

BASIS PEORIA SCIENCE BOWL

NATIONALS ROUND 4

TOSS-UP

1) Biology – *Multiple Choice* Which of the following statements is not true?

W) Most of the muscles that move the hand are located in the forearm.
X) The clavicle is the most frequently fractured bone in the body.
Y) The elbow joint is the weakest joint in the body.
Z) The masseter is the most powerful muscle in the body by weight.

ANSWER: Y) The elbow joint is the weakest joint in the body.

BONUS

1) Biology – *Multiple Choice* Which of the following is incorrectly matched?

W) Ball and socket joint - Glenohumeral joint
X) Plane joint - Between adjacent vertebrae
Y) Pivot joint - Between atlas and axis
Z) Condylar joint - Between tarsal bones

ANSWER: Z) Condylar - Between tarsal bones

TOSS-UP

2) Chemistry – *Short Answer* What reagent is used to test for the presence of aldehydes and is famous for producing a silver mirror when positive?

ANSWER: TOLLEN'S REAGENT

BONUS

2) Chemistry – *Short Answer* What famous reaction do aldehydes undergo in reaction with themselves under basic conditions that forms a difunctionalized compound?

ANSWER: ALDOL REACTION

TOSS-UP

3) Physics – *Short Answer* The π^+ meson decays by the process $\pi^+ \rightarrow \mu^+ + \nu$. To what lepton family does this neutrino belong?

ANSWER: MUON

BONUS

3) Physics – *Multiple Choice* Which of the following are always conserved in particle physics 1) intrinsic spin; 2) lepton number; 3) baryon number; 4) charge; 5) strangeness?

W) 2, 3, 4, 5
X) 1, 3, 5
Y) 1, 2, 3, 4
Z) All

ANSWER: Z) ALL

TOSS-UP

4) Math – *Multiple Choice* Which of the following methods for numerical integration is most accurate?

W) Simpson's rule
X) Double step rule
Y) Rectangular rule
Z) Trapezoidal rule

ANSWER: W) SIMPSON'S RULE

BONUS

4) Math – *Short Answer* What is the highest degree polynomial for which a 15-point Gaussian quadrature rule is exact?

ANSWER: 29

TOSS-UP

5) Earth and Space – *Multiple Choice* A star with a surface temperature of 20, 000 Kelvins emits the most radiation at what wavelength, in nanometers?

W) 1050
X) 740
Y) 385
Z) 145

ANSWER: Z) 145

BONUS

5) Earth and Space – *Short Answer* At around wavelength, in nanometers, is the Lyman Beta spectral line for hydrogen?

W) 10,000
X) 1000
Y) 100
Z) 10

ANSWER: Y) 100

TOSS-UP

6) Energy – *Multiple Choice* Scientists at Fermi National Accelerator Laboratory are using the machine known as DUNE to learn more about how supernovae occur by studying and observing which of the following particles?

W) Barions
X) Fermions
Y) Mesons
Z) Neutrinos

ANSWER: Z) Neutrinos

BONUS

6) Energy – *Short Answer* Scientists from Fermi National Accelerator Laboratory were stationed in Antarctica to conduct the IceCube experiment at the IceCube Observatory. While in Antarctica, these scientists discovered ultra high-energy neutrinos. Where are these high-energy neutrinos believed to have come from?

ANSWER: Outside our solar system

TOSS-UP

7) Biology – *Multiple Choice* How do the ascending and descending tracts of the nervous system differ?

W) Ascending tracts carry sensory information to the brain, and descending tracts carry motor commands from the brain.
X) Both ascending and descending tracts carry sensory information to the brain.
Y) Ascending tracts carry sensory information from the brain, and descending tracts carry sensory information to the brain.
Z) Both ascending and descending tracts carry motor information from the brain.

ANSWER: W) Ascending tracts carry sensory information to the brain, and descending tracts carry motor command from the brain.

BONUS

7) Biology – *Multiple Choice* Which of the following is the region that the spinal cord spans?

W) Brainstem to lower thoracic region.
X) Brainstem to upper lumbar region.
Y) Brainstem to lower lumbar region
Z) Brainstem to sacral region.

ANSWER: X) Brainstem to upper lumbar region.

TOSS-UP

8) Chemistry – *Short Answer* A carboxylic acid can be formed from the oxidation of an aldehyde in what reaction, first discovered in 1899 that often uses mCPBA as a reagent?

ANSWER: Baeyer-Villiger Oxidation

BONUS

8) Chemistry – *Short Answer* Answer the following questions about organic chemistry.

A) What is the term for a cyclic ether, formed by the baeyer-villiger oxidation of a cyclic ketone?
B) What order of carbocation has the highest migratory aptitude?
C) The Baeyer-Villiger Oxidation of ketones forms what functional group?

ANSWER: LACTONE, TERTIARY, ESTER

TOSS-UP

9) Physics – *Multiple Choice* What is the term for the electrostatic potential difference between two metals (or one metal and one electrolyte) that are in contact and are in thermodynamic equilibrium?

W) Galvani potential
X) Fermi level
Y) Volta potential
Z) Kelvin force

ANSWER: Y) VOLTA POTENTIAL

BONUS

9) Physics – *Multiple Choice* Which of the following has the highest negative charge on the triboelectric series?

W) Teflon
X) Synthetic rubber
Y) Polyethylene
Z) Orlon

ANSWER: W) TEFLON

TOSS-UP

10) Math – *Multiple Choice* Which of the following is not an odd function?

W) erf(x)
X) tanh(x)
Y) sin(x)
Z) arccosh(x)

ANSWER: Z) ARCCOSH(X)

BONUS

10) Math – *Short Answer* What is the term for a Taylor series where zero is the point where the derivatives are considered?

ANSWER: MACLAURIN SERIES

TOSS-UP

11) Earth and Space – *Short Answer* Pangaea split up along the equator into which two landmasses?

ANSWER: LAURASIA AND GONDWANA

BONUS

11) Earth and Space – *Short Answer* The oxygenation of the atmosphere led oxygen to react with iron in the ocean, which came out of solution and built up on the ocean floor, creating what features?

ANSWER: BANDED IRON FORMATIONS

TOSS-UP

12) Energy – *Short Answer* Researchers at Brookhaven National Lab are searching for a hypothetical type of neutrino that can only interact with other particles through gravity. What is this neutrino called?

ANSWER: Sterile Neutrino; Inert Neutrino

BONUS

12) Energy – *Short Answer* Scientists at Brookhaven National Laboratory are looking for a particle that mixes with the three known neutrino types to prove the existence of the sterile neutrino. What are these three known neutrino types?

ANSWER: Muon, Tau, and Electron

TOSS-UP

13) Biology – *Short Answer* Provide the name for a fibrous sheet of connective tissue that fills the gap between two bones.

ANSWER: Interosseous membrane

BONUS

13) Biology – *Short Answer* Interosseous membranes fill the wide gap between two bones. For example, there is an interosseous membrane that connects the radius and ulna in the forearm. Interosseous membranes are an example of what broader type of joint?

W) Gomphosis
X) Synchondrosis
Y) Syndesmosis
Z) Symphysis

ANSWER: Y) Syndesmosis

TOSS-UP

14) Chemistry – *Short Answer* What are the three basic types of pericyclic reactions?

ANSWER: CYCLOADDITION REACTIONS, ELECTROCYCLIC REACTIONS, AND SIGMATROPIC REARRANGEMENTS

BONUS

14) Chemistry – *Short Answer* Answer the following questions about pericyclic reactions.

A) What type of cycloaddition is a Diels-Alder reaction?
B) How many pi bonds are formed in a sigmatropic rearrangement?

C) What is the name of the [3,3] sigmatropic rearrangement often found in aryl, allylic ethers?

ANSWER: [4+2], 0, Claisen Rearrangement

TOSS-UP

15) Physics – *Short Answer* The K_α x-rays arising from a cobalt target have a wavelength of about 179 pm. Is the wavelength of the K_α x-rays arising from a nickel target greater or less than 179 pm?

ANSWER: LESS

BONUS

15) Physics – *Short Answer* An electron is in a quantum state for which the magnitude of the electron's orbital angular momentum L is (2√3) * ħ ***[read: two square root of three times h-bar]***. How many projections of the electron's orbital magnetic dipole moment on a z axis are allowed?

ANSWER: 7

TOSS-UP

16) Math – *Short Answer* What theorem in vector calculus theorem relates the integral of the curl of the vector field over some surface, to the line integral of the vector field around the boundary of the surface?

ANSWER: KELVIN-STOKES THEOREM (ACCEPT: CURL THEOREM)

BONUS

16) Math – *Multiple Choice* Find the curl of the vector field $\mathbf{F}(x, y, z) = -x^2\mathbf{j}$.

W) $-2x\mathbf{k}$
X) $-2\mathbf{k}$
Y) $-2x\mathbf{j}$
Z) $-2\mathbf{j}$

ANSWER: W) -2X**K**

TOSS-UP

17) Earth and Space – *Short Answer* The first animals appeared during which period?

ANSWER: EDIACARAN

BONUS

17) Earth and Space – *Short Answer* What period occurred immediately following the first mass extinction of the Phanerozoic Eon?

ANSWER: SILURIAN

TOSS-UP

18) Energy – *Short Answer* Researchers at Brookhaven National Laboratory have determined, by means of experimenting with the Relativistic Heavy Ion Collider, that what fundamental force displays near-symmetry in nuclei?

ANSWER: Strong

BONUS

18) Energy – *Short Answer* Researchers at Brookhaven National Laboratory were studying "strange-matter" nuclei and its antimatter counterpart. What is the name given to the "strange-matter" nuclei

ANSWER: Hypertriton

TOSS-UP

19) Biology – *Short Answer* The C1 and C2 vertebrae both possess different structures than the rest of the cervical vertebrae. This is because the articulation between the occipital condyles, C1 vertebra, and C2 vertebra allows for the rotation of the head. Provide the unique names given to the C1 and C2 vertebrae, respectively

ANSWER: Atlas and axis

BONUS

19) Biology – *Short Answer* The axis possesses a bony projection that articulates with the atlas to form a pivot joint in the neck. Provide the name of this projection.

ANSWER: Dens (Accept: Odontoid process)

TOSS-UP

20) Chemistry – *Short Answer* What functional group that is a carboxylic acid derivative can be hydrolyzed to give an amide?

ANSWER: NITRILE

BONUS

20) Chemistry – *Short Answer* What reagent can convert an amide into a nitrile?

ANSWER: SOCl2

TOSS-UP

21) Physics – *Short Answer* Rounded to the nearest ten, how many times more massive is a proton than an electron?

ANSWER: 1840

BONUS

21) Physics – *Short Answer* In kiloelectron volts to the nearest unit, what is the rest energy of an electron?

ANSWER: 511

TOSS-UP

22) Math – *Short Answer* What is the term for a matrix that is not invertible?

ANSWER: SINGULAR

BONUS

22) Math – *Short Answer* What is the null space of an invertible matrix?

ANSWER: ZERO (ACCEPT NULL OR EMPTY SET OR EQUIVALENT)

TOSS-UP

23) Earth and Space – *Multiple Choice* A P Cygni profile in a stellar spectrum is caused by what?

W) Planet formation
X) Mass loss
Y) Stellar flares
Z) Rapid Rotation

ANSWER: X) MASS LOSS

BONUS

23) Earth and Space – *Multiple Choice* Which class of T Tauri star is experiencing high levels of accretion?

W) FU Orionis
X) RR Lyrae
Y) UV Ceti
Z) P Cygni

ANSWER: W) FU ORIONIS