

Niskayuna Winter Invitational Round Robin 1

TOSS-UP

1) PHYSICS – *Short Answer*—A person drops a 50 kg cube from the top of a cliff that is 20 meters tall. If the acceleration of gravity is 10 meters per second squared, what is the speed of the ball right before it hits the ground?

ANSWER: 20 m/s

BONUS

1) PHYSICS – *Short Answer*—A cube is submerged at the bottom of a lake. The cube has a volume of 1 m^3 . An upwards force of 98 newtons is applied to the cube, and the cube begins to move upwards at a constant velocity. In kilograms, what is the mass of the cube?

ANSWER: 1010

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### TOSS-UP

2) CHEMISTRY – *Short Answer*— By name or number, order the following three ions in terms of increasing atomic radius. 1)  $\text{Ca}^{2+}$ , 2)  $\text{K}^+$ , 3)  $\text{S}^{2-}$

ANSWER: 1, 2, 3

### BONUS

2) CHEMISTRY – *Short Answer* — Aarush is experimenting with various substances to make his Tournament Director crown out of. His favorite substance, Vanderium, has a specific heat of  $0.125 \text{ J / g} \cdot \text{K}$ . If his crown needs 2kg of molten Vanderium, how much energy, in Joules, will Aarush need to raise his sample of Vanderium, currently at  $0^\circ\text{C}$ , to its melting point of  $2000 \text{ C}^\circ$ ?

ANSWER: 500,000 JOULES

### TOSS-UP

3) ENERGY – *Short Answer*—Researchers at Columbia’s Canman lab are developing microscope systems to study proteins involved in the contractile ring in cytokinesis. The contractile ring in cytokinesis is composed of actin and what family of motor proteins?

ANSWER: MYOSIN

### BONUS

3) ENERGY – *Multiple Choice*—Thin-film solar panels are created by depositing thin photovoltaic material onto a substrate. Compared to thicker crystalline silicon panels, thin-film solar panels are often more economical, smaller, and are easier to install. Which of the following elements is least likely to be contained in the photovoltaic material used in thin-film solar panels?

- W) Lithium
- X) Cadmium
- Y) Silicon
- Z) Indium

ANSWER: W) LITHIUM

### TOSS-UP

4) EARTH AND SPACE – *Multiple Choice*—Despite the fact that the Hawaiian islands are located far away from any plate boundary, they were formed by volcanism. Which of the following is the type of geologic setting that explains the formation of the Hawaiian islands?

- W) Island arc
- X) Rift
- Y) Mid-ocean ridge
- Z) Hotspot

ANSWER: Z) HOTSPOT

### BONUS

4) EARTH AND SPACE – *Short Answer*—By name or number, identify all of the following three characteristics that are characteristics of Hawaiian eruptions: 1) high gas content in lava, 2) low viscosity of lava, 3) low silica content of lava

ANSWER: 2 AND 3

### TOSS-UP

5) MATH – *Short Answer*—Vincent goes to the store and buys 72 watermelons. He gives  $\frac{1}{6}$  of the watermelons to his friend Aryeh and then gives 20% of the remaining watermelons to his other friend James. How many watermelons does he have left for himself?

ANSWER: 48

### BONUS

5) MATH – *Short Answer*—Find the equation of the slant asymptote of  $\frac{x^2+4x+7}{x+3}$ . (read as: the function with numerator x squared plus four x plus seven and denominator x plus three).

ANSWER:  $y=x+1$

### TOSS-UP

6) BIOLOGY – *Short Answer*—By name or number, identify all of the following four genetic disorders that can be caused by nondisjunction: 1) Patau syndrome, 2) Down syndrome, 3) Klinefelter's syndrome, 4) cystic fibrosis

ANSWER: 1, 2 AND 3

### BONUS

6) BIOLOGY – *Short Answer*—By name or number, identify all of the following three statements that are true regarding peroxisomes. 1) They are bound by a double membrane, 2) they are responsible for neutralizing free radicals, 3) peroxisomes contain their own DNA

ANSWER: 2 ONLY

### TOSS-UP

7) PHYSICS – *Short Answer*—A ball of cotton is rubbed against a small strip of plastic, and the plastic loses some electrons in the process. What is the sign of the charge of the plastic strip?

ANSWER: POSITIVE

### BONUS

7) PHYSICS – *Multiple Choice*—Two charges,  $+q$  and  $-2q$ , are placed at a distance  $d$  apart. At what point between the charges is the electric potential zero?

W) At a distance  $d/3$  from  $+q$

X) At a distance  $d/2$  from  $+q$

Y) At a distance  $d$  from  $+q$

Z) At a distance  $2d$  from  $+q$

ANSWER: W) AT A DISTANCE  $D/3$  FROM  $+Q$

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### TOSS-UP

8) CHEMISTRY – *Multiple Choice*— Which of the following terms best describes two molecules that are non-superimposable mirror images of each other, such as D-glucose and L-glucose?

W) Enantiomers

X) Diastereomers

Y) Cis-trans isomers

Z) Atropisomers

ANSWER: W) ENANTIOMERS

### BONUS

8) CHEMISTRY – *Short Answer* — Rank the following 3 salts in terms of increasing lattice energy. 1) NaCl; 2) NaBr; 3) MgO

ANSWER: 2, 1, 3

### TOSS-UP

9) ENERGY – *Multiple Choice*—Which of the following subatomic particles was discovered through the bombardment of beryllium by alpha particles and observation of the resultant radiation?

- W) Proton
- X) Electron
- Y) Neutron
- Z) Quark

ANSWER: Y) NEUTRON

### BONUS

9) ENERGY – *Short Answer*—Scientists are currently working on researching how to achieve nuclear fusion. What is the name of the barrier that must be overcome in order to achieve nuclear fusion?

ANSWER: COULOMB BARRIER

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TOSS-UP

10) EARTH AND SPACE – *Multiple Choice*—Which of the following choices best describes the formation of a badlands topography?

- W) Landslides remove softer rock, leaving behind harder rocks
- X) Chemical erosion of limestone substrate, leaving behind insoluble rocks
- Y) Compressional stress resulting in folding
- Z) Water and wind erosion of softer rocks

ANSWER: Z) WATER EROSION OF SOFT ROCKS

BONUS

10) EARTH AND SPACE – *Short Answer*—The drainage patterns in badlands topographies are characterized by parallel ridges of resistant rock and valleys in which water drains. What is the name given to this type of drainage pattern?

ANSWER: TRELLIS

TOSS-UP

11) MATH – *Short Answer*—If the first three numbers of an arithmetic sequence are 3, 8 and 13, what is the 10th term in this sequence?

ANSWER: 48

BONUS

11) MATH – *Multiple Choice* — Which of the following cubics has roots of 2 and $4 + 3i$?

W) $x^3 - 10x^2 + 41x - 50$

X) $x^3 + 6x^2 + 9x - 50$

Y) $x^3 + 10x^2 + 21x - 10$

Z) $x^3 + 4x^2 + 3x + 2$

ANSWER: W) $x^3 - 10x^2 + 41x - 50$

TOSS-UP

12) BIOLOGY – *Short Answer*—Marshlands are a transition area between dry ecosystems and wet ecosystems. What is the name for areas that represent a transition between two ecosystems?

ANSWER: ECOTONE

BONUS

12) BIOLOGY – *Multiple Choice*—Which of the following types of dispersion would most likely be exhibited by a population of penguins, which are territorial animals?

W) Clumped

X) Uniform

Y) Random

Z) No clear dispersion pattern

ANSWER: X) UNIFORM

TOSS-UP

13) PHYSICS – *Multiple Choice*—Which of the following situations is an example of an inelastic collision?

W) A tennis ball hits another tennis ball of equal mass

X) A tennis racket hits a tennis ball

Y) Two hydrogen atoms move towards each other at equal speeds and collide with each other¹

Z) An arrow hits a swinging target hanging from a tree branch and is lodged inside

ANSWER: Z) AN ARROW HITS A SWINGING TARGET HANGING FROM A TREE BRANCH AND IS LODGED INSIDE

BONUS

13) PHYSICS – *Short Answer*—By name or number, identify all of the following three values that are conserved in an inelastic collision: 1) momentum, 2) kinetic energy, 3) acceleration

ANSWER: 1 AND 3

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### TOSS-UP

14) CHEMISTRY – *Short Answer*— If 2 moles of an ideal gas are placed in a container with volume 1 liter and pressure 2 atmospheres, what will be the new pressure, in atmospheres, if the container expands to a volume of 4 liters and the temperature does not change?

ANSWER: 0.5

### BONUS

14) CHEMISTRY – *Short Answer* — Identify all of the following 3 compounds that are NOT network solids. 1) glucose, 2) silicon dioxide, 3) silicon carbide

ANSWER: 1 ONLY

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<sup>1</sup> Answer choice “Y” would have been accepted if on the basis of fusion occurring.



## TOSS-UP

15) ENERGY – *Multiple Choice*—Scientists at Stanford’s Kavli Institute for Particle Astrophysics and Cosmology are studying pulsars. Pulsars are rotating forms of which of the following classes of stellar objects?

- W) White dwarfs
- X) Red giants
- Y) Neutron stars
- Z) Black holes

ANSWER: Y) NEUTRON STAR

## BONUS

15) ENERGY – *Multiple Choice*—Neutron stars can form from stars of solar masses larger than which of the following limits, representing the maximum mass of a white dwarf?

- W) Roche limit
- X) Hill radius
- Y) Chandrasekhar limit
- Z) Tolman-Oppenheimer Volkoff limit

ANSWER: Y) CHANDRASEKHAR LIMIT

### **TOSS-UP**

16) EARTH AND SPACE – *Short Answer*—A tree with a curved trunk is noticed on a steep slope. This can be explained by the fact that the soil mass on the slope is pulled down at an imperceptibly slow rate by the force of gravity. What is the term given to those slow, downslope movements of soil materials?

ANSWER: CREEP

### **BONUS**

16) EARTH AND SPACE – *Short Answer*—What element is often used as an identifier of meteor impacts, such as that which is thought to have caused the K-Pg extinction?

ANSWER: IRIDIUM

### TOSS-UP

17) MATH – *Short Answer*—In triangle ABC, angle B is a right angle, and sides AB and AC are 9 and 41, respectively. What is the length of the altitude from B to side AC?

ANSWER: 360/41

### BONUS

17) MATH – *Short Answer*—What is the area of a parallelogram with side lengths 4 and 8 and an interior angle of 60 degrees?

ANSWER:  $16\sqrt{3}$



### TOSS-UP

18) BIOLOGY – *Multiple Choice*—The distinctive orange and black patterns of the poisonous viceroy butterflies are similar to the orange and black patterns of the poisonous monarch butterflies. This is a classic example of which of the following types of mimicry?

- W) Automimicry
- X) Aggressive
- Y) Batesian
- Z) Müllerian

ANSWER: Z) MÜLLERIAN

### BONUS

18) BIOLOGY – *Short Answer*—By name or number, identify all of the following four things that would be observed in a population in Hardy-Weinberg equilibrium: 1) small population size, 2) no mutations, 3) random mating, 4) constant emigration and immigration

ANSWER: 2 AND 3

### TOSS-UP

19) EARTH AND SPACE – *Multiple Choice*—Passive margins are characterized by a lack of tectonic activities, and characterize a good portion of the world's coasts. Which of the following is a passive margin?

- W) Southern coast of Sumatra and Java
- X) Southern coast of Alaska
- Y) Coast of California
- Z) West coast of Africa

ANSWER: Z) WEST COAST OF AFRICA

### BONUS

19) EARTH AND SPACE – *Short Answer*—By name or number, rank the following three supercontinents from earliest to latest in formation: 1) Pangaea, 2) Gondwanaland, 3) Rodinia

ANSWER: 3, 1, 2

### TOSS-UP

20) PHYSICS – *Short Answer*—Which thermodynamic property represents the maximum useful work obtainable from a system under constant temperature and pressure conditions?

ANSWER: HELMHOLTZ FREE ENERGY

### BONUS

20) PHYSICS – *Short Answer*—In kilograms per meter squared, what is the moment of inertia of a uniform solid sphere with mass 1 kg and radius 50 cm?

ANSWER: 0.1