ROUND 15

TOSS-UP

1) ENERGY *Short Answer* When a 10 kilogram object is lifted 10 meters, in a gravitational field of 9.8 meters per second squared, what is the change in potential energy of the object in joules?

ANSWER: 980

BONUS

1) ENERGY *Short Answer* Taking g as 10 meters per second squared and assuming there is no friction, at about what height in meters must a 100 kilogram roller coaster start from rest in order to achieve a speed of 100 meters per second at the bottom?

ANSWER: 500

TOSS-UP

2) CHEMISTRY *Multiple Choice* Which of the following is the name of the compound $HClO_4$?

W) Hydrogen perchlorite
X) Chloric acid
Y) Perchloric acid
Z) Hypochloric acid

ANSWER: Y) PERCHLORIC ACID

BONUS

2) CHEMISTRY *Multiple Choice* Which of the following is NOT a state function?

W) Volume
X) Energy
Y) Pressure
Z) Heat

ANSWER: Z) HEAT

TOSS-UP

3) MATH *Short Answer* Express $\sum_{x=1}^{n} \log x$ (read as: the summation of *x* equals 1 to n of log of *x*) with a factorial.

ANSWER: log *n*!

BONUS

3) MATH *Short Answer* How many different letter arrangements can be formed using the six letters in the word “energy”?

ANSWER: 360

TOSS-UP

4) PHYSICS *Short Answer* If Tajon applies 100 newtons of force on a 2-meter wrench at a right angle to the wrench and parallel to the plane of rotation, how much torque, in newton meters, is he applying to the bolt?

ANSWER: 200

BONUS

4) PHYSICS *Multiple Choice* What makes arches and domes more stable than flat roofed structures?

W) They transmit compressive forces along their length to the ground, uniformly bearing the load of gravity
X) Each section is under great tension, using the stronger dimension of the components
Y) Torsional resistance to sideways swaying ensures that such structures are stable, even in high winds
Z) The surface tension of the arched shape allows the building components to be hollowed out, saving weight.

ANSWER: W) THEY TRANSMIT COMPRESSIVE FORCES ALONG THEIR LENGTH TO THE GROUND, UNIFORMLY BEARING THE LOAD OF GRAVITY

TOSS-UP

5) EARTH AND SPACE *Multiple Choice* Which of the following is a common mineral that is composed entirely of silicon and oxygen?

W) Pyrite
X) Quartz
Y) Bauxite (read as: BOHK-syt)
Z) Feldspar

ANSWER: X) QUARTZ

BONUS

5) EARTH AND SPACE *Multiple Choice* Which of the following minerals is a mafic silicate?

W) Fluorite
X) Diamond
Y) Muscovite
Z) Pyroxene (read as: py-ROHK-seen)

ANSWER: Z) PYROXENE

TOSS-UP

6) MATH *Multiple Choice* Which of the following functions is one-to-one?

W) $f(x) = |x| + 3$ (read as: f of x equals the absolute value of x plus 3)
X) $f(x) = x^2 - 6x + 11$ (read as: f of x equals x squared minus 6 x plus 11)
Y) $f(x) = 5x^3 + 9$ (read as: f of x equals 5 x cubed plus 9)
Z) $f(x) = \frac{1}{x^2}$ (read as: f of x equals 1 over x squared)

ANSWER: Y) $f(x) = 5x^3 + 9$

BONUS

6) MATH *Short Answer* A triangle has sides of length 5, 7, and 8 meters. In simplest form and in meters squared, what is the area of the triangle?

ANSWER: $10\sqrt{3}$

TOSS-UP

7) ENERGY *Multiple Choice* Why is riding a bicycle on a well-maintained road more energy efficient than walking or running?

W) Bipedal motion is highly inefficient
X) The coefficient of sliding friction between tires and the ground is less than that between shoes and the ground
Y) Gravity does very little work on a bicyclist relative to a walker or runner
Z) Bicycling requires more calories than walking

ANSWER: Y) GRAVITY DOES VERY LITTLE WORK ON A BICYCLIST RELATIVE TO A WALKER OR RUNNER

BONUS

7) ENERGY *Short Answer* When a ball of mass *m* is launched vertically to a height *h* and returns to its original starting point of launch, what is the value of its change in gravitational potential energy?

ANSWER: 0

TOSS-UP

8) PHYSICS *Multiple Choice* Which of the following has NOT been proposed as a way to test string theory?

W) Cosmic ray experiments
X) High energy particle collisions
Y) Electron mapping
Z) Precision tests of short-range gravitational forces

ANSWER: Y) ELECTRON MAPPING

BONUS

8) PHYSICS *Multiple Choice* A jet engine gets its thrust by taking in air, heating and compressing it and then ejecting it at a high speed. If a particular engine takes in 20 kilograms of air per second at 100 meters per second, and ejects it at 500 meters per second, what is the thrust of the engine in newtons?

W) 760
X) 8000
Y) 9100
Z) 10,500

ANSWER: X) 8000

TOSS-UP

9) ENERGY *Short Answer* On a football team, there is a defensive lineman who weighs 350 pounds and can run at 10 miles per hour. On the same team, the wide receiver weighs 175 pounds and can run 20 miles per hour. At top speed, which player has more kinetic energy?

ANSWER: WIDE RECEIVER

BONUS

9) ENERGY *Short Answer* A race car initially moving with a velocity of 50 meters per second produces a skid mark on the road while braking. Using g as 10 meters per second squared, and providing your answer to the nearest integer, how long is the skid mark in meters if the coefficient of kinetic friction is 1.0?

ANSWER: 125

TOSS-UP

10) EARTH AND SPACE *Short Answer* Transpolar drift is responsible for the net transport of water and ice in what direction in the Arctic Basin?

ANSWER: WEST TO EAST

BONUS

10) EARTH AND SPACE *Short Answer* Most sea ice exiting the Arctic Basin passes through what large strait between Greenland and Svalbard (read as: SVAHL-bahr)?

ANSWER: THE FRAM STRAIT

TOSS-UP

11) PHYSICS *Multiple Choice* A car of mass 700 kilograms travels at 20 meters per second and collides with a stationary truck of mass 1400 kilograms. The two vehicles interlock as a result of the collision and slide along an icy road. Which of the following is the approximate velocity in meters per second of the combined system?

W) 5.6
X) 6.6
Y) 7.6
Z) 8.6

ANSWER: X) 6.6

BONUS

11) PHYSICS *Multiple Choice* Given that the specific heat of iron is 0.12 calories per gram degree Celsius, what will be the final temperature in degrees Celsius of 100 grams of 20 degree Celsius water when 100 grams of 40 degree Celsius iron nails are submerged in it? Provide your answer to the nearest whole number.

ANSWER: 22

TOSS-UP

12) MATH *Short Answer* Find the derivative of $12x^3 - 6x^2 + \frac{3}{x^5} - 25$ (read as: 12 *x* cubed minus 6 *x* squared plus 3 over *x* to the fifth minus 25)

ANSWER: $36x^2 - 12x - \frac{15}{x^6}$

BONUS

12) MATH *Short Answer* A particle's displacement in meters can be described by the function $f(x) = 2x^3 + 3x^2 - 10x + 30$. At $x = 5$ seconds, what is the acceleration in meters per second squared? Provide your answer to the nearest integer.

ANSWER: 66

TOSS-UP

13) EARTH AND SPACE *Short Answer* Besides Earth, what is the only other planet in our solar system known to have water ice on its surface?

ANSWER: MARS

BONUS

13) EARTH AND SPACE *Multiple Choice* Which of the following are carbon compounds in natural water that have diameters of less than 0.45 micrometers?

W) Particulate organic matter
X) Nondissolved solids
Y) Particulate colloids
Z) Dissolved organic carbon

ANSWER: Z) DISSOLVED ORGANIC CARBON

TOSS-UP

14) MATH *Short Answer* What is $\tan \frac{5\pi}{4} + \sin \frac{\pi}{6}$?

ANSWER: $\frac{3}{2}$

BONUS

14) MATH *Short Answer* What is the contrapositive of the statement *p* implies *q*?

ANSWER: NOT *q* IMPLIES NOT *p* (ACCEPT: IF NOT *q*, THEN NOT *p*)

TOSS-UP

15) CHEMISTRY *Short Answer* What is the pH of 1.0 mole of sodium hydroxide dissolved in 10 liters of water?

ANSWER: 13

BONUS

15) CHEMISTRY *Short Answer* Two Lewis structures depict the ozone molecule equally well and there is no way to distinguish between the two structures. What is the term that describes this phenomenon?

ANSWER: RESONANCE

TOSS-UP

16) BIOLOGY *Multiple Choice* Which of the following best describes the way in which the summation of action potentials from a motor neuron can bring a muscle fiber to the maximal level of contraction?

W) Summation of contractions
X) Suprastimulus
Y) Maximal twitch rate
Z) Tetany (read as: TEHT-nee)

ANSWER: Z) TETANY

BONUS

16) BIOLOGY *Short Answer* Order the following from smallest to largest: myofibril; muscle, actin; myosin; sarcomere (read as: SAHR-koh-mir); muscle fiber.

ANSWER: ACTIN; MYOSIN; SARCOMERE; MYOFIBRIL; MUSCLE FIBER; MUSCLE

TOSS-UP

17) CHEMISTRY *Multiple Choice* The ability of geckos to climb smooth surfaces is due to which of the following?

W) Hydrogen bonding
X) Van der Waals forces
Y) Ion-dipole forces
Z) Intramolecular forces

ANSWER: X) VAN DER WAALS FORCES

BONUS

17) CHEMISTRY *Multiple Choice* Nanotechnologists are creating butterfly scale patterns on paper money to foil counterfeiters using which of the following substances?

W) Calcium oxide
X) Zinc oxide
Y) Magnesium oxide
Z) Aluminum oxide

ANSWER: Z) ALUMINUM OXIDE

TOSS-UP

18) BIOLOGY *Short Answer* Tay Sachs is a fatal genetic disease. Individuals with Tay Sachs are homozygous for the recessive disease allele. If a husband and wife are both heterozygous for the gene, what is the percent chance that they will have a child with the disease?

ANSWER: 25%

BONUS

18) BIOLOGY *Multiple Choice* A diploid cell has 32 chromatids in the G2 phase of the cell cycle. If you examine the cell in Prophase II you would find 2 cells each containing which of the following?

W) 16 molecules of DNA
X) 16 chromosomes made of DNA
Y) 32 molecules of DNA
Z) 32 chromosomes made of DNA

ANSWER: W) 16 MOLECULES OF DNA

TOSS-UP

19) CHEMISTRY *Multiple Choice* Which of the following bonds should have the longest length?

W) C-C (read as: C single bond C)
X) C=C (read as: C double bond C)
Y) C-H (read as: C single bond H)
Z) C≡C (read as: C triple bond C)

ANSWER: W) C-C

BONUS

19) CHEMISTRY *Multiple Choice* Which of the following contains polar covalent bonds?

W) F_2
X) HF
Y) NaH
Z) O_2

ANSWER: X) HF

TOSS-UP

20) BIOLOGY *Multiple Choice* Darwin's theory of evolution stated all of the following except:

W) Those organisms best fit for their environment survive and reproduce most successfully
X) Acquired characteristics can be inherited
Y) Species change over time through the process of natural selection
Z) More organisms are produced than can survive, so living things compete for resources

ANSWER: X) ACQUIRED CHARACTERISTICS CAN BE INHERITED

BONUS

20) BIOLOGY *Short Answer* Name all of the following in which the embryonic blastopore becomes the anus, and the mouth originates after the anus: 1) leopard frog, 2) cockroach, 3) bull shark, 4) earthworm, and/or 5) human.

ANSWER: 1) LEOPARD FROG, 3) BULL SHARK AND 5) HUMAN

TOSS-UP

21) PHYSICS *Multiple Choice* What is one way in which power can be calculated?

W) Subtracting the relative vectors ***F*** and ***v***
X) The time derivative of work performed
Y) The strength of the force times *g*
Z) The second derivative of acceleration

ANSWER: X) THE TIME DERIVATIVE OF WORK PERFORMED

BONUS

21) PHYSICS *Multiple Choice* In a wild shot, Guido flings a pool ball of mass *m* off a 0.68 meter high pool table with downward spin, and the ball hits the floor with a vertical speed of 6.0 meters per second. How fast was the ball moving vertically in meters per second when it left the pool table?

W) 6.7
X) 5.7
Y) 4.7
Z) 3.7

ANSWER: Y) 4.7

TOSS-UP

22) EARTH AND SPACE *Short Answer* If the moon is in a crescent phase and appears in the eastern sky at sunrise, what phase will be next?

ANSWER: NEW MOON

BONUS

22) EARTH AND SPACE *Multiple Choice* Which of the following are the chemical reactants associated with the formation of Karst topography?

W) HCl and PbS
X) H_2SO_4 and SiO_2
Y) H_2O and $MgSiO_3$
Z) H_2CO_3 and $CaCO_3$

ANSWER: Z) H_2CO_3 and $CaCO_3$

TOSS-UP

23) MATH *Short Answer* If someone has 1 red shirt, 2 blue shirts, 4 red pants, and 3 green pants from which to choose, what is the probability that a randomly selected shirt and pant combination has at least one red item? Provide your answer as a fraction in simplest form.

ANSWER: 5/7

BONUS

23) MATH *Short Answer* If the mean of a certain sample is 8 and the standard deviation is 0.25, what value has a z-score of 12?

ANSWER: 11

TOSS-UP

24) BIOLOGY *Multiple Choice* An apple flower is hermaphroditic, it has both a pistil and a stamen, which means it is a type of:

W) Monoecious plant
X) Dioecious plant (read as: dy-EE-shehs)
Y) Diatomaceous plant (read as: dy-ah-toh-MAY-shehs)
Z) Monostomate plant

ANSWER: W) MONOECIOUS PLANT

BONUS

24) BIOLOGY *Short Answer* Many monoecious plant species avoid self pollination, reducing their likelihood of expressing deleterious recessive alleles in future generations. One strategy used by monoecious plants is to produce pollen long after the carpel of the same flower becomes able to receive it. Give the name for this strategy.

ANSWER: PROTOGYNOUS FLOWERING (ACCEPT: PROTOGYNY)

TOSS-UP

25) EARTH AND SPACE *Multiple Choice* During which of the following two days is the maximum solar altitude less than 90° at the equator?

W) Winter solstice and vernal equinox
X) Vernal and autumnal equinoxes
Y) Winter and summer solstices
Z) Summer solstice and autumnal equinox

ANSWER: Y) WINTER AND SUMMER SOLSTICES

BONUS

25) EARTH AND SPACE *Short Answer* Put the formation of the following in chronological order from oldest to youngest: Rocky Mountains, Great Lakes, Colorado River, Appalachian Mountains.

ANSWER: APPALACHIAN MOUNTAINS, ROCKY MOUNTAINS, COLORADO RIVER, GREAT LAKES