

BASIS PEORIA SCIENCE BOWL

NATIONALS ROUND 2

TOSS-UP

1) Biology – *Multiple Choice* Supination and pronation are both movements of the forearm. Which of the following best describes the positions of the radius and the ulna during these movements?

W) During supination, the radius and ulna form an X-shape. During pronation, the radius and ulna are parallel.
X) During supination, the radius and ulna are parallel. During pronation, the radius and ulna form an X-shape.
Y) During both supination and pronation, the radius and ulna are parallel.
Z) During both supination and pronation, the radius and ulna form an X-shape.

ANSWER: X) During supination, the radius and ulna are parallel. During pronation, the radius and ulna form an X-shape.

BONUS

1) Biology – *Short Answer* Answer the following questions. (1) What is the largest joint in the human body? (2) What bones articulate at this joint?

ANSWER: (1) Knee joint. (2) Femur, tibia, and patella.

TOSS-UP

2) Chemistry – *Short Answer* Vanadium (V) Oxide is commonly used as a catalyst in the *contact process*. It catalyzes the oxidation of sulfur dioxide in the presence of oxygen to give what common atmospheric pollutant?

ANSWER: SULFUR TRIOXIDE

BONUS

2) Chemistry – *Short Answe*r What phenomenon prevents colloid suspension like Iron III Hydroxide from settling out of solution? The small particles are constantly bombarded by solvent molecules due to this.

ANSWER: BROWNIAN MOTION

TOSS-UP

3) Physics – *Short Answer* What is the term for the reactive force to a centripetal force?

ANSWER: REACTIVE CENTRIFUGAL FORCE

BONUS

3) Physics – *Short Answer* In classical mechanics, the relativistic momentum of an object is equal to the classical momentum multiplied by what unitless factor?

ANSWER: LORENTZ FACTOR

TOSS-UP

4) Math – *Short Answer* Find the determinant of the 2 by 2 matrix with top left value 7, top right value 8, bottom left value 3, and bottom right value 4.

ANSWER: 4

BONUS

4) Math – *Short Answer* Find the cross product a cross b with a=(3,6,1) and b=(2,4,5).

ANSWER: (26,-13,0)

TOSS-UP

5) Earth and Space – *Short Answer* The majority of the sun's nuclear fusion occurs through which specific process, which turns four hydrogen atoms into one helium atom?

ANSWER: PROTON-PROTON CHAIN

BONUS

5) Earth and Space – *Short Answer* At the end of the sun's first red giant phase, what event will occur, in which the core becomes hot enough to burn helium, making the sun return to roughly the same size and temperature it is now?

ANSWER: HELIUM FLASH

TOSS-UP

6) Energy – *Short Answer* Scientists at SLAC National Accelerator Laboratory have shown electrons can be accelerated by riding waves of plasma. What other particle can be accelerated in a similar manner?

ANSWER: Positrons (ACCEPT: Anti-electrons)

BONUS

6) Energy – *Short Answer* Scientists at SLAC National Accelerator Laboratory discovered that positrons and electrons can be accelerated and collided by riding waves of plasma. Name the particle accelerator that is the only machine that is capable of accelerating electrons and positrons via this new method.

ANSWER: FACET (Facility for Advanced Accelerator Experimental Tests)

TOSS-UP

7) Biology – *Short Answer* This muscle's main function is to flex the forearm. It primarily acts as a synergist to the biceps brachii muscle and is located deep to the biceps brachii. Name this muscle.

ANSWER: Brachialis

BONUS

7) Biology – *Short Answer* Answer the following questions. (1) What is the name of this muscle, which originates from the sternum and clavicle and inserts into the temporal bone. Its primary function is to rotate the head. 2) What is the name of this large trapezoidal muscle, which inserts into the scapula. Its primary function is to elevate the shoulders, pull the scapulas together, and tilt the head backwards.

ANSWER: (1) Sternocleidomastoid. (2) Trapezius.

TOSS-UP

8) Chemistry – *Short Answer* What mineral is commonly used to dissolve bauxite in the electrolytic processing of aluminum?

ANSWER: CRYOLITE

BONUS

8) Chemistry – *Short Answe*r Answer the following questions about vanadium.

1) What color is a solution of V5+ ion?
2) What color is a solution of V3+ ion?
3) What color is a solution of V4+ ion?

ANSWER: YELLOW, GREEN, BLUE

TOSS-UP

9) Physics – *Multiple Choice* In Lagrangian mechanics, what property of a system is equal to the sum of the kinetic energies of all the objects in the system minus the sum of all the potential energies of all the objects in the system?

W) Lagrangian
X) Euler-Lagrangian energy
Y) Euler energy
Z) D'Alembert's Factor

ANSWER: LAGRANGIAN

BONUS

9) Physics – *Short Answer* There is a star of mass n and a planet whose mass m is much less than that of the star. The planet and star interact through the gravitational potential V(r) = -Gnm/r, where r is the distance separating the star and planet. A: What is the Lagrangian of the planet? B: Is the planet's angular momentum constant?

ANSWER: A: $1/2mv^2 + 1/2mr^2\omega^2$ B: YES

TOSS-UP

10) Math – *Short Answer* Write the equation of a 3-dimensional sphere with radius 6 centered at the origin in spherical coordinates.

ANSWER: $\rho = 6$

BONUS

10) Math – *Multiple Choices* The following equation in cylindrical coordinates: r=z defines which of the following surfaces?

W) Sphere
X) Cylinder
Y) Cone
Z) Plane

ANSWER: Y

TOSS-UP

11) Earth and Space – *Short Answer* What is the term for large, singular igneous formation that extends to unknown depths and is formed when a magma chamber cools before the magma reaches the surface?

ANSWER: BATHOLITH

BONUS

11) Earth and Space – *Multiple Choice* Which of the following rocks could be found in an accretionary wedge?

W) Sandstone
X) Slate
Y) Granite
Z) Gabbro

ANSWER: W) SANDSTONE

TOSS-UP

12) Energy – *Short Answer* Electric trucks have been discussed as a great way to help clean the Earth, but the issue is that the electric trucks require up to ten times more electricity than the standard electric car. Researchers at Argonne National Lab have proposed a solution to this problem, suggesting that they build what at truck stops to give them the large amount of energy they require?

ANSWER: Microreactors (Mini Nuclear Reactors)

BONUS

12) Energy – *Short Answer* Researchers at Argonne National Laboratory have proposed that we should construct microreactors at truck stops to power electric trucks, but there are still safety issues concerning the nuclear waste. What type of fuel could the microreactor use? (Hint: this fuel is made of three elements, encapsulated by three layers of carbon and ceramics)

ANSWER: Tri-structural Isotropic (TRISO) pellets

TOSS-UP

13) Biology – *Multiple Choice* This part of the brain is derived from the Latin word for bridge. It obtained its name from its function of connecting parts of the brain. Name this structure, which is the main connection between the cerebellum and brainstem.

W) Thalamus
X) Hypothalamus
Y) Pons
Z) Midbrain

ANSWER: Y) Pons

BONUS

13) Biology – *Short Answer* This disease primarily affects the substantia nigra of the basal nuclei. It is a result of neurons in this region dying, which results in the deficiency of an important neurotransmitter. As a result, this forces the basal nuclei into the indirect pathway and prevents the direct pathway from being activated. Name this famous neurodegenerative disorder, which is characterized by hypokinesia.

ANSWER: Parkinson's disease

TOSS-UP

14) Chemistry – *Short Answer* What is the electron configuration of chromium?

ANSWER: 1s2 2s2 2p6 3s2 3p6 4s1 3d5

BONUS

14) Chemistry – *Multiple Choice* What other transition metal in period 4 has an electron configuration that doesn't follow Aufbau's principle?

W) Manganese
X) Cobalt
Y) Nickel
Z) Copper

ANSWER: Z) Copper

TOSS-UP

15) Physics – *Multiple Choice* Which of the following laws states that the probability density of finding a particle at a given point is proportional to the square of the magnitude of the particle's wavefunction at that point?

W) Cauchy-Born rule
X) Heisenberg's uncertainty principle
Y) Born rule
Z) Schrodinger equation

ANSWER: Y) BORN RULE

BONUS

15) Physics – *Short Answer* A photon can be in one of two states: horizontally or vertically polarized. The photon is in a superposition of the two states, stated as $|\psi\rangle = \sin(\pi/2)|H\rangle - \cos(\pi/2)|V\rangle$ ***[read: the superposed state is equal to the sin of pi over two times horizontal-state minus the cosine of pi over two times vertical-state]***. What is the probability that, when the polarization of the photon is measured, that it is horizontally polarized?

ANSWER: ½

TOSS-UP

16) Math – *Multiple Choice* Which of the following is the term for the curve that results if you hang an ideal rope between two poles?

W) Tractrix
X) Troposkein
Y) Parabola
Z) Catenary

ANSWER: Z) Catenary

BONUS

16) Math – *Short Answer* What is the derivative of the arc hyperbolic tangent, in terms of x?

ANSWER: $\frac{1}{1-X^2}$

TOSS-UP

17) Earth and Space – *Short Answer* A dust cloud can produce what two effects on light from a star behind it?

ANSWER: EXTINCTION AND REDDENING

BONUS

17) Earth and Space – *Short Answer* What type of nebula receives light from a star and reflects it to Earth?

ANSWER: REFLECTION NEBULA

TOSS-UP

18) Energy – *Multiple Choice* Researches at Jefferson National Accelerator Laboratory are experimenting with "artificial photosynthesis" where they are attempting to convert sunlight into which of the following?

W) Petroleum
X) Glucose
Y) Carbon-Based Liquid Fuels
Z) Saltwater

ANSWER: Y) Carbon-Based Liquid Fuels

BONUS

18) Energy – *Short Answer* During artificial photosynthesis, synthetic catalysts are used. One example of a synthetic photocatalyst used in artificial photosynthesis is titanium dioxide. What is the name of the effect in which it was discovered that titanium dioxide photocatalyzed hydrolysis?

ANSWER: Honda-Fujishima Effect

TOSS-UP

19) Biology – *Short Answer* During embryonic development of the nervous system, 5 secondary vesicles form. Which of these vesicles eventually develops into the cerebrum of the brain.

ANSWER: Telencephalon

BONUS

19) Biology – *Short Answer* This structure connects the left and right hemispheres of the cerebral cortex, allowing for communication. Name this structure, which consists of white matter.

ANSWER: Corpus Callosum

TOSS-UP

20) Chemistry – *Multiple Choice* Which of the following is not an allotrope of carbon?

W) Biradical catena chains
X) Buckytube
Y) Lonsdaleite
Z) Schwarzite

ANSWER: W) Biradical catena chains

BONUS

20) Chemistry – *Short Answer* What allotrope of carbon resembles the shape of a soccer ball and has a formula of C60?

ANSWER: Buckminsterfullerene

TOSS-UP

21) Physics – *Multiple Choice* Which of the following terms describes the best-focused spot of light that a perfect lens with a circular aperture can make?

W) Sparrow's resolution limit
X) Airy disk
Y) Rayleigh criterion
Z) Dawes' limit

ANSWER: X) AIRY DISK

BONUS

21) Physics – *Multiple Choice* Which of the following is not always conserved in optics?

W) Polarization
X) Etenduè
Y) Basic radiance
Z) Energy

ANSWER: W) POLARIZATION

TOSS-UP

22) Math – *Short Answer* What vector in vector calculus can be interpreted as the direction and rate of fastest increase of a scalar function?

ANSWER: GRADIENT

BONUS

22) Math – *Short Answer* Find the gradient of the scalar function u(x, y, z) = sin(xyz).

ANSWER: yz*cos(xyz) **i** + xz*cos(xyz) **j** + xy*cos(xyz) **k**

TOSS-UP

23) Earth and Space – *Short Answer* What volcanic event occurs when a powerful eruption causes the volcano to eject a massive column of ash, which subsequently collapses, sending huge quantities of superheated ash and rock falling down the volcano?

ANSWER: PYROCLASTIC FLOW

BONUS

23) Earth and Space – *Multiple Choice* Mount Kilauea in Hawaii has been continuously erupting since what year?

W) 1924
X) 1955
Y) 1983
Z) 2018

ANSWER: Y) 1983