TOSS-UP

1) PHYSICS *Short Answer* A 36 V battery is connected in an R-L circuit to 1.5 ohm resistor and a solenoid with an inductance of 12 H. After the switch has been in the "on" position for a very long time, what is the total current running through the circuit?

ANSWER: 24 A

BONUS

1) PHYSICS *Short Answer* Winnie is gazing out his window when he suddenly sees a 5 kg jar of honey fly up and then fall back down the 3 m length in a total of 2 seconds. Assuming no air resistance, what is the maximum height the jar will go above the window?

ANSWER: 0.2 m

TOSS-UP

2) BIOLOGY *Short Answer* Genes that code for human MHC complexes are found on which chromosome?

ANSWER: Chromosome 6

BONUS

2) BIOLOGY *Multiple Choice* Which of the following organelles is located next to the neurite that will differentiate into an axon during neuron development?

W) Mitochondria
X) Nucleus
Y) Golgi Body
Z) ER

ANSWER: Y) Golgi Body

TOSS-UP

3) EARTH AND SPACE *Multiple Choice* Which of the following rocks takes up the most volume of Earth's Crust?

W) Diorite
X) Sandstone
Y) Granite
Z) Basalt

ANSWER: Z) Basalt

BONUS

3) EARTH AND SPACE *Multiple Choice* Which of the following phyllosilicates is commonly known as magnesium mica?

W) Annite
X) Phlogopite (FLO-GO-PITE?)
Y) Siderophyllite (SID-UR-OH-FIE-LIGHT)??
Z) Muscovite

ANSWER: X) Phlogopite

TOSS-UP

4) CHEMISTRY *Multiple Choice* Which of the following can make up the mobile phase in gas chromatography?

W) Chlorine

X) Nitrogen

Y) Hydrogen

Z) Oxygen

ANSWER: X) Nitrogen

BONUS

4) CHEMISTRY *Short Answer* Lugol's solution is a mixture of what two elements?

ANSWER: Potassium and Iodine

TOSS-UP

5) ENERGY *Short Answer* What is the term for the energy required to melt a substance?

ANSWER: heat of fusion

BONUS

5) ENERGY *Short Answer* How much energy, in kJ to two significant figures, is required to turn 50 grams of water at 0º C into steam at 100º C? The heat of vaporization for water is 40.65 kJ/mol.

ANSWER: 130 kJ

TOSS-UP

6) MATH *Short Answer* What is the shortest distance between the point (4, 6) and the line 15y= 8x?

ANSWER: 58/17

BONUS

6) MATH *Short Answer* Find the slope of the line tangent to the graph with equation $\square\square^2 + 6\square^2 = 21$at the point (1,3).

ANSWER: -6/37 (dy/dx = $-2xy/(x^2+12y)$)

TOSS-UP

7) BIOLOGY *Multiple Choice* Which of the following chordates display chevron segmentation?

W) Tunicate
X) Lancelet
Y) Myxini
Z) Lamprey

ANSWER: X) Lancelet

BONUS

7) BIOLOGY *Short Answer* Name three bacteria-associated PAMPs:

ANSWER: N-formylmethionine, peptidoglycan, lipopolysaccharide, uncapped RNA, no poly-A tail

TOSS-UP

8) EARTH AND SPACE *Multiple Choice* Which of the following ocean currents brings warm water down through the Mozambique Channel near Madagascar?

W) Benguela
X) Agulhas
Y) Mozambique
Z) South Indian

ANSWER: X) Agulhas

BONUS

8) EARTH AND SPACE *Short Answer* List the following galaxies in order of increasing size within the Local Group:

I) Milky Way
II) Andromeda
III) Triangulum
IV) Large Magellanic Cloud

ANSWER: IV, III, I, II

TOSS-UP

9) CHEMISTRY *Short Answer* What is the oldest documented form of resistance heating alloy, consisting of 80% nickel and 20% chromium by mass?

ANSWER: Nichrome (Nickel-chrome)

BONUS

9) CHEMISTRY *Multiple Choice* In fractional distillation, what kind of gas condenser is known as the bulb condenser, consisting of a long glass tube marked by a series of bulbs on said tube?

W) Allihn condenser

X) Davies condenser

Y) Liegib condenser

Z) West Condenser

ANSWER: W) Allihn condenser

TOSS-UP

10) MATH *Multiple Choice* Which of the following conditions would best describe a possible graph of f(x) in [a,b] (the open interval from a to b) if it is concave down in that range?

W) $f''(x) > 0$, $f'(x)$ is increasing
X) $f''(x) < 0$, $f'(x)$ is increasing
Y) $f''(x) > 0$, $f'(x)$ is decreasing
Z) $f''(x) < 0$, $f'(x)$ is decreasing

ANSWER: Z) $f''(x) < 0$, $f'(x)$ is decreasing

BONUS

10) MATH *Short Answer* 5 points are positioned on a circle. Find the number of regions the circle is cut into if lines are drawn connecting every distinct pair of points and no three lines intersect at the same point.

ANSWER: 16

TOSS-UP

11) ENERGY *Short Answer* A system does 54 J of work on its surroundings and then absorbs 17 J as heat. What is its change in internal energy?

ANSWER: -37 J

BONUS

11) ENERGY *Short Answer* What is the internal energy of two moles of an ideal gas at 200 K at constant pressure?

ANSWER: 8314 J

TOSS-UP

12) PHYSICS *Short Answer* If an electric current flows through a conductor in a magnetic field, what phenomenon is responsible for the creation of a potential difference perpendicular to both the current and magnetic field?

ANSWER: Hall Effect

BONUS

12) PHYSICS *Short Answer* If an object is in freefall and its area is doubled, by how much does the drag force on the object increase by?

ANSWER: 2

TOSS-UP

13) BIOLOGY *Short Answer* Which two organs in the human body contain glucose-6-phosphatase?

ANSWER: Liver and kidney

BONUS

13) BIOLOGY *Multiple Choice* Which of the following does not occur in humans with Type II diabetes:

W) Amylin induced beta cell apoptosis
X) Postprandial hyperglycemia
Y) Overactivation of GLUT 4
Z) Impaired insulin secretion

ANSWER: Y) Overactivation of GLUT 4

TOSS-UP

14) PHYSICS *Short Answer* In terms of any electromagnetic constants, what is the energy stored in the magnetic field of a solenoid with an average 5 turns per unit length, carrying a current of 4 A?

ANSWER: $200\mu_0$J

BONUS

14) PHYSICS *Short Answer* What law states that the intensity of a beam of plane polarized light is directly proportional to the square of the cosine of the angle through which the polarizer is rotated?

ANSWER: Law of Malus (ACCEPT: Malus's Law)

TOSS-UP

15) EARTH AND SPACE *Multiple Choice* What is the anion in pyrite?

W) S^{2-}
X) S^{-}
Y) S_2^{2-}
Z) S_2^{3-}

ANSWER: Y

BONUS

15) EARTH AND SPACE *Short Answer* Which of the following elements are present in feldspar?

I. Al
II. C
III. Fe

ANSWER: I only

TOSS-UP

16) CHEMISTRY *Multiple Choice* Which of the following are in the anode compartment under standard conditions?

W) oxidizing agent, oxidized species
X) oxidizing agent, reduced species
Y) reducing agent, oxidized species
Z) reducing agent, reduced species

ANSWER: Y

BONUS

16) CHEMISTRY *Short Answer* A redox reaction can be separated into the sum of three different reactions: two oxidations and a reduction. If the standard reduction potentials are +0.50 V and -0.30 V and +0.90 V, what is the e^o for the entire reaction?

ANSWER: +1.60 V

TOSS-UP

17) ENERGY *Short Answer* What is the change in Gibbs free energy for the vaporization of water at 100ºC?

ANSWER: 0

BONUS

17) ENERGY *Short Answer* State whether the following processes increases or decreases the free energy of the system

I. hydrogen reacting with oxygen
II. battery charging
III. burning natural gas
IV. boiling water at room temperature

ANSWER: I. decrease II. increase III. decrease IV. increase

TOSS-UP

18) MATH *Short Answer* What is the 63rd triangular number?

.ANSWER: 2016

BONUS

18) MATH *Short Answer* Find the remainder when P(x)= x^4+3x^2-17x+23 is divided by x+2.

ANSWER: 85

TOSS-UP

19) BIOLOGY *Short Answer* Classify each of the following chordates as oviparous, viviparous, or ovoviviparous:

I) Ratites
II) Monotremes
III) Marsupials
IV) Eutherians

ANSWER: I) Oviparous II) Oviparous, III) Viviparous IV) Viviparous

BONUS

19) BIOLOGY *Multiple Choice* At which section of the axon terminal do potassium channels aggregate in order to ensure that only the strongest waves of depolarization are passed on?

W) Juxtaparanode
X) Paranode
Y) Heminode
Z) Nodes of Ranvier

ANSWER: Y) Heminode

TOSS-UP

20) PHYSICS *Multiple Choice* A 10 kg ball is loosely attached to a massless spring on a table with a spring constant of 6 N/m which is currently compressed a distance of 4 m from equilibrium and then released. If the coefficient of kinetic friction of the table is 0.5, what is the resulting acceleration of the mass?

W) 0.8 m/s^2

X) 1.2 m/s^2

Y) 1.6 m/s^2

Z) 2.4 m/s^2

ANSWER: X) 1.2 m/s^2

BONUS

20) PHYSICS *Short Answer* If Xavier is 30 kg and Yavier is 60 kg and are standing together in an inertial frame, what is the reduced mass of the system?

ANSWER: 20 kg (1/(1/m1+1/m2))

TOSS-UP

21) CHEMISTRY *Multiple Choice* Tm is the chemical symbol for which element?

W) Thorium
X) Thulium
Y) Thallium
Z) Tellurium

ANSWER: X

BONUS

21) CHEMISTRY *Short Answer* What is the electron configuration of Au^{3+}

ANSWER: [Xe] $4f^{14}$ $5d^{8}$

TOSS-UP

22) EARTH AND SPACE *Short Answer* What type of air mass is abbreviated as cP?

ANSWER: continental polar

BONUS

22) EARTH AND SPACE *Short Answer* The dew point of an air mass at sea level is 6°C. Given that the temperature is 25°C, at what elevation will the water begin to condense?

ANSWER: 2.5 km

TOSS-UP

23) ENERGY *Multiple Choice* Which of the following is not a method for the production of syngas?

W) water-gas shift
X) steam reforming
Y) dry reforming
Z) partial oxidation

ANSWER: W

BONUS

23) ENERGY *Multiple Choice* Production of aluminum by recycling requires what percent of the energy required to produce the same amount from bauxite?

W) 1%
X) 5%
Y) 50%
Z) 90%

ANSWER: X

TOSS-UP

24) MATH *Short Answer* Zarr needs to file 12 sheets of paper. First, he separates them into two piles, one containing the first 6 papers counting from the top and another containing the last 6. Then, he draws one sheet from the first pile into another pile and puts a sheet from the second pile on top of the third pile and continues this process until all of the paper is in the third pile. How many pieces of paper are below the paper that was the 9th from the top in the original pile?

ANSWER: 4

BONUS

24) MATH *Short Answer* How many ways are there to color a circular spinner with five equal sections with the colors red, blue, and purple, assuming reflections are distinct and only one color may occupy a single sector at a time?

ANSWER: 51

TOSS-UP

25) CHEMISTRY *Short Answer* What is the formal charge of Cl in ClO_4^- if there are no double bonds?

ANSWER: +3

BONUS

25) CHEMISTRY *Short Answer* Rank the following in order of increasing bond order

I. O_2^+

II. CO^{2-}

III. N_2

ANSWER: II, I, III