

BASIS PEORIA SCIENCE BOWL

DOUBLE ELIMINATION ROUND 9

TOSS-UP

1) Biology – *Short Answer* A patient is unsure of whether or not they have been infected with a certain disease. What plate - based assay technique could be done to detect the presence of antibodies specific for the disease within the patient's blood, which will reveal if the patient's immune system has been combating any foreign pathogens.

ANSWER: ELISA (Accept: EIA, enzyme - linked immunosorbent assay, or enzyme - linked immunoassay)

BONUS

1) Biology – *Multiple Choice* There are many different types of ELISA with different strengths and weaknesses. Which of the following types of ELISA has the highest specificity for the antigen?

W) Direct ELISA
X) Indirect ELISA
Y) Sandwich ELISA
Z) Competitive ELISA

ANSWER: Y) Sandwich ELISA

TOSS-UP

2) Chemistry – *Short Answer* How many sigma and pi bonds can be found in cyanide, respectively?

ANSWER: 1 sigma, 2 pi

BONUS

2) Chemistry – *Short Answer* In 1937, this unique effect regarding molecular symmetry was discovered. Under this effect, the geometry of molecules is distorted in order to remove degeneracy and lower the energy of a species. Name this effect.

ANSWER: JAHN-TELLER EFFECT

TOSS-UP

3) Physics – *Short Answer* Using Hubble's Law, find the distance of a star moving away from the Earth at 210 km/s. Round to the nearest whole number. Give units with your answer.

ANSWER: 3 Megaparsecs

BONUS

3) Physics – *Short Answer* Find the distance in parsecs of an object experiencing a parallax angle of 300 milliarcseconds. Give your answer as a fraction.

ANSWER: 10/3

TOSS-UP

4) Math – *Short Answer* Which of the following functions is NOT monotonic for all real values of x from 0 to infinity.

W) x^2
X) 1/x
Y) e^x
Z) x^3

ANSWER: Z

BONUS

4) Math – *Short Answer* What is the $\int_1^\infty \frac{1}{x^2} dx$?

ANSWER: 1

TOSS-UP

5) ESS– *Short Answer* For a gas cloud cloud to be stable, the potential energy of the system must be at least what integer multiple of the kinetic energy?

ANSWER: TWO

BONUS

5) ESS– *Short Answer* What British physicist and astronomer is known for his mass and length formulas that define limits for the stability of a gas cloud?

ANSWER: JEANS

TOSS-UP

6) Energy – *Multiple Choice* Which of the following values is the maximum power coefficient of a wind turbine

W) 0.221
X) 0.374
Y) 0.593
Z) 0.982

ANSWER: Y) 0.593

BONUS

6) Energy – *Short Answer* In reality wind turbines can only reach around 80-90% of their maximum power coefficient. However, the turbines can be augmented with certain devices that are capable of increasing the efficiency. Which of the following additions will NOT increase the efficiency of a turbine?

W) Actuator
X) Diffuser
Y) Fins
Z) Vortex generators

ANSWER: W) Actuator

TOSS-UP

7) Biology – *Multiple Choice* In an ultrasound image, what term is used to describe a structure that appears darker than its surroundings?

W) Hypoechoic
X) Hyperechoic
Y) Anechoic
Z) Isoechoic

ANSWER: W) Hypoechoic

BONUS

7) Biology – *Multiple Choice* What term would be used to describe the appearance of blood and blood vessels under an ultrasound?

W) Hypoechoic
X) Hyperechoic
Y) Anechoic
Z) Isoechoic

ANSWER: Y) Anechoic

TOSS-UP

8) Chemistry – *Short Answer* Solubility and pressure of a gas are directly proportional. What is the constant of proportionality between these two properties?

ANSWER: HENRY'S CONSTANT

BONUS

8) Chemistry – *Short Answer* Which of the following is a description of Raoult's Law?

W) Equal volumes of all gases, at the same temperature and pressure, have the same number of molecules
X) The partial pressure of any vapor in a mixture is equal to the product of the vapor's vapor pressure and its mole fraction
Y) The total pressure in a container is the sum of the partial pressures of the components
Z) Pressure and Volume are inversely proportional at constant temperature

ANSWER: X

TOSS-UP

9) Physics – *Short Answer* What property may be defined as the reciprocal as electrical resistivity?

ANSWER: ELECTRICAL CONDUCTIVITY

BONUS

9) Physics – *Multiple Choice* Which of the following metals has the highest resistivity at 20 degrees C?

W) Tungsten
X) Silver
Y) Gold
Z) Platinum

ANSWER: Z

TOSS-UP

10) Math – *Short Answer* What is the third term in the Taylor series of sin x at 0?

ANSWER: $\frac{x^5}{120}$

BONUS

10) Math – *Short Answer* Estimate the integral of sinx/x with respect to x by using the first three terms of a Maclaurin series. Assume the constant of integration is zero.

ANSWER: x-x^3/18+x^5/600

TOSS-UP

11) ESS– *Short Answer* What was the first spacecraft to land on Venus?

ANSWER: VENERA 7

BONUS

11) ESS– *Short Answer* Answer the following questions about Venus.

A) What acidic compound is found in the clouds of Venus?
B) In antiquity how many planets was Venus believed to be?

ANSWER: SULFURIC ACID; 2

TOSS-UP

12) Energy – *Multiple Choice* In liquid metal-cooled fast reactors, which metal is most commonly used to cool the fuel

ANSWER: Sodium

BONUS

12) Energy – *Multiple Choice* Which of the following is an advantage of using LMF reactors?

W) Low fire hazard risk
X) Less corrosion
Y) Higher Power density
Z) Less waste production

ANSWER: Y) Higher Power density

TOSS-UP

13) Biology – *Short Answer* Ketosis is a metabolic state in which alternative sources other than carbohydrates are used for energy within the body during times of low carbohydrate intake. Instead, fat is broken down into fatty acids and glycerol, which travel to the liver. While the fatty

acids are converted to ketone bodies through ketogenesis, what process converts glycerol into sugar that can be used in cellular respiration?

ANSWER: Gluconeogenesis

BONUS

13) Biology – *Short Answer* The liver converts fat into ketone bodies, which can serve as an alternative source of energy. During ketosis, the level of ketone bodies in the blood is higher than usual but still at a safe level. If ketone body levels increase to dangerous levels within the bloodstream due to a lack of insulin, what condition develops as a result?

ANSWER: Acidosis (Accept: Ketoacidosis)

TOSS-UP

14) Chemistry – *Short Answer* What chemical procedure for separating volatile chemicals relies on a difference in boiling point between the components?

ANSWER: DISTILLATION

BONUS

14) Chemistry – *Short Answer* What is the term for a mixture whose composition remains unchanged during distillation?

ANSWER: AZEOTROPE

TOSS-UP

15) Physics – *Short Answer* What vector can be used to the rate of energy transport per unit area and direction of travel of an EM wave?

ANSWER: POYNTING VECTOR

BONUS

15) Physics – *Short Answer* The second partial derivative with respect to position of an EM wave is equal to the second partial derivative with respect to time of an EM wave divided by what fundamental constant squared.

ANSWER: SPEED OF LIGHT

TOSS-UP

16) Math – *Short Answer* What special type of Taylor series expands functions of the form $(1+x)^a$

ANSWER: BINOMIAL SERIES

BONUS

16) Math – *Short Answer* What is the third term in the binomial series for $\sqrt{9-x}$.

ANSWER: $-\frac{x^2}{216}$

TOSS-UP

17) ESS– *Short Answer* First discovered in 1962 what is the term for the special type of stellar binaries where an accretor absorbs the mass of the donor releasing high energy electromagnetic radiation? The first one discovered was called Scorpius X-1.

ANSWER: X-RAY BINARIES

BONUS

17) ESS– *Short Answer* What is the term for radio emitting x-ray binaries that are smaller versions of another stellar phenomenon of similar name? These stellar phenomena have relativistic jets and include SS 433 and Cygnus X-1.

ANSWER: MICROQUASARS

TOSS-UP

18) Energy – *Short Answer* What is the name of the process that is used to produce liquid hydrocarbon fuels from coal and natural gas?

ANSWER: Fischer-Tropsch process

BONUS

18 Energy – *Short Answer* What is the most common carbon to hydrogen ratio in the hydrocarbon molecule produced as a result of the Fischer-Tropsch process

ANSWER: 1:2

TOSS-UP

19) Biology – *Short Answer* What enzyme, also called tRNA ligase, catalyzes the synthesis of tRNA molecules through amino acid polymerization?

ANSWER: Aminoacyl tRNA Synthetase

BONUS

19) Biology – *Short Answer* Sickle cell anemia is a fatal disease caused by a point mutation that causes amino acid A to become amino acid B. What are amino acids A and B?

ANSWER: Amino Acid A: Glutamic Acid, Amino Acid B: Valine

TOSS-UP

20) Chemistry – *Short Answer* Brownian motion is observed in what type of suspensions?

ANSWER: COLLOIDS

BONUS

20) Chemistry – *Short Answer* Answer these questions about the types of colloids.

A) An emulsion is a mixture of two substances in what state of matter
B) A sol is an immersion of what state of matter in a liquid

ANSWER: SOLID, SOLID

TOSS-UP

21) Physics – *Short Answer* What electric device can be made by connecting dissimilar metal wires at different temperatures in a loop to induce a current?

ANSWER: THERMOCOUPLE

BONUS

21) Physics – *Short Answer* What is the term for the effect observed in a thermocouple where the voltage across the junction differs based on temperature?

ANSWER: SEEBECK EFFECT

TOSS-UP

22) Math – *Short Answer* What special case of the mean value theorem states that states that any real-valued differentiable function that attains equal values at two distinct points must have at least one stationary point somewhere between them.

ANSWER: ROLLE'S THEOREM

BONUS

22) Math – *Short Answer* What mathematician stated and proved the Mean value Theorem in its modern form?

ANSWER: CAUCHY

TOSS-UP

23) ESS– *Short Answer* What is the term for a compact region at the center of a galaxy that has a much-higher-than-normal luminosity over at least some portion of the electromagnetic spectrum with characteristics indicating that the luminosity is not produced by stars?

ANSWER: ACTIVE GALACTIC NUCLEUS

BONUS

23) ESS– *Short Answer* What is the term for the apparent faster-than-light motion observed in some radio galaxies, quasars, and blazars? Bursts of energy moving out along the relativistic jets emitted from these objects can have a proper motion that appears greater than the speed of light.

ANSWER: SUPERLUMINAL MOTION