

Science Bowl – Varied Team Round – 1/7/13

TOSS-UP

1) PHYSICS *Multiple Choice* Which of the following is defined as the suppression of unitary time evolution caused by quantum decoherence in quantum systems?

W) local hidden variable

X) entanglement

Y) quantum Zeno effect

Z) quantum measurement

ANSWER: Y) QUANTUM ZENO EFFECT

BONUS

1) PHYSICS *Short Answer* What is the de Broglie wavelength of a particle with a velocity of $0.6c$? Express your answer in terms of Planck's constant h and mass of the particle m .

ANSWER: $\frac{4h}{3m}$

TOSS-UP

2) CHEMISTRY *Multiple Choice* Consider the following gaseous equilibrium: $\text{PCl}_3 + \text{Cl}_2 = \text{PCl}_5 + \text{Heat}$. Which of the following changes will shift the reaction to the right?

W) removing some Cl_2

X) lowering the temperature

Y) increasing the volume

Z) adding a catalyst

ANSWER: X) LOWERING THE TEMPERATURE

BONUS

2) CHEMISTRY *Short Answer* At 25° Celsius, the vapor pressure of water is about 3 kilopascals and the vapor pressure of methanol is about 15 kilopascals. Assuming no deviation from Raoult's law, determine the vapor pressure, in kilopascals, of a mixture of 1 mole of methanol and 2 moles of water.

ANSWER: 7 kPa

TOSS-UP

3) 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 (pron.: TEHT-nee)

ANSWER: Z) TETANY

BONUS

3) BIOLOGY *Short Answer* By name or number, order the following five cell layers in a eudicot root from most lateral to most medial.

1: pericycle

2: epidermis

3: endodermis

4: phloem

5: cortex

ANSWER: 2, 5, 3, 1, 4

TOSS-UP

4) EARTH/SPACE *Short Answer* On rare occasions of abundant rainfall or snowmelt in a mountainous desert, streams may flow across alluvial fans to the center of a basin, converting the basin floor into what?

ANSWER: PLAYA LAKE

BONUS

4) EARTH/SPACE *Short Answer* If a supernova was observed for the first time in the year 2000 to be 40 parsecs away from the Earth, then how many years before observation, rounded to the nearest whole number, did the supernova occur?

ANSWER: 130 YEARS

TOSS-UP

5) MATH *Multiple Choice* Which of the following is TRUE about any two successive terms in the Fibonacci sequence?

W) they are relatively prime

X) their product is a Fibonacci number

Y) their quotient is the golden ratio

Z) they are either both odd or both even

ANSWER: W) THEY ARE RELATIVELY PRIME

BONUS

5) MATH *Short Answer* Cards numbered 1 through 10 lie on a table. If two cards are picked at random, without replacement, what is the probability, as a fraction in lowest terms, that the two cards will have values within one of each other?

ANSWER: 1/5

TOSS-UP

6) ENERGY *Multiple Choice* Which of the following best approximates the solar energy intensity in watts per square meter incident on the Earth?

W) 200

X) 1400

Y) 4000

Z) 10000

ANSWER: X) 1400

BONUS

6) ENERGY *Short Answer* Companies A, B, and C are forced to pay one dollar of tax per ton of carbon dioxide equivalent emissions. If Company A emits 100 tons of carbon dioxide and 4 tons of nitrous oxide, Company B emits 10 tons of carbon dioxide and 5 tons of nitrous oxide, and Company C emits 200 tons of carbon dioxide and no nitrous oxide, which company has to pay the largest tax?

ANSWER: COMPANY B

TOSS-UP

7) PHYSICS *Multiple Choice* Which of the following is known as the shifting and splitting of spectral lines of atoms and molecules due to presence of an external static electric field?

W) Stokes shift

X) Zeeman effect

Y) Stark effect

Z) fine structure

ANSWER: Y) STARK EFFECT

BONUS

7) PHYSICS *Short Answer* What is the equivalent resistance of an infinite number of resistors in parallel, beginning with a 1 ohm resistor and each successive resistor with a resistance that is twice the resistance of the previous resistor?

ANSWER: $\frac{1}{2}$ OHM

TOSS-UP

8) CHEMISTRY *Short Answer* For the following 3 processes, predict whether the change in enthalpy, is positive or negative, respectively.

1: decomposition of ammonium nitrate

2: sublimation of dry ice

3: condensation of gaseous iodine to liquid iodine

ANSWER: 1: + 2: + 3: –

BONUS

8) CHEMISTRY *Short Answer* The molar mass of carbon dioxide is 44 grams. Providing your answer to the nearest integer, if 88 grams of solid carbon dioxide sublimates, how many liters of carbon dioxide gas will be formed at standard temperature and pressure?

ANSWER: 45

TOSS-UP

9) BIOLOGY *Multiple Choice* Which of the following are mostly under the control of the hypothalamus?

W) metabolism, heart rate, ovulation

X) metabolism, heart rate, sleep

Y) metabolism, heart rate, micturition

Z) metabolism, heart rate, balance

ANSWER: X) METABOLISM, HEART RATE, SLEEP

BONUS

9) BIOLOGY *Short Answer* An unknown substance is tested by 2 reagents. The Lugol's test yields a black color while the Benedict's test yields a light blue color. Amylase is added and then the substance is retested. The Lugol's test is negative, while the Benedict's test yields a red color. What substances were present before and after the amylase was added, respectively?

ANSWER: POLYSACCHARIDE (ACCEPT: STARCH, DO NOT ACCEPT: GLYCOGEN)
AND MONOSACCHARIDE (ACCEPT: SIMPLE SUGAR, REDUCING SUGAR)

TOSS-UP

10) EARTH/SPACE *Multiple Choice* Which of the following types of fog may form when the skies clear after a rainfall and the air near the surface is close to saturation, possibly making it dangerous to drive at sunset?

W) frontal

X) advection

Y) radiation

Z) steam

ANSWER: Y) RADIATION

BONUS

10) EARTH/SPACE *Short Answer* Identify all of the following five that are characteristic of a Seyfert galaxy.

- 1: spiral galaxy
- 2: luminous at radio wavelengths
- 3: spectra containing broad emission lines
- 4: nucleus containing a neutron star
- 5: nucleus that is a few light-minutes in diameter

ANSWER: 1, 3, AND 5 (SPIRAL GALAXY, SPECTRA CONTAINING BROAD EMISSION LINES, NUCLEUS THAT IS A FEW LIGHT-MINUTES IN DIAMETER)

TOSS-UP

11) MATH *Short Answer* What is the maximum number of spheres with a radius of 1 that can fit inside a cube with edge lengths of 6?

ANSWER: 27

BONUS

11) MATH *Short Answer* A spherical balloon is being inflated at a constant rate of π cubic meters per second. In meters per second, how fast is the radius increasing when the radius is 3 m?

ANSWER: 1/36

TOSS-UP

12) ENERGY *Short Answer* Which of the following is TRUE regarding the burning of biodiesel versus gasoline in automobile engines?

- 1: biodiesel combustion does not emit SO_2
- 2: biodiesel contains more oxygen than gasoline
- 3: the CO_2 released when biodiesel is burned is the same CO_2 the plants removed from the atmosphere as they grew
- 4: the energy content per gallon of biodiesel is approx. 28% lower than that of ethanol

ANSWER: 1, 2, 3

BONUS

12) ENERGY *Multiple Choice* If you were to use hydrogen fuel cells in a spacecraft, what kind of fuel cell type would you most likely prefer?

- W) phosphoric acid
- X) molten carbonate
- Y) solid oxide
- Z) alkaline

ANSWER: Z) ALKALINE

.