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Science Bowl – Varied Team Round – 12/26/12

TOSS-UP

1) PHYSICS *Short Answer* Determine the final speed of a 10 kg metal projectile launched from a railgun in 1 second if the current passing through it is 1 million amperes, the strength of the magnetic field is 10 teslas, and the distance between the parallel rails is 1 meter.
ANSWER: 1 MILLION METERS PER SECOND

BONUS

1) PHYSICS *Short Answer* In terms of the magnetic constant μ_0 (mu-not), determine the strength of the magnetic field along the central axis 5 m from the center of a current-carrying coil with 25 turns, π m^2 enclosed by each turn, and 10 amperes of current in each turn.
ANSWER: μ_0 TESLA (MU-NOT TESLA)

TOSS-UP

2) CHEMISTRY *Multiple Choice* Sulphur tetrafluoride is a molecule with seesaw molecular geometry. What is the steric number of this molecule?
W) 3
X) 4
Y) 5
Z) 6
ANSWER: Y) 5

BONUS

2) CHEMISTRY *Short Answer* What is the name given to a type of vibration causing molecules of certain geometries to isomerize by exchanging the two axial ligands for two of the equatorial ones?
ANSWER: BERRY MECHANISM or BERRY PSEUDOROTATION

TOSS-UP

3) BIOLOGY *Multiple Choice* A person suffering from cystic fibrosis, specifically mucus buildup in the lungs, can best treat his condition by inhaling which of the following enzymes?
W) reverse transcriptase
X) DNA polymerase
Y) DNA helicase
Z) deoxyribonuclease
ANSWER: Z) DEOXYRIBONUCLEASE

BONUS

3) BIOLOGY *Short Answer* What explains the existence of only about 45 tRNAs, instead of 61?
ANSWER: WOBBLE (ACCEPT: FLEXIBLE BASE PAIRING IN THE 3^{RD} POSITION AT THE 3' END OF AN mRNA CODON)

TOSS-UP

4) EARTH/SPACE *Short Answer* Identify all of the following four that must occur in a star for it to die by supernova.
1: collapse of an iron core
2: production of radioactive nickel-56
3: burst of neutrinos
4: turbulent convection
ANSWER: 1, 3, AND 4 (COLLAPSE OF AN IRON CORE, BURST OF NEUTRINOS, TURBULENT CONVECTION)

BONUS

4) EARTH/SPACE *Multiple Choice* As the Antennae Galaxies use up the last of their gas and dust making stars, they will
W) merge to form a single spiral galaxy
X) become normal elliptical galaxies or merge to form a single elliptical galaxy
Y) separate and travel in different directions
Z) collapse and form a single black hole
ANSWER: X) BECOME NORMAL ELLIPTICAL GALAXIES OR MERGE TO FORM A SINGLE ELLIPTICAL GALAXY

TOSS-UP

5) MATH *Multiple Choice* Which of the following is characteristic of Gabriel's Horn, the graph of $y=1/x$ with domain $x \geq 1$, rotated in three dimensions about the x-axis?
W) infinite volume, but finite surface area
X) infinite surface area, but finite volume
Y) infinite surface area and infinite volume
Z) finite surface area and finite volume
ANSWER: X) INFINITE SURFACE AREA, BUT FINITE VOLUME

BONUS

5) MATH *Short Answer* For what positive integer *n* is the quantity $\frac{n}{3} + \frac{40}{n}$ minimized?
ANSWER: 11

TOSS-UP

6) PHYSICS *Short Answer* A science bowler notices a proton heading towards him at a speed of $0.8c$. In terms of the speed of light *c* and mass of the proton *m*, what force does he need to apply on the proton if he wants to catch it with his "proton mitt" in 1 second?
ANSWER: $\frac{4}{3}mc$ NEWTONS

BONUS

6) PHYSICS *Short Answer* If a spacecraft lifts off with a total mass of e^{15} kg and has a final total mass of e^{11} kg after consuming its fuel, determine the maximum change in speed of the spacecraft, given that the spacecraft's engine has a specific impulse of 500 s and the acceleration due to gravity is 10 m/s^2.
ANSWER: 20 THOUSAND METERS PER SECOND

TOSS-UP

7) CHEMISTRY *Multiple Choice* Consider the following equilibrium reaction, $FeO_{(solid)} + CO_{(gas)} \leftrightarrow Fe_{(solid)} + CO2_{(gas)}$, where delta-H equals -10 kilojoules. Which of the following would have a similar effect on the equilibrium position as lowering the temperature?
W) adding iron
X) increasing pressure
Y) removing carbon dioxide
Z) removing carbon monoxide
ANSWER: Y) REMOVING CARBON DIOXIDE

BONUS

7) CHEMISTRY *Short Answer* How many sigma and pi bonds, respectively, are there in a molecule with the following formula: $CH_3CHCHCH_2CH_3$?
ANSWER: 14 SIGMA BONDS, 1 PI BOND

TOSS-UP

8) BIOLOGY *Short Answer* What common organic molecule has a hydrocarbon phytol tail and a multi-ring structure with a magnesium metal ion in the center?
ANSWER: CHLOROPHYLL (ACCEPT: ANY CHLOROPHYLL)

BONUS

8) BIOLOGY *Multiple Choice* Which of the following is the primary difference in regulation between the lactose and tryptophan operons?
W) tryptophan activates its repressor and lactose leads to an inactive repressor
X) when tryptophan is present, the repressor is inactive and the opposite is true for allolactose in the lac operon
Y) allolactose is considered a co-repressor whereas tryptophan is actually an inducer
Z) when tryptophan is not present, the co-repressor is able to inactivate the promoter directly
ANSWER: W) TRYPTOPHAN ACTIVATES ITS REPRESSOR AND LACTOSE LEADS TO AN INACTIVE REPRESSOR

TOSS-UP

9) EARTH/SPACE *Short Answer* Identify all of the following four types of galaxies that constitute the majority of galaxies in a rich cluster
1: spiral
2: S0 (pronounced “Ess-Zero”)
3: irregular
4: elliptical
ANSWER: 2 AND 4 (S0 AND ELLIPTICAL)

BONUS

9) EARTH/SPACE *Short Answer* If the objective of your telescope has a diameter of 0.1 m and you choose to increase its light-gathering power by a factor of 100, what will its new resolving power be, in arcseconds?
ANSWER: 0.116 ARCSECONDS

TOSS-UP

10) MATH *Short Answer* Compute the average of the integers 2, 3, 4,…, 12.
ANSWER: 7

BONUS

10) MATH *Short Answer* In a 10 by 10 grid of dots, what is the maximum number of lines that can be drawn connecting two dots on the grid so that no two lines are parallel?
ANSWER: 112

TOSS-UP

11) ENERGY *Multiple Choice* What is the name given to the process in which natural gas is burned together with another fuel in order to reduce air pollutants?
W) cleansing
X) dual-compressing
Y) cogenerating
Z) cofiring
ANSWER: Z) COFIRING

BONUS

11) ENERGY Renewable resources comprise what percentage of the United States' total energy consumption?
W) 3%
X) 7%
Y) 16%
Z) 28%
ANSWER: X) 7%

TOSS-UP

12) ENERGY *Multiple Choice* Through 14 transformations, uranium-238 decays into
W) Protactinium-234
X) Lead-206
Y) Radon-222
Z) Bismuth-210
ANSWER: X) LEAD-206

BONUS

12) ENERGY *Multiple Choice* What percentage of uranium in a nuclear fuel rod remains after one-time use in a reactor?
W) 44%
X) 63%
Y) 81%
Z) 96%
ANSWER: Z) 96%