple Choice* Simplify the following trigonometric equation for a right triangle ABC whose right angle is at B: $(\operatorname{cosecant}^2 A - 1) \times \frac{\cosine(90^\circ - A)}{\sine(90^\circ - A)}$

- W) sine A
- X) cosine A
- Y) tangent A
- Z) cotangent A

ANSWER: Z) COTANGENT A

(Solution: $\cot^2 A \times (\sin A / \cos A)$; $= \cot^2 A \tan A$; $= \cot A$)

BONUS

5) MATH *Short Answer* The monthly revenue, in dollars, for sales of widgets is given by the equation $R(q) = 8.5q - 0.02q^2$, where q is the number of widgets made per month. The cost for creating the widgets is given by the equation, $C(q) = 200 + 0.5q$ dollars. A maximum of 400 widgets can be made in 1 month. How many widgets should be made each month to maximize the profit, as given by the revenue minus the cost?

ANSWER: 200

TOSS-UP

6) EARTH SCIENCE *Multiple Choice* Which of the following organisms eventually sediments onto the ocean seafloor as a calcareous ooze:

- W) foraminifera
- X) radiolarians
- Y) diatoms
- Z) fish scales

ANSWER: W) FORAMINIFERA

BONUS

6) EARTH SCIENCE *Short Answer* In the geological time scale, the Devonian Period belongs to which Era?

ANSWER: PALEOZOIC

TOSS-UP

7) GENERAL SCIENCE *Multiple Choice* Cyanocobalamin (Pronounced SIGH-ano-CO-bal-amin) is more commonly known as:

- W) vitamin B₁₂
- X) vitamin D
- Y) vitamin A
- Z) vitamin K₃

ANSWER: W) VITAMIN B₁₂

BONUS

7) GENERAL SCIENCE *Short Answer* What disease was first discovered in the mid-19th century in the Far East and later correlated to a vitamin deficiency caused by the introduction of polished rice as a food staple?

ANSWER: BERI-BERI

TOSS-UP

8) COMPUTER SCIENCE *Multiple Choice* In C programming, the number used to refer to a particular element of an array is called its:

- W) numerator
- X) superscript
- Y) subscript
- Z) exponent

ANSWER: Y) SUBSCRIPT

BONUS

8) COMPUTER SCIENCE *Multiple Choice* The following are all reasons why the LISP programming language is NOT widely used except:

- W) its dependence on recursion
- X) most LISP systems are interpreted, and thus slower
- Y) LISP is only effective for explicitly defined problems
- Z) dynamic storage allocation is expensive

ANSWER: Y) LISP IS ONLY EFFECTIVE FOR EXPLICITLY DEFINED PROBLEMS

TOSS-UP

9) PHYSICS *Short Answer* What name did Marie and Pierre Curie give the radioactive substance they separated from uranium ore that had chemical properties close to bismuth?

ANSWER: POLONIUM

BONUS

9) PHYSICS *Short Answer* In collaboration with Bémout, the Curies found what other radioactive substance with chemical properties similar to barium?

ANSWER: RADIUM

TOSS-UP

10) BIOLOGY *Short Answer* ATP is to energy-rich phosphate as NADPH₂ is to energy-rich:

ANSWER: ELECTRONS

BONUS

10) BIOLOGY *Short Answer* Order the following 3 monosaccharides from the smallest to the largest: erythrose, glyceraldehyde, arabinose

ANSWER: GLYCERALDEHYDE, ERYTHROSE, ARABINOSE

TOSS-UP

11) CHEMISTRY *Multiple Choice* In general, a buffer solution used in titrations is characteristically which of the following:

- W) a strong acid and its conjugate base
- X) a strong base and its conjugate acid
- Y) a weak acid and its conjugate base
- Z) a solution that changes very rapidly in pH when acids or bases are added

ANSWER: Y) A WEAK ACID AND ITS CONJUGATE BASE

BONUS

11) CHEMISTRY *Multiple Choice* According to the Henderson-Hasselbalch equation, the pH equals the pK_a (read as: p, k, a) when the ratio of the conjugate base and weak acid equals:

- W) 0
- X) 1
- Y) 2
- Z) 7

ANSWER: X) 1

TOSS-UP

12) ASTRONOMY *Short Answer* Members of the “Key Project”, while working with the Hubble space telescope, are using observation primarily of what specific type of celestial object to calculate the Hubble constant?

ANSWER: CEPHEIDS (ACCEPT: CEPHEID VARIABLES)

BONUS

12) ASTRONOMY *Short Answer* Rounded to the first decimal place, how many synodic months are in an accurate calendar year if a tropical year is 365.2 days?

ANSWER: 12.4

(Solution: $365.2/29.5 = 12.4$)

TOSS-UP

13) MATH *Short Answer* In 1931, who disproved that axioms of arithmetic were consistent and could sufficiently prove or disprove any mathematical conjecture?

ANSWER: KURT GÖDEL (ACCEPT: GÖDEL)

BONUS

13) MATH *Short Answer* What is the derivative of the following expression with respect to the variable x: $4x^{\frac{3}{2}} - 5x^{\frac{1}{2}}$ (Read as: 4x to the 3/2 power minus 5x to the 1/2 power)

ANSWER: $6x^{\frac{1}{2}} - 2.5x^{-\frac{1}{2}}$ (ACCEPT: $6x^{0.5} - 2.5x^{-0.5}$)

TOSS-UP

14) EARTH SCIENCE *Short Answer* Land is to tornadoes as the ocean is to what?

ANSWER: WATERSPOUTS

BONUS

14) EARTH SCIENCE *Multiple Choice* Which of the following is TRUE regarding the development of a hurricane:

- W) they develop in waters of at least 80°F at 0° latitude
- X) they develop in waters of at least 80°F between 20° and 40° latitude
- Y) a hurricane originating in the eastern tropical Atlantic is driven westward by westerly trade winds in the tropics
- Z) they develop in waters of at least 80°F between 5° and 20° latitude

ANSWER: Z) THEY DEVELOP IN WATERS OF AT LEAST 80°F BETWEEN 5° AND 20° LATITUDE

TOSS-UP

15) GENERAL SCIENCE *Multiple Choice* In computer graphics, the electronic process of eliminating or reducing jaggies in an image is called:

- W) pixelation
- X) anti-aliasing
- Y) digitizing
- Z) radial filling

ANSWER: X) ANTI-ALIASING

BONUS

15) GENERAL SCIENCE *Multiple Choice* A termite is best classified in which trophic level:

- W) herbivore
- X) omnivore
- Y) primary detritivore
- Z) secondary detritivore

ANSWER: W) HERBIVORE

TOSS-UP

16) COMPUTER SCIENCE *Multiple Choice* In the Operating System environment, what is a shell:

- W) a specific type of operating system
- X) a user application program written in Java
- Y) the interface that interprets commands between the user and the operating system
- Z) the part of the operating system which allocates blocks of memory to a process

ANSWER: Y) THE INTERFACE THAT INTERPRETS COMMANDS BETWEEN THE USER AND THE OPERATING SYSTEM

BONUS

16) COMPUTER SCIENCE *Short Answer* As a format for representing integers in which each digit is represented by four bits, what does the acronym BCD stand for?

ANSWER: BINARY-CODED DECIMAL

TOSS-UP

17) PHYSICS *Short Answer* Considering air resistance is negligible and that gravitational acceleration is 9.8 meters per second squared, what is the velocity acquired by a body in free fall, starting from rest, after 5 seconds?

ANSWER: 49 METERS/SECOND

(Solution: $v = gt; = 9.8 \times 5 = 49$)

BONUS

17) PHYSICS *Multiple Choice* If a person passes a yard stick at $1/2$ light speed, what length would he measure the yard to be, rounded to the second decimal place:

- W) 1.13 yards
- X) 0.13 yards
- Y) 0.75 yards
- Z) 0.87 yards

ANSWER: Z) 0.87 YARDS

(Solution: $L^1 = L \sqrt{(1-(V/c)^2)} = 1 \text{ yard } \sqrt{(1-0.25)} = 1 \times \sqrt{.75} = 0.8660$)

TOSS-UP

18) BIOLOGY *Short Answer* What term, coined by Mendel, delineates the variant form of a gene?

ANSWER: ALLELE

BONUS

18) BIOLOGY *Multiple Choice* Which of the following pore-size filters would typically be the upper size limit to ensure removal of all bacteria:

- W) 5.0 microns
- X) 1.5 microns
- Y) 0.85 microns
- Z) 0.22 microns

ANSWER: Z) 0.22 MICRONS

TOSS-UP

19) CHEMISTRY *Multiple Choice* Which of the following is considered a chiral object:

- W) a coffee cup
- X) a tennis ball
- Y) a corkscrew
- Z) a banana

ANSWER: Y) A CORKSCREW

BONUS

19) CHEMISTRY *Short Answer* If a 5.0×10^5 liter swimming pool at 25°C contains 35 grams of chloride ions, what is the concentration of chloride ions in parts per million?

ANSWER: 0.07

(Solution: $35,000 \text{ mg Cl}^- / 500,000 \text{ L} = 0.07 \text{ ppm}$)

TOSS-UP

20) ASTRONOMY *Short Answer* The two points where the ecliptic intersects the celestial equator are known as what:

ANSWER: EQUINOXES

BONUS

20) ASTRONOMY *Short Answer* If a star were to be 9 times farther away than it originally was, how many times fainter would it appear to be if all other things remain constant?

ANSWER: 81 TIMES

(Solution: inverse square law... $9^2 = 81$)

TOSS-UP

21) EARTH SCIENCE *Short Answer* What term is given to a body of sediments deposited where a stream flows into a body of standing water and its velocity and transporting power are suddenly reduced?

ANSWER: DELTA (ACCEPT: DELTA PLAIN)

BONUS

21) EARTH SCIENCE *Short Answer* The land counterpart of a delta, what is the term for a fan-shaped assemblage of sediments built where a stream moves from a steep gradient to a flatter gradient and suddenly loses transporting power?

ANSWER: ALLUVIAL FAN

TOSS-UP

22) GENERAL SCIENCE *Multiple Choice* When referring to disease, endemic refers to:

- W) the habitual presence of disease within a geographic population
- X) the occurrence of a group of illnesses clearly in excess of normal expectancy
- Y) a worldwide epidemic
- Z) diseases which often exhibit a seasonal pattern

ANSWER: W) THE HABITUAL PRESENCE OF DISEASE WITHIN A GEOGRAPHIC POPULATION

BONUS

22) GENERAL SCIENCE *Short Answer* What are the five countries that currently produce the greatest amount of nuclear electric energy?

ANSWER: USA, FRANCE, JAPAN, GERMANY AND RUSSIA (accept in any order)

TOSS-UP

23) PHYSICS *Short Answer* What scientific term is most often used when specifically referring to the nucleus of a deuterium atom?

ANSWER: DEUTERON

BONUS

23) PHYSICS *Short Answer* Classify the following 3 particles as bosons, leptons, mesons, or baryons: muon; pion; neutron

ANSWER: MUON = LEPTON; PION = MESON; NEUTRON = BARYON

TOSS-UP

24) BIOLOGY *Short Answer* In primates, what is the final product of most purine degradation?

ANSWER: URIC ACID

BONUS

24) BIOLOGY *Short Answer* When bacteria are introduced into a nutrient rich medium they follow a standard bacterial growth curve. Place the following into the proper sequence from the earliest to the latest in this growth phase: stationary, log, decline, lag

ANSWER: LAG, LOG, STATIONARY, DECLINE

TOSS-UP

25) CHEMISTRY *Multiple Choice* According to Beer's law:

- W) the energy of a photon of light is inversely proportional to its wavelength
- X) the concentration of a species that absorbs light can be measured by the amount of light absorbed
- Y) the energy of characteristic X-rays increases with increasing atomic number of the emitting element
- Z) excitation of the electrons in a molecule takes place on a shorter time scale than motion of the nuclei

ANSWER: X) THE CONCENTRATION OF A SPECIES THAT ABSORBS LIGHT CAN BE MEASURED BY THE AMOUNT OF LIGHT ABSORBED

BONUS

25) CHEMISTRY *Short Answer* What is the efficiency, in percent, of a Carnot cycle operating between 1140°F and 140°F?

ANSWER: 62.5%