

ROUND 3

TOSS-UP

1) Earth and Space – *Multiple Choice* What is the name of the mass wasting event where a mass of rock or material moves along a curved surface?

- W) Lahar
- X) Earthflow
- Y) Creep
- Z) Slump

ANSWER: Z) SLUMP [SP]

BONUS

1) Earth and Space – *Short Answer* What drainage pattern would form on a volcano?

ANSWER: RADIAL [SP]

TOSS-UP

2) Physics – *Short Answer* Identify all of the following particles emitted from the nucleus during beta minus decay: 1) Electron 2) Neutron 3) Neutrino 4) Antineutrino

ANSWER: Electron and Antineutrino, 1 and 4

BONUS

2) Physics – *Short Answer* A bodybuilder is performing 20 repetitions of raising a 5 kilogram dumbbell up and down a height of 1 meter. After the 20 repetitions, what is the total work done on the dumbbell?

ANSWER: X) 0, 0 Joules

TOSS-UP

3) Chemistry – *Multiple Choice* Molality is expressed as the moles of solute divided by what quantity

- W) kilograms of solution

- X) liters of solution
- Y) kilograms of solvent
- Z) liters of solvent

Answer: Y) kilograms of solvent

BONUS

3) Chemistry -- *Multiple Choice* Why is molality an important measure of concentration in chemistry?

- W) It is solute independent
- X) It is solvent independent
- Y) It is pressure independent
- Z) It is temperature independent

Answer: Z) It is temperature independent

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**TOSS-UP**

4) Math – *Multiple Choice* A particle's position can be defined by the equation x of t equals 4 times t cubed minus 3 times t squared plus 2 times t minus 1 meter, where t is in seconds. At t equals 4 seconds, what is the acceleration of the particle in meters per second squared?

- W) 80
- X) 90
- Y) 100
- Z) 120

ANSWER: X) 90

**BONUS**

4) Math – *Short Answer* How many distinct ordered pairs of integers  $x$  and  $y$  satisfy 1 over x plus 1 over y equals 1 over 2?

ANSWER: 5

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TOSS-UP

5) Biology – *Multiple Choice* Which of the following biological structures are mismatched to their function?

- W) Flagella - whiplike motion for motility
- X) Cilia - rowing motion for motility
- Y) Fimbriae - pulls egg into oviduct
- Z) Pili - transduction of ovum

ANSWER: Z) Pili - transduction of ovum

BONUS

5) Biology – *Multiple Choice* Which of the following utilize oxygen as part of their metabolism when it is available but are also capable of living anaerobically?

- W) Microaerophiles
- X) Facultative aerobes
- Y) Aerotolerant anaerobes
- Z) Facultative anaerobes

ANSWER: Z) FACULTATIVE ANAEROBES

TOSS-UP

6) Physics – *Short Answer* What is the total work done by a jack that raises one side of a 400-kilogram box by 25 centimeters, rounded to the nearest ten Joules?

ANSWER: 980, 980 J

BONUS

6) Physics – *Short Answer* A large, heavy, rigid sail is still in space. An asteroid with a mass of 20 kg and speed 15 m/s collides into it and bounces back off with the same speed. What is the momentum of the sail after the collision, in Newton seconds?

ANSWER: 600, 600 Newton seconds

TOSS-UP

7) Biology – *Multiple Choice* Which of the following structures are NOT homologous to the other mentioned structures?

- W) Fins of a cetacean
- X) Arms of a hominid
- Y) Wings of a gliding squirrel
- Z) Tentacles of an cnidarian

ANSWER: Z) TENTACLES OF AN cnidarian

BONUS

7) Biology – *Multiple Choice* Which of the following excretory structures is mismatched to the organism within which they are present?

- W) Flame cells - freshwater flatworm
- X) Malpighian Tubules - black widow
- Y) Nephridia - earthworms
- Z) Antennal gland - grass shrimp

X) MALPIGHIAN TUBULES - BLACK WIDOW

TOSS-UP

8) Math – *Multiple Choice* A continuous function f passes through points 2 comma 8 and 6 comma 10. Which of the following points can f pass through, by the Intermediate Value Theorem:

- W) 3 comma 6
- X) 6 comma 7
- Y) 7 comma 9
- Z) 3 comma 9

ANSWER: Z) 3 comma 9

BONUS

8) Math – *Multiple Choice* What shape is described by the equation x squared plus y squared plus 2 times x times y equals 4?

- W) Parabola
- X) Ellipse

- Y) Hyperbola
- Z) Parallel lines

ANSWER: Z) Parallel lines

TOSS-UP

9) Earth and Space – *Multiple Choice* Which of the following is a term for a gaping crack in a glacier formed when it moves over irregular terrain

- W) Zone of Fracture
- X) Crevass
- Y) Fjord
- Z) Glacial Trough

ANSWER: X) CREVASSE [SP]

BONUS

9) Earth and Space – *Short Answer* The Hawaiian Islands are well known for being formed by volcanoes. What type of volcanoes are the Hawaiian Islands composed of?

ANSWER: SHIELD [SP]

TOSS-UP

10) Chemistry – *Short Answer* What are the units of a rate constant of a second-order reaction?

ANSWER: $1/(M^*s)$ (read as: 1 over molar seconds, or inverse molar times inverse seconds, etc)
(Accept: Hz/M or any other equivalent unit)

BONUS

10) Chemistry -- *Short Answer* What is the term for the stage of a reaction with the highest free energy?

Answer: Rate-determining Step

TOSS-UP

11) Biology – *Short Answer* Which of the following would be higher in eukaryotic organisms than bacterial organisms in respect to their genomes?

- 1) Genome size in mega-base pairs
- 2) Gene density
- 3) Number of genes
- 4) Noncoding DNA

ANSWER: 1, 3, AND 4

BONUS

11) Biology – *Short Answer* Under which phylum are platypuses classified, ~~and which phylum is most closely related to this phylum?~~

ANSWER: CHORDATA, ~~HEMICORDATA~~

TOSS-UP

12) Chemistry – *Short Answer* How many rotational degrees of freedom does a molecule of carbon dioxide have?

Answer: 2

12) Chemistry -- *Short Answer* What is the maximum number of vibrational degrees of freedom a nonlinear molecule with 3 atoms have?

Answer: 3

TOSS-UP

13) Math – *Short Answer* Among the 30 students in the AP Physics 2 class at Dulles, 6 students are also taking AP Physics C and 18 are also taking AP Chemistry. Among these 30 students, what is the maximum number of students potentially taking only one of the three courses mentioned?

ANSWER: 12

BONUS

13) Math – *Short Answer* Two spheres of radii [ray – dee – ai] 6 and 12 are externally tangent. The two common externally tangent planes to these spheres intersect at a line. What is the closest distance from a point on this line to a point on the sphere of radius 6?

ANSWER: 12

TOSS-UP

14) Physics – *Multiple Choice* Polarizing filters are used by photographers to eliminate glare. What fraction of the intensity of unpolarized light remains after passing through a linear polarizer?

- W) One quarter
- X) One half
- Y) Three quarters
- Z) One

ANSWER: X) One half

BONUS

14) Physics – *Short Answer* Identify all of the following that a photon lacks: 1) Energy, 2) Momentum, 3) Mass

ANSWER: 3 Only

TOSS-UP

15) Earth and Space – *Short Answer* What is the name of the formation where multiple supernova remnants merge. This formation eventually leads to the formation of a galactic fountain.

ANSWER: SUPERBUBBLE [SP]

BONUS

15) Earth and Space – *Multiple Choice* The Crab Nebula has a characteristic hazy glow in its center caused by high-speed electrons spiraling through an electric field and is known as which of the following?

- W) Synchrotron Radiation
- X) Cyclotron Radiation
- Y) Cherenkov Radiation
- Z) Gamma Radiation

ANSWER: W) SYNCHROTRON RADIATION [SP]

TOSS-UP

16) Chemistry – *Short Answer* What is the hybridization of xenon tetrafluoride?

Answer: sp₃d₂ (accept: d₂ sp₃)

BONUS

16) Chemistry -- *Short Answer* Because of xenon tetrafluoride's low volatility compared to xenon difluoride and xenon hexafluoride, it can be purified using what technique?

Answer: Fractional sublimation

TOSS-UP

17) Math – *Short Answer* Alice and Bob play a game in which they each roll a standard six-sided die and compute the absolute value of their difference. If the obtained value is positive, then they get a point and otherwise they lose a point. After 6 rolls each, what is the expected number of points that they would have?

ANSWER: 4

BONUS

17) Math – *Short Answer* What is the sum of the squares of the roots of the polynomial x squared minus 2022 times x plus 242?

ANSWER: 4,088,000

TOSS-UP

18) Physics – *Multiple Choice* Room A is filled with helium gas, He. Room B is identical to Room A; however, it is filled with methane gas, CH₄. Under the same conditions, what is the approximate ratio of the speed of sound in Room A to that in Room B?

- W) 0.5
- X) 1.7
- Y) 2.2
- Z) 7.9

ANSWER: Y) 2.2

BONUS

18) Physics – *Multiple Choice* The intensity from a point source of light is proportional to the distance raised to what power?

- W) 1
- X) 2
- Y) -1
- Z) -2

ANSWER: Z) -2



TOSS-UP

19) Earth and Space – *Short Answer* Which of the Galilean moons has the youngest surface characterized by a lack of impact craters?

ANSWER: IO [SP]

BONUS

19) Earth and Space – *Multiple Choice* About what percentage of galaxies contain active galactic nuclei?

- W) 0.1%
- X) 1%
- Y) 10%
- Z) 50%

ANSWER: X) 1% [SP]

TOSS-UP

20) Biology – *Short Answer* In a human sarcomere, which filaments would you find in the H band?

ANSWER: THICK FILAMENTS (ACCEPT: MYOSIN)

BONUS

20) Biology – *Short Answer* Which of the following orders of *Insecta* undergo incomplete metamorphosis?

- 1) Coleoptera
- 2) Lepidoptera
- 3) Orthoptera
- 4) Hymenoptera

ANSWER: 3 ONLY (ORTHOPTERA)
