Tossup

1) *Math – Multiple Choice:* Which of the following is not a possible value that the inverse of the function f(x) = tan(x) could attain?

    W) -pi/4
    X) 0
    Y) pi / 4
    Z) pi/2

ANSWER: Z) pi/2

Bonus

1) *Math – Short Answer:* Consider four real numbers x, y, a, and b such that x is less than a and y is less than b. Identify all of the following 4 inequalities that must be true:

    I) x+y is less than a+b
    II) x-y is less than a+b
    III) x times y is less than a times b
    IV) x to the power of y is less than a to the power of b

ANSWER: I only

Tossup

2) *Physics – Multiple Choice:* The area contained inside the P-V graph of a thermodynamic cycle is equal to which of the following?

    W) The change in pressure over one cycle
    X) The change in volume over one cycle
    Y) The amount of work done in one cycle
    Z) The change in internal energy in one cycle

ANSWER: Y) The amount of work done in one cycle

Bonus

2) *Physics – Short Answer:* Identify all of the following types of processes that can be represented as a straight line on a P-V graph:

    I) Isothermal
    II) Isochoric
    III) Adiabatic
    IV) Isobaric

ANSWER: II and IV

Tossup

3) *Chemistry – Multiple Choice:* Equal volumes of the following chemicals are mixed. Which of the following mixtures is most likely to separate into layers?

W) Methanol and ethanol
X) Benzene and toluene
Y) Hexane and pentane
Z) Carbon Tetrachloride and methanol

ANSWER: Z) Carbon Tetrachloride and methanol

Bonus

3) *Chemistry – Short Answer:* Gilalite is a dark blue silicate mineral with dehydrated chemical formula $Cu_5Si_6O_{17}$. What is the average oxidation state of copper in Gilalite?

ANSWER: 2

Tossup

4) *Biology – Short Answer:* How many histone proteins are found in a nucleosome?

ANSWER: 8

Bonus

4) *Biology – Short Answer:* Sanger sequencing uses what modified form of a nucleotide that terminates a growing DNA chain?

ANSWER: Dideoxynucleotide (ACCEPT: ddNTP)

Tossup

5) *Earth and Space – Multiple Choice:* Which of the following is a characteristic of lava spewed by shield volcanoes?

    W) Low Silica
    X) Low Temperature
    Y) High Volatile Content
    Z) High Viscosity

ANSWER: W) Low Silica

Bonus

5) *Earth and Space – Multiple Choice:* Which of the following gases is most directly responsible for the negative environmental lapse rate in the stratosphere?

    W) Carbon Dioxide
    X) Water Vapor
    Y) Ozone
    Z) Methane

ANSWER: Y) Ozone

Tossup

6) *Energy – Short Answer:* Department of Energy researchers are studying beta decay in atomic nuclei. What particle was theorized to allow beta decay to conserve energy, momentum, and spin?

ANSWER: Neutrino

Bonus

6) *Energy – Short Answer:* Scientists at Argonne National Laboratory are studying the mechanisms of DNA replication in an alien species. Assuming the scientists followed the same experimental setup as the Messelson-Stahl experiment, if half the DNA double helices are heavy and half are light after one round of replication, what mode of replication does this species exhibit?

ANSWER: Conservative

Tossup

7) *Math – Short Answer:* What is the name of the diagram that shows all possible logical relations between a finite collection of sets?

ANSWER: Venn Diagram

Bonus

7) *Math – Short Answer:* On the Enloe Science Bowl Tryouts 10% of the students got 10 points, 60% of the students got 9 points and 30% of the students got 7 points. What is the difference between the mean and median scores on the tryouts?

    W) 0
    X) 0.5
    Y) 1
    Z) 1.5

ANSWER: X) 0.5

Tossup

8) *Physics – Short Answer:* An ideal fluid is flowing along a pipe. It starts in a tube of cross sectional area 140 cm^2 moving at a velocity of 60 m/s. The pipe enlarges to 350 cm^2. What is the new velocity of the fluid in meters per second?

ANSWER: 24

Bonus

8) *Physics – Short Answer:* Brian drops a ball off of a tall building on a mystery planet. Giving your answer in exact form, if the ball takes 2 seconds to fall 20 meters after it is dropped, how long in seconds will it take to fall 100 meters?

ANSWER: $2\sqrt{5}$

Tossup

9) *Biology – Short Answer:* What cytoskeletal element makes up the nuclear lamina in cells?

ANSWER: Intermediate filaments

Bonus

9) *Biology – Short Answer:* Order the following 4 taxonomic classifications from least to most specific:

    1) Chordata
    2) Suidae
    3) Artiodactyla
    4) Sus

ANSWER: 1, 3, 2, 4

Tossup

10) *Earth and Space – Short Answer:* The stars Deneb, Altair, and Vega form what astronomical asterism that appears in the Northern sky during summer?

ANSWER: Summer Triangle

Bonus

10) *Earth and Space – Multiple Choice:* Order the following 4 stages in the Sun's star cycle from earliest to latest:

    1) Main Sequence
    2) Hayashi Track
    3) Red Giant
    4) White Dwarf

ANSWER: 2, 1, 3, 4

Tossup

11) *Physics – Short Answer:* A car is traveling around a circular track. It takes 10 seconds for the car to travel from its starting position around the track to 5 meters behind its starting position. What is the average velocity of the car during this time?

ANSWER: 0.5 m/s (ACCEPT: -0.5 m/s)

Bonus

11) *Physics – Multiple Choice:* Colin throws a hammer into the air, imparting it with some angular momentum as it leaves his hand. Neglecting air resistance, which of the following is true of the angular speed of the hammer as it travels through the air?

   W) It decreases to a finite value
   X) It decreases to zero
   Y) It increases without bound
   Z) It remains the same

ANSWER: Z) It remains the same

Tossup

12) *Math – Short Answer:* How many numbers are there in the list of perfect squares from 49 to 961, inclusive?

ANSWER: 25

Bonus

12) *Math – Short Answer:* How many different factors does the number 1296 have?

ANSWER: 25

Tossup

13) Chemistry – *Short Answer:* What law relates the mass of gas particles with their rate of diffusion?

ANSWER: Graham's Law

Bonus

13) *Chemistry – Short Answer:* What is the name of the remaining substance in solution after a crystallization or centrifugation?

ANSWER: Supernatant

Tossup

14) *Biology – Multiple Choice:* Which of the following molecules is the Casparian Strip primarily made of?

    W) Cellulose
    X) Suberin
    Y) Lignin
    Z) Chitin

ANSWER: X) Suberin

Bonus

14) *Biology – Short Answer:* Identify all of the following 4 stages of the cell cycle where you would expect high concentrations of active maturation promoting factor (MPF)

    I) S
    II) Prophase
    III) Metaphase
    IV) Anaphase

ANSWER: II and III

Tossup

15) *Earth and Space – Short Answer:* Identify all of the following 3 stratigraphic formations which result from compressional forces:

    I) Monocline
    II) Angular Unconformity
    III) Nonconformity

ANSWER: I and II

Bonus

15) *Earth and Space – Multiple Choice:* Which of the following rocks is most mafic?

    W) Scoria
    X) Tuff
    Y) Granite
    Z) Andesite

ANSWER: W) Scoria

Tossup

16) *Energy – Multiple Choice:* Researchers at CERN are studying dark matter. Approximately what percentage of the universe consists of dark matter?

    W) 3%
    X) 19%
    Y) 27%
    Z) 44%

ANSWER: Y

Bonus

16) *Energy – Short Answer:* Researchers at Sandia National Laboratory are studying ways to make electrical circuits more efficient. Power dissipation can be easily calculated for devices that are Ohmic. Identify all of the following 4 circuit elements that are Ohmic:

    I) Resistor
    II) Capacitor
    III) Diode
    IV) Inductor

ANSWER: I only

Tossup

17) *Physics – Short Answer:* Nikhil the chemistry main has decided to learn physics. He is confused why gravity and the spring force have potential energy, but the friction force doesn't. What property of a force causes it to have a potential energy associated with it?

ANSWER: Conservative (ACCEPT: Path independent)

Bonus

17) *Physics – Multiple Choice:* In which of the following cases would the application of Faraday's law be most appropriate?

    W) An electron moving through a magnetic field
    X) A magnet dropped through a metal coil
    Y) A charge moving parallel to a wire
    Z) A magnet spinning around its central axis in free space

ANSWER: X) A magnet dropped through a metal coil

Tossup

18) *Chemistry – Short Answer:* Concentrated solutions of Mn^{2+} appear as what color?

ANSWER: Pink (accept light pink/purple)

Bonus

18) *Chemistry – Multiple Choice:* Nikhil wants to perform the titration of a weak acid with sodium hydroxide. After preparing the solid sodium hydroxide, he decides to take a break and play the hit game "Genshin Impact," after which he returns and completes the titration. Knowing that sodium hydroxide is hygroscopic, how will his calculation for the concentration of the weak acid deviate from its true value?

    W) His calculated value will be higher than the true value
    X) His calculated value will be lower than the true value
    Y) His calculated value will be the same as the true value
    Z) There is not enough information to determine the error

ANSWER: W) His calculated value will be higher than the true value

Tossup

19) *Math – Short Answer:* Rohit biked from home to school at an average speed of x miles per hour. However, his bike was stolen by Colin, so Rohit walked home at a speed of 3 miles per hour. If his overall average speed was 5 mph, then what is the value of x?

ANSWER: 15 mph

Bonus

19) *Math – Short Answer:* What is the distance between a circumcenter and incenter of an equilateral triangle of side length 6?

ANSWER: 0

Tossup

20) *Earth and Space – Short Answer:* What is the limit on the mass of a neutron star at which the star would collapse under its own mass?

ANSWER: Tollman-Oppenheimer-Volkoff limit, TOV limit

Bonus

20) *Earth and Space– Short Answer:* Sukrith and Brian are chilling on the surface of Ceres and decide they want to start counting their age in Ceres years. Ceres orbits 2.8 AU from the sun. If they are celebrating their first Ceres birthday today, to one significant figure, in how many Earth years will they be able to celebrate their second Ceres birthday?

ANSWER: 5

Tossup

21) *Chemistry – Short Answer:* Order the following 4 compounds in increasing order by number of carbons:

1) Cyclopentane
2) Acetic acid
3) Propanol
4) Formaldehyde

ANSWER: 4, 2, 3, 1

Bonus

21) *Chemistry – Short Answer:* Order the following 4 elements from highest to lowest placement on the periodic table:

1) Potassium
2) Silicon
3) Barium
4) Indium

ANSWER: 2, 1, 4, 3

Tossup

22) *Energy – Short Answer:* Researchers at Lawrence Livermore National Laboratory were experimenting with the ability of mice blood to clot upon injection of buckminsterfullerene. Which of the following materials are these structures made out of?

W) Fluorine
X) Oxygen
Y) Carbon
Z) Nitrogen

ANSWER: Y) Carbon

Bonus

22) *Energy – Short Answer:* Researchers at Sandia National Laboratory are studying the effects of greenhouse gases on the environment and human body. Identify all of the following 4 compounds that are considered to be greenhouse gases:

I) Carbon Dioxide
II) Nitrous Oxide
III) Hydrogen Chloride
IV) Sulfur Hexafluoride

ANSWER: I, II, IV

Tossup

23) *Biology – Short Answer:* Order the following 4 components of blood in order of increasing presence by percentage:

1) Plasma
2) Basophil **[base-o-fill]**
3) Platelets
4) Erythrocytes **[er-eeth-ro-sites]**

ANSWER: 2, 3, 4, 1

Bonus

#) *Biology – Short Answer:* What plant hormone is responsible for direct immune responses against biotrophic pathogens in plants, and is activated by the removal of a methyl group?

ANSWER: Salicylic acid (ACCEPT: Methylsalicylic acid)