

TOSS-UP

1) EARTH AND SPACE *Multiple Choice* Type II - P and type II - L supernova are distinguished by differences in which of the following?

W) Hydrogen Lines

X) Light Curve

Y) Helium Lines

Z) Initial Mass

ANSWER: X) Light Curve

BONUS

1) EARTH AND SPACE *Short Answer* What is the radius of a photon sphere of a Schwarzschild Black hole with a Schwarzschild radius of 16 km?

ANSWER: 24 km

TOSS-UP

2) MATHEMATICS *Short Answer* How many digits does the ternary representation of 245 base 10 have?

ANSWER: 6

BONUS

2) MATHEMATICS *Short Answer* Divide 420 base 5 by 10 base 5. Express your answer as a number in base 8.

ANSWER: 26

TOSS-UP

3) PHYSICS *Short Answer* What junction is created by P doping on one side and N doping on the other?

ANSWER: PN Junction

BONUS

3) PHYSICS *Short Answer* What is the name for the effect shown in which a superconductor will expel a magnetic field?

ANSWER: Meissner-Ochsenfeld effect (ACCEPT: Meissner Effect)

TOSS-UP

4) CHEMISTRY *Short Answer* What is the van't Hoff factor of the dimerization of benzoic acid in benzene solution ?

ANSWER: 1/2

BONUS

4) CHEMISTRY *Multiple Choice* In the Fischer esterification reaction, what role does the hydrogen ion play ?

W) Catalyst

X) Intermediate

Y) Reactant

Z) Product

ANSWER: W) Catalyst

TOSS-UP

5) BIOLOGY *Short Answer* What is the name for the disease in which the brain lacks dopamine?

ANSWER: Parkinson's (ACCEPT: MY DEPRESSION)

BONUS

5) BIOLOGY *Short Answer* What is the most common neurotransmitter found in the brain?

ANSWER: Glutamate

TOSS-UP

6) EARTH AND SPACE *Short Answer* Name all of the following minerals which do NOT have a streak, given that a ceramic plate has a hardness of 6.9 on Moh's hardness scale:

- 1) Ruby
- 2) Aquamarine
- 3) Apatite

ANSWER: 1 and 2

BONUS

6) EARTH AND SPACE *Short Answer* Name all of the following 3 which can be considered to be greasy:

- 1) Talc
- 2) Gypsum
- 3) Opal

ANSWER: 1 and 3

TOSS-UP

7) BIOLOGY *Short Answer* What syndrome is characterized by periods of euphoria and periods of heavy depression?

ANSWER: Bipolar Disease

BONUS

7) BIOLOGY *Short Answer* What is the name of the drug originally used to treat morning sickness in women but could be fatal if the chirality of the mixture was not right?

ANSWER: Thalidomide

TOSS-UP

8) MATHEMATICS *Short Answer* A certain bag contains 3 red balls and 2 blue balls. Another bag contains 7 blue balls and 4 red balls. If 3 balls are picked out of each bag, what is the probability that no red balls are chosen?

ANSWER: 0%

BONUS

8) MATHEMATICS *Short Answer* Find the inverse of the 3 by 3 matrix with top row 3, 2, 1, middle row 4, 2, 3 and bottom row 1, 2, 0

ANSWER: top row 1, $-\frac{1}{3}$, $-\frac{2}{3}$, middle row $-\frac{1}{2}$, $\frac{1}{6}$, $\frac{5}{6}$, and bottom row -1, $\frac{2}{3}$, $\frac{1}{3}$

TOSS-UP

9) PHYSICS *Multiple Choice* Which of the following

ANSWER:

BONUS

9) PHYSICS *Short Answer* If winston churchill likes to make speeches at 1000000 KHZ, and his microphone dies, which of the following frequencies should he talk at to make money

ANSWER:

TOSS-UP

10) CHEMISTRY *Short Answer* A sample of propane is burned inside a sealed elastic box with an oxygenated atmosphere. Which of the following 3 changes will cause the production of more reactants ?

1. Doubling the volume
2. Increasing the temperature
3. Adding more propane

ANSWER: None

BONUS

10) CHEMISTRY *Multiple Choice* Which of the following 4 cesium halides has the crystal structure with the lowest coordination number ?

- W) CeF
- X) CeCl
- Y) CeBr
- Z) CeI

ANSWER: W) CeF

TOSS-UP

11) MATH *Short Answer* 11 people made DOE science bowl at a Oak Ridge High School. They had 3 Daniels, and are indistinguishable from one another, but all of the rest are distinguishable. How many ways are there to choose an A and B team if order does not matter and no more than 1 Daniel can be on each team? Assume that each team has 5 people.

ANSWER: 70 ways

BONUS

11) MATH *Short Answer* Give the inverse of the 2x2 matrix with the top row being -4, 3 and the bottom row being 13, 3.

ANSWER: The 2x2 matrix with top row $-1/17$, $1/17$ and bottom row of $13/51$ and $4/51$

TOSS-UP

12) EARTH AND SPACE *Short Answer* What is the name for a fast moving band of thunderstorms which most commonly forms in the midwest, and often forms tornadoes?

ANSWER: Derecho

BONUS

12) EARTH AND SPACE *Multiple Choice* Give the associated type of tide with each of the following 3 locations:

- 1) Boston, Massachusetts
- 2) Galveston, Texas
- 3) Los Angeles, California

ANSWER: 1) Semidiurnal, 2) Diurnal, 3) Mixed

TOSS-UP

13) PHYSICS *Short Answer* Daniel blares loud music. Given that the human pain threshold is 130 decibels, how many times as loud must he play his 50 decibel music to hurt Gideon's ears?

ANSWER: 256

BONUS

13) PHYSICS *Short Answer* Daniel rides around town, blaring a constant note with a frequency of 432 Hz. He (illegally) drives towards Gideon, who is standing still, at 30 m/s. Given that the

speed of sound is 300m/s, what is the frequency which Gideon perceives, rounded to the nearest integer?

ANSWER: 480 Hz

TOSS-UP

14) CHEMISTRY *Short Answer* What scattering effect affects colloids with light (GT)?

ANSWER: Tyndall effect

BONUS

14) CHEMISTRY *Short Answer* A gas phase carbon atom with atomic mass 12 amu at its average speed at a temperature T elastically collides rightwards with a gas phase oxygen atom of mass 16 amu moving towards it, also at its average speed. In terms of the gas constant R and the temperature T, what is the speed of the center of mass of the system after the collision ?

ANSWER: $(3\sqrt{RT/12} + 4\sqrt{RT/16})/7$

TOSS-UP

15) BIOLOGY *Short Answer* What is the name for the molecule that mediates the binding of oxygen to hemoglobin?

ANSWER: BPG (Accept: Biphosphoclycerate)

BONUS

15) BIOLOGY *Short Answer* What is the name of the kinase that is ultimately activated with the production of DAG and IP3 from phosphatidylinositol?

ANSWER: Protein Kinase C

TOSS-UP

16) EARTH AND SPACE *Short Answer* Parent materials which are transported by wind and then deposited are best known as what?

ANSWER: Eolian

BONUS

16) EARTH AND SPACE *Short Answer* Name all of the following pairs of parent material transportation methods and names which are correct.

- 1) Gravity - Colluvial
- 2) Through Lakes - Lacustrine
- 3) By ice - glacial
- 4) Through Oceans - Alluvial

ANSWER: 1, 2, 3

TOSS-UP

17) BIOLOGY *Short Answer* What is the common name for the phenomena of which describes lack of coloration?

ANSWER: Albino

BONUS

17) BIOLOGY *Short Answer* What is the most common protein within blood plasma?

ANSWER: Albumin

TOSS-UP

18) CHEMISTRY *Short Answer* A battery is created from the 2 half cells $\text{Fe}^{3+}/\text{Fe}^{2+}$ and Ag/Ag^+ , with a standard cell potential of 1.57 V. When the hydrogen ion concentration is increased 10 fold, what is the new cell potential of the battery, assuming all other conditions remain constant ?

ANSWER: 1.57 V

BONUS

18) CHEMISTRY *Short Answer* What type of MO orbital is formed between two d orbitals?

ANSWER: Delta

TOSS-UP

19) MATHEMATICS *Short Answer* What is $\sin^2(15) + \cos^2(15)$?

ANSWER: 1

BONUS

19) MATHEMATICS *Short Answer* What is the name of the theorem that states that every number can be expressed as a sum of 2 fibonacci numbers?

ANSWER: Zeckendorf's Theorem

TOSS-UP

20) CHEMISTRY *Short Answer* According to Zaitsev's rule, the more substituted form of what type of functional group is more favorable as the product of an elimination reaction ?

ANSWER: Alkene

BONUS

20) CHEMISTRY *Short Answer* List the following 4 oxides as acidic, basic, or amphoteric :

1. Sodium Ethoxide
2. Carbon Dioxide
3. Aluminum Oxide
4. Magnesium Oxide

ANSWER: 1) Basic, 2) Acidic, 3) Amphoteric, 4) Basic

TOSS-UP

21) MATHEMATICS *Short Answer* Evaluate $\frac{2+3i}{3+2i}$

ANSWER: $12/13 + 5/13 i$

BONUS

21) MATHEMATICS *Short Answer* Evaluate $\frac{d}{dx} \int_{f(x)}^{g(x)} h(t) dt$

ANSWER: $h(g(x))g'(x) - h(f(x))f'(x)$

TOSS-UP

22) PHYSICS *Short Answer* What is the velocity of the center of mass after a 50 kg object initially at rest explodes into 4 equal sized pieces each of which have no angular momentum around the axis?

ANSWER: 0

BONUS

22) PHYSICS *Short Answer* What is the cross product of the linear momentum and the position vector?

ANSWER: Torque

TOSS-UP

23) EARTH AND SPACE *Multiple Choice* At which of the following locations would you most likely find a slightly acidic soil?

W) Amazon Rainforest

X) Antarctica

Y) Serengeti

Z) Sahara Desert

ANSWER: W) Amazon Rainforest

BONUS

23) EARTH AND SPACE *Short Answer* Rank the following the following 3 soil types in increasing average pH:

1) Calcareous Soils

2) Sulfate Soils

3) Sodic soils

ANSWER: 2, 1, 3

TOSS-UP

24) PHYSICS *Short Answer* What is the molar heat capacity at constant pressure of Neon, in terms of the gas constant R?

ANSWER: 1.5R

BONUS

24) PHYSICS *Short Answer* The angular momentum of a round hollow ball with a mass and radius of 1 kilogram and 6 meters, respectively, is $L=t^4+3t^3+6t^2+10t+15$, where t is time. What is the angular velocity over the time interval from initial $t=0$ to $t=5$ seconds, in radians per second?

ANSWER: 240 radians/second

TOSS-UP

25) BIOLOGY *Short Answer* What is the name of the cytokine produced by the kidney in response to low levels of erythrocytes in the blood?

ANSWER: Erythropoietin (ACCEPT: Hematopoietin)

BONUS

25) BIOLOGY *Short Answer* What disorder that causes buildup of mucus in the lungs is caused by the incorrect activity of chloride ion channels?

ANSWER: Cystic Fibrosis