

BASIS PEORIA SCIENCE BOWL

NATIONALS ROUND 1

TOSS-UP

1) Biology – *Multiple Choice* Which of the following is the correct size range for which particles including viruses are said to be airborne?

W) 20-30 micrometers
X) 20-30 nanometers
Y) .5 micrometers- 20 nanometers
Z) Less than .5 Micrometers

ANSWER: Z

BONUS

1) Biology – *Multiple Choice* Relatively common in the world today, this sexually transmitted disease can lead to a sore throat, swollen lymph nodes, muscle aches and fatigue. If left untreated, the bacterium from which the disease arises, *Treponema pallidum*, can infect the Cerebrospinal Fluid of the brain and spinal cord, a rare development in the 21st century. Treatments range from antibiotics in the early stages of infection to daily penicillin injections. Which of the following accurately names this disease?

W) Chancroid
X) Syphilis
Y) Gonorrhea
Z) HIV

ANSWER: X

TOSS-UP

2) Chemistry – *Short Answer* What medically applied gas is produced by the decomposition of ammonium nitrate upon heating at 250 degrees Celsius? It is commonly referred to as laughing gas.

ANSWER: N_2O aka DINITROGEN MONOXIDE

BONUS

2) Chemistry – *Short Answer* Atmospheric nitrogen dioxide gas disproportionates to form acid rain. What strong acid is produced by the reaction between NO_2 and water?

ANSWER: NITRIC ACID or HNO_3

TOSS-UP

3) Physics – *Short Answer* This expression of quantum mechanics was devised between 1925 and 1927 by Niels Bohr and Werner Heisenberg. What is the term for this interpretation, named after the Dutch city in which it was developed?

ANSWER: COPENHAGEN INTERPRETATION

BONUS

3) Physics – *Short Answer* What is the quantum analogue of Newton's second law?

ANSWER: SCHRÖDINGER EQUATION

TOSS-UP

4) Math – *Short Answer* What are the period and phase shift respectively of $y = 2sin(\pi x - 1) + 7$

ANSWER: 2; 1

BONUS

4) Math – *Short Answer* Sum the infinite geometric series with first term 1 and third term 0.5. Give your answer in simplified radical form.

ANSWER: $2 + \sqrt{2}$

TOSS-UP

5) Earth and Space – *Short Answer* What gemstone is made entirely out of microscopic glass spheres arranged like a crystal lattice?

ANSWER: OPAL

BONUS

5) Earth and Space – *Short Answer* The mineral corundum has a hardness of 9 on the Mohs scale, and is relatively common in its pure form. When impurities appear in corundum, which two gemstones can it be recognized as?

ANSWER: RUBY AND SAPPHIRE

TOSS-UP

6) Energy – *Short Answer* Scientists at Argonne National Laboratory are using what technique, which involves exciting electron spins, to study substances containing unpaired electron spins?

ANSWER: Electron Paramagnetic Resonance Spectroscopy

BONUS

6) Energy – *Short Answer* Electron paramagnetic resonance spectroscopy is most commonly used to detect and identify what group of atoms or molecules?

ANSWER: Free radicals

TOSS-UP

7) Biology – *Short Answer* Contrary to its counterparts, this type of virus uses reverse transcriptase to convert its RNA to DNA and embed its genetic material into the host cell. Common examples of this virus include HIV and Corona Viruses. What is the name of this type of virus?

ANSWER: RETROVIRUS

BONUS

7) Biology – *Short Answer* An Intravenous medication is a type of medicine that must be administered directly into a vein and the bloodstream in order to take effect. One common method of administering an intravenous medication is through an IV drip. Which of the following, if any, is an Intravenous medication?

1) Hydromorphone
2) Amphotericin
3) Penicillin G

ANSWER: 1 AND 2

TOSS-UP

8) Chemistry – *Short Answer* How many types of Bravais lattices exist?

ANSWER: 14

BONUS

8) Chemistry – *Short Answer* Which of the following is closest to the packing efficiency of a cubic close packed unit cell structure?

W) 34%
X) 52%
Y) 68%
Z) 74%

ANSWER: Z

TOSS-UP

9) Physics – *Multiple Choice* Which of the following is true about inductors and capacitors?

W) Capacitors preserve voltage by storing energy in an electric field, whereas inductors preserve current by storing energy in a magnetic field.
X) Capacitors preserve voltage by storing energy in a magnetic field, whereas inductors preserve current by storing energy in an electric field.
Y) Capacitors preserve current by storing energy in an electric field, whereas inductors preserve voltage by storing energy in a magnetic field.
Z) Capacitors preserve current by storing energy in a magnetic field, whereas inductors preserve voltage by storing energy in an electric field.

ANSWER: W) CAPACITORS PRESERVE VOLTAGE BY STORING ENERGY IN AN ELECTRIC FIELD, WHEREAS INDUCTORS PRESERVE CURRENT BY STORING ENERGY IN A MAGNETIC FIELD.

BONUS

9) Physics – *Short Answer* A capacitor with a voltage of -sin(n) and a capacitor with a voltage of sin(-n)/(n-1) are connected in series. What is the limit of the capacitance of the circuit as n approaches 0?

ANSWER: 1

TOSS-UP

10) Math – *Short Answer* Find the divergence of the following vector field: f(x,y)=x*i_hat + y*j_hat

ANSWER: 2

BONUS

10) Math – *Short Answer* Gauss's law can be converted from derivative to integral form using what fundamental theorem of multivariable calculus.

ANSWER: DIVERGENCE THEOREM

TOSS-UP

11) Earth and Space – *Multiple Choice* About how massive, in solar masses, is the smallest known black hole to date?

W) 0.08
X) 1.4
Y) 5
Z) 4 million

ANSWER: Y) 5

BONUS

11) Earth and Space – *Multiple Choice* What is the ratio of the diameters of two black holes where the ratio of their masses is 100?

W) 1/10
X) 10
Y) 100
Z) 10, 000

ANSWER: Y) 100

TOSS-UP

12) Energy – *Multiple Choice* Scientists at Brookhaven National Laboratory are trying to recreate the state of the universe just after the Big Bang using the Relativistic Heavy Ion Collider. According to quantum chromodynamics, only what two elementary particles were present after the Big Bang?

W) Gluons and quarks
X) W and Z Bosons
Y) Quarks and leptons
Z) Leptons and gluons

ANSWER: W) Gluons and quarks

BONUS

12) Energy – *Short Answer* According to quantum chromodynamics, both quarks and gluons share what property, which explains why it is impossible to isolate these elementary particles?

ANSWER: Color confinement

TOSS-UP

13) Biology – *Short Answer* Which of the following, if any, is NOT one of the target tissues for the hormone Aldosterone.

1)Salivary Glands
2)Sweat Glands
3)Kidney

ANSWER: NONE

BONUS

13) Biology – *Short Answer* The plant *Primula* produces a chemical called malvidin. The K gene controls the synthesis of this chemical, while inhibition is controlled by the D gene. Both genes are considered to be hereditarily dominant. However, if the dominant D allele is present, there will be no gene expression regardless of whether the K allele is present. What is this phenomenon called?

ANSWER: EPISTASIS OR DOMINANT EPISTASIS OR SIMPLE EPISTASIS

TOSS-UP

14) Chemistry – *Short Answer* Yttrium oxysulfide is a common phosphor—a material that exhibits this property when impacted with electron or UV rays.

ANSWER: PHOSPHORESCENCE

BONUS

14) Chemistry – *Short Answer* For all of the following three substances, identify the color of the LED they are commonly used in.

1) Aluminum gallium arsenide
2) Indium gallium nitride
3) Zinc selenide

ANSWER: 1) RED 2) GREEN 3) BLUE

TOSS-UP

15) Physics – *Multiple Choice* A particle's acceleration is given by a(t) = C*(t^n) where C is a positive constant, n is a real number, and t is time. What is true about the jerk of the particle?

W) It is positive for any n
X) It is zero for any n
Y) It depends on only C

Z) It is positive as long as n is greater than 0

ANSWER: Z) IT IS POSITIVE AS LONG AS n IS GREATER THAN 0

BONUS

15) Physics – *Short Answer* A particle's acceleration is given by a(t) = C*(t^n) where C is a positive constant, n is a real number, and t is time. Give the equation for velocity in terms of t, C, n, and v0.

ANSWER: $V(t) = \frac{C}{n+1} t^{n+1} + V_0$

TOSS-UP

16) Math – *Short Answer* Find the vector perpendicular to the plane 3x+2y+2z=9.

ANSWER: (3,2,2)

BONUS

16) Math – *Multiple Choice* Which of the following is of the planes 4x-9y-z=2 and x+2y-14z=-6

W) They are parallel
X) They are orthogonal
Y) They intersect at an angle between 0 and 90 degree
Z) They are not planes

ANSWER: X

TOSS-UP

17) Earth and Space – *Short Answer* What formation is created when magma seeps up from underground, cutting through existing rock layers, before it hardens into rock itself?

ANSWER: DIKE

BONUS

17) Earth and Space – *Multiple Choice* Which of the following is not an igneous feature?

W) Sill
X) Batholith
Y) Laccolith
Z) Accretionary Wedge

ANSWER: Z) ACCRETIONARY WEDGE

TOSS-UP

18) Energy – *Multiple Choice* Lawrence Berkeley Lab was founded by Ernest Orlando Lawrence, who won the 1939 Nobel Prize in physics for the invention of what type of particle accelerator?

W) Betatron
X) Synchrotron
Y) Linac
Z) Cyclotron

ANSWER: Z) Cyclotron

BONUS

18) Energy – *Short Answer* What special type of cyclotron was invented by Edward McMillan? In this type of accelerator, relativistic mass increases do not impose a limit on the particles' energy, unlike a cyclotron.

ANSWER: Synchrocyclotron

TOSS-UP

19) Biology – *Short Answer* This type of White Blood Cell is responsible for fighting parasitic infection and plays a major role in the body's immune system and inflammatory response. It also contains granules that are easily stained by eosin. What type of leukocyte is this?

ANSWER: EOSINOPHILE

BONUS

19) Biology – *Short Answe*r Which of the following types of cells, if any, permanently enters the G0 phase after cell division.

1) Cardiac cells
2) Purkinje cells
3) Olfactory Cells

ANSWER: 1 AND 2

TOSS-UP

20) Chemistry – *Short Answer* When an alkyne is reacted with H2 gas in the presence of Lindlar's catalyst, what functional group is created?

ANSWER: ALKENE

BONUS

20) Chemistry – *Short Answer* A ketone exists in equilibrium with another functional group which is called its tautomer. Name this other functional group.

ANSWER: ENOL

TOSS-UP

21) Physics – *Short Answer* In an astronaut training exercise, an airplane at high altitude above Earth travels along a circular arc in order to simulate weightlessness for its passengers. To simulate weightlessness, the centripetal acceleration of the airplane must be equal to what constant?

ANSWER: g

BONUS

21) Physics – *Short Answer* A flywheel for a single piston engine rotates at an average speed of 1500 RPM. During half a rotation the flywheel has to absorb 2000 J of energy. If the maximum permissible speed fluctuation is ± 60 RPM, what is the minimum rotational inertia of the flywheel in kilograms? Assume there is no friction and give your answer to two decimal places.

ANSWER: 1.02

TOSS-UP

22) Math – *Multiple Choice* Which of the following is true about the series defined as the sum from n=1 to infinity of $(-1)^{n+1}/n$?

W) It diverges.
X) It converges absolutely.
Y) It converges conditionally.
Z) Its convergence cannot be determined.

ANSWER: Y

BONUS

22) Math – *Short Answer* Indicate whether each of the following two series diverges or converges.

1. The sum from n=2 to infinity of $\frac{cos(n\pi)}{\sqrt{n}}$

2. The sum from n=1 to infinity of $\frac{(-1)^n n^2}{n^2+5}$

ANSWER: 1 CONVERGES 2 DIVERGES

TOSS-UP

23) Earth and Space – *Multiple Choice* What may form when a maritime low pressure system becomes large enough to spin due to the Coriolis effect?

W) Tornado
X) Hurricane
Y) Anticyclone
Z) Nor'easter

ANSWER: X) HURRICANE

BONUS

23) Earth and Space – *Short Answer* Rising ocean temperatures have resulted in what effect in coral reefs, in which corals lose their symbiotic algae, making them turn white before dying?

ANSWER: BLEACHING