

BASIS PEORIA SCIENCE BOWL

NATIONALS ROUND 3

TOSS-UP

1) Biology – *Multiple Choice* Which of the following types of epithelium lines the upper respiratory tract?

W) Simple squamous epithelium
X) Simple columnar epithelium
Y) Pseudostratified columnar epithelium
Z) Stratified cuboidal epithelium

ANSWER: Y) Pseudostratified columnar epithelium

BONUS

1) Biology – *Short Answer* There are three main types of cartilage present in the human body. Identify the following terms. (1) This type of cartilage is found in the rib cage. (2) This type of cartilage is found in the intervertebral disks.

ANSWER: (1) Hyaline cartilage. (2) Fibrocartilage.

TOSS-UP

2) Chemistry – *Short Answer* In electrochemistry, what law states that the amount of mass deposited at an electrode is directly proportional to the charge of the current passed through it?

ANSWER: Faraday's first law of electrolysis

BONUS

2) Chemistry – *Short Answer* In addition to Faraday's first law of electrolysis, his second law of electrolysis states that there is a direct relationship between the amount of mass deposited at an electrode and what other quantity at a constant electricity?

ANSWER: Equivalent weight

TOSS-UP

3) Physics – *Short Answer* What hypothesis states that a gravitational singularity is not observable?

ANSWER: COSMIC CENSORSHIP HYPOTHESIS

BONUS

3) Physics – *Short Answer* By number, give all of the following things that are true about charged black holes. 1) they have two horizons; 2) black holes with a charge greater than their

mass have been observed in nature; 3) they must satisfy the Reissner-Nordström equations; 4) they cannot become degenerate.

ANSWER: 1 AND 3

TOSS-UP

4) Math – *Multiple Choice* The point (1, 5) is reflected across first the line y = x and then the line x = 1. What are the coordinates of the final point?

W) (-3, -1)
X) (-3, 1)
Y) (3, 1)
Z) (3, -1)

ANSWER: X) (-3, 1)

BONUS

4) Math – *Short Answer* Find the cross product of the two vectors **i** - 2**j** + 5**k** and 3**i** + **j** - 3**k**.

ANSWER: **i** + 18**j** + 7**k**

TOSS-UP

5) Earth and Space – *Short Answer* The K-Pg boundary layer contains unusually high quantities of what element, which on Earth, almost exclusively exists within the core ?

ANSWER: IRIDIUM

BONUS

5) Earth and Space – *Multiple Choice* Mare Moscoviense is a lunar mare, a dark spot on the Moon formed by lava on the Moon's surface immediately after an asteroid or comet impact. Mare Moscoviense is different from virtually all other lunar mare for what reason?

W) It is the largest mare
X) It is on the Moon's far side
Y) It is shaped like a star
Z) It is the darkest mare of all

ANSWER: X) IT IS ON THE MOON'S FAR SIDE

TOSS-UP

6) Energy – *Short Answer* Scientists at Oakridge National Laboratory are using the Spallation Neutron Source to find contrasts in the molecular structures of different neutrons. To find the contrast in neutron spallation of protium atoms, what should protium be replaced with?

ANSWER: Deuterium (Heavy Hydrogen)

BONUS

6) Energy – *Short Answer* Due to decades of use of antibiotics, many bacteria have acquired a resistance to most modern-day antibiotics. Researchers at Oakridge National Lab are using the Spallation Neutron Source to investigate the interaction on a neutron level between what enzyme and the antibiotics?

ANSWER: Beta-lactamase

TOSS-UP

7) Biology – *Short Answer* BCG is a relatively uncommon vaccine in the United States. However, in countries where this disease is more prevalent, it is usually administered to infants and small children. Name the disease that this vaccine prevents.

ANSWER: Tuberculosis

BONUS

7) Biology – *Short Answer* This group of diseases is caused by infectious proteins called prions. More specifically, this group consists of rare neurodegenerative diseases, such as kuru, mad cow disease, and Creutzfeldt - Jakob Disease. Name this group of fatal diseases, which give the brain a spongy appearance and have the acronym TSE.

ANSWER: Transmissible Spongiform Encephalopathies

TOSS-UP

8) Chemistry – *Short Answer* What type of diagram is used to display the speeds of different particles at specific temperatures?

ANSWER: Maxwell - Boltzmann Distribution

BONUS

8) Chemistry – *Multiple Choice* Which of the following would have the lowest standard deviation on a Maxwell - Boltzmann distribution?

W) SO_2
X) SeO_2

Y) CO2
Z) NO2

ANSWER: X) SeO2

TOSS-UP

9) Physics – *Short Answer* For which of the following objects would Gauss' Law apply?

W) Klein bottle
X) Möbius strip
Y) Röman surface
Z) Torus

ANSWER: Z) TORUS

BONUS

9) Physics – *Short Answer* Suppose that an infinitely long straight current-carrying wire has a uniform linear charge density λ. Let this wire be on the y-axis of the xy-plane, and let x > 0 be the distance between the y-axis and a point P on the xy-plane. What is the strength of the electric field at the point P?

ANSWER: $\lambda/2\pi\epsilon_0 x$

BOTTOM

TOSS-UP

10) Math – *Short Answer* Give the derivative of sin(x)/x.

ANSWER: $\frac{xcos(x)-sin(x)}{x^2}$

BONUS

10) Math – *Multiple Choice* Find the equation of the normal line to $y = x^2$ at $x = \sqrt{3}$.

W) $y = \frac{1}{2}x - \frac{2}{5}$
X) $y = \frac{\sqrt{3}}{2}x - \frac{5}{2}$
Y) $y = \frac{\sqrt{3}}{6}x + \frac{5}{2}$
Z) $y = \frac{\sqrt{3}}{6}x + \frac{2}{5}$

ANSWER:Y)$Y = \frac{\sqrt{3}}{6}X + \frac{5}{2}$

TOSS-UP

11) Earth and Space – *Short Answer* 100 million years ago, the Mancos Sea stretched between Alaska down to the Gulf of Mexico, effectively cutting North America in half. What were the names given to these two halves?

ANSWER: LARAMIDIA AND APPALACHIA

BONUS

11) Earth and Space – *Multiple Choice* Approximately 70 million years ago, the Mancos Sea suddenly disappeared, leaving North America as a whole continent again. What event was the likely cause of this disappearance?

W) The death of the dinosaurs
X) Lowering of sea levels
Y) Ice sheets blocking off the inlets
Z) The rise of the Rocky Mountains

ANSWER: Z) THE RISE OF THE ROCKY MOUNTAINS

TOSS-UP

12) Energy – *Multiple Choice* Scientists at Lawrence Berkeley National Laboratory are using the Advanced Light Source Facility to study things like fuel cells and batteries. Which of the following types of microscopy do they most likely use?

W) X-Ray Absorption Spectroscopy
X) Transmission Electron Microscopy
Y) Confocal Microscopy
Z) Ultraviolet Spectroscopy

ANSWER: W) X-Ray Absorption Spectroscopy

BONUS

12) Energy – *Short Answer* A scientist at Lawrence Berkeley National Laboratory used the facilities at the ALS to reveal the CRISPR-Cas9 protein complex, which was a key development in the development of genome editing. Name this scientist who also won a Nobel Prize in Chemistry in 2020.

ANSWER: Doudna (ACCEPT: Jennifer Doudna)

TOSS-UP

13) Biology – *Multiple Choice* Bacteria vary drastically in their sizes, shapes, and arrangements. Axial filaments are motile structures contained within an external sheath of a prokaryote. Which of the following types of bacteria use axial filaments for movement rather than flagella?

W) Spirochete
X) Spirillum
Y) Vibrio
Z) Streptobacillus

ANSWER: W) Spirochete

BONUS

13) Biology – *Short Answer* In 1975, this disease caused a cluster of cases that were originally diagnosed as rheumatoid arthritis. This seasonal disease causes unusual skin rashes and is caused by the spirochete Borrelia burgdorferi. Name this disease and the organism that acts as its vector.

ANSWER: Lyme Disease (Accept: Lyme Borreliosis or Borreliosis), Ticks

TOSS-UP

14) Chemistry – *Short Answer* What is the limiting reactant in the following reaction: $ZnCl_2$ + KF yields ZnF_2 + KCl at equimolar amounts.

ANSWER: KF

BONUS

14) Chemistry – *Short Answer* A student reacts 2 moles of Mg with excess O_2 in the air, and they obtain a final compound of mass 30.23 g. What is the percent yield of MgO to the nearest whole number?

ANSWER: 38%

TOSS-UP

15) Physics – *Multiple Choice* Which of the following is the term for a vector that has a magnitude equal to the amplitude of the wave and that rotates around an origin, where its angular speed is equal to the angular frequency of the wave?

W) Pressure amplitude
X) Doppler vector
Y) Polar wave vector
Z) Phasor

ANSWER: Z) PHASOR

BONUS

15) Physics – *Short Answer* Two waves with the same amplitude and wavelength interfere in three different situations to produce resultant waves with the following equations: 1) 4 sin(5x - 4t); 2) 4 sin(5x) cos(4t); 3) 4 sin(5x + 4t). By name or number, give all of the preceding equations where the combining waves are traveling towards negative x.

ANSWER: 3

TOSS-UP

16) Math – *Short Answer* What is the term for the theorem that gives the relationship between a line integral around a simple closed curve C and a double integral over the plane region D bounded by C?

ANSWER: GREEN'S THEOREM

BONUS

16) Math – *Short Answer* A car starts at point (0, 1), drives in a unit circle, and arrives at the point (0, 1) again. It does work against the wind, which is defined by a vector field $\mathbf{F} = 6x^2y\mathbf{i} + (2x^3 + y)\mathbf{j}$. What is the total work done by the car during this trip?

ANSWER: 0

TOSS-UP

17) Earth and Space – *Short Answer* What is the chemical formula for cinnabar?

ANSWER: HgS

BONUS

17) Earth and Space – *Short Answer* Gypsum is a hydrate of what mineral?

ANSWER: ANHYDRITE

TOSS-UP

18) Energy – *Multiple Choice* Scientists at Argonne National Laboratory are using x-rays to find which of the following properties in 3D-printed titanium alloys?

W) Heat Resistance

X) Luster
Y) Porosity
Z) Opacity

ANSWER: Y) Porosity

BONUS

18) Energy – *Multiple Choice* Which of the following is a step in the process of 3D printing metals?

W) Atomization of the metal into fine powder
X) Drawing the metal into thin wires
Y) Use of a high-velocity spinning blade to cut the metal into the desired shape
Z) Use of high-power robot arms to bend the metal into the desired shape

ANSWER: W) Atomization of the metal into fine powder

TOSS-UP

19) Biology – *Multiple Choice* Which of the following is not a general sense of the nervous system?

W) Pain
X) Proprioception
Y) Touch
Z) Sight

ANSWER: Z) Sight

BONUS

19) Biology – *Short Answer* The receptors on our tongue can recognize 5 basic types of taste. The first 4 of these are sweet, sour, salty, and bitter. However, in the late 20th century, a fifth taste was discovered. Name this fifth taste.

ANSWER: Umami

TOSS-UP

20) Chemistry – *Short Answer* Provide the name of the reagent that is used to detect the presence of reducing sugars and is a mixture of copper sulfate pentahydrate, sodium citrate, and sodium carbonate in distilled water?

ANSWER: Benedict's reagent

BONUS

20) Chemistry – *Short Answer* If the Benedict's test appears blue, approximately what percent of sugar is present?

W) 0
X) 0.5 - 1
Y) 1 - 1.5
Z) 1.5 - 2

ANSWER: W) 0

TOSS-UP

21) Physics – *Short Answer* The position vector of a particle moving around a circle of radius r is x. What is the value of $\oint$ r * ds ***[read: the closed line integral of r times ds]*** around the circle?

ANSWER: 0

BONUS

21) Physics – *Multiple Choice* Two long parallel wires are 8.0 cm apart. What must the magnitude of the equal antiparallel current running through the wires be if the magnetic field between them is to have a magnitude of 300 microteslas?

W) 30 Amperes
X) 240 Amperes
Y) 375 Amperes
Z) 19200 Amperes

ANSWER: W) 30 Amperes

TOSS-UP

22) Math – *Short Answer* What is the term for the sequence of integers, A000959 in the OEIS, which begins with 1, 3, 7, 9, 13 and is generated by a method similar to the Sieve of Eratosthenes?

ANSWER: LUCKY NUMBERS

BONUS

22) Math – *Short Answer* What is the value of $\pi(100)$ ***[read: pi of one hundred]***?

ANSWER: 25

TOSS-UP

23) Earth and Space – *Short Answer* What is the term for the process of nuclear fusion used in large main-sequence stars?

ANSWER: CNO CYCLE

BONUS

23) Earth and Space – *Short Answer* What is the term for an object that forms directly from a collapsing molecular cloud just like a star, but is not massive enough to fuse anything at all?

ANSWER: SUB-BROWN DWARF