

Round 1

1. PHYSICS

Toss Up: Multiple Choice

A body at rest in a system is capable of doing work if:

- W) the potential energy of the system is positive
- X) it is free to move in such a way as to decrease the potential energy of the system
- Y) it is free to move in such a way as to increase the potential energy of the system
- Z) it is free to move in such a way as to decrease its kinetic energy

Toss Up Answer: X

Bonus: Short Answer

If the force of a non-linear spring is defined as $F(x) = 3x^2 + 2x + 5$, what is the work done on the spring if it's stretched to 3 meters from equilibrium?

Bonus Answer: 51 J

2. PHYSICS

Toss Up: Short Answer

It is known that 28 g of a certain ideal gas occupy 22.4 liters at standard conditions. The volume occupied by 42 g of this gas at standard conditions is:

Bonus Answer: 33.6 liters

Bonus: Multiple Choice

Use $R = 8.2 \times 10^{-5} \text{ m}^3 \cdot \text{atm/mol} \cdot \text{K}$ and $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$. The approximate number of air molecules in a 1 m^3 volume at 300K and atmospheric pressure is:

- W) 41
- X) 450
- Y) 2.5×10^{25}
- Z) 5.4×10^{26}

Bonus Answer: Y

3. PHYSICS

Toss Up: Short Answer

A parallel circuit has two resistors, one with a resistance of 4 ohms, and the other of 8 ohms. What is the equivalent resistance of the circuit? State the answer as a fraction.

Bonus Answer: 8/3 ohms

Bonus: Short Answer

What is the equivalent capacitance of a parallel circuit with capacitors of 8 micro-Farads, 12 micro-Farads, and 15 micro-Farads?

Bonus Answer: 35 micro-Farads

4. PHYSICS

Toss Up: Short Answer

In a well-known physical experiment, two small masses were suspended by a thread, each positioned near two much larger stationary masses. A mirror was used to measure the angle through which the thread twists due to the rotation of the small masses' movement. Which physicist conducted this experiment, and what constant did he/she derive from it?

Bonus Answer: Henry Cavendish (accept "Cavendish") and Universal gravitational constant (accept "big G", don't accept "gravity" or just "g")

Bonus: Short Answer

A skydiver leaps from a plane at a high altitude. Given acceleration due to gravity is equal to 10 meters per second squared and it takes 45 seconds for the skydiver to fall, calculate the height at which the skydiver fell from, rounded to the nearest thousand meters.

Bonus Answer: 20000 [Calculation: $x = a * t^2 = (10 \text{ m/s}^2)(45\text{s})^2 = 20250\text{m} \rightarrow \text{rounded to } 20000$]

5. MATHEMATICS**Toss Up: Multiple Choice**

Which of these numbers are transcendental?

- W) i
- X) root 2
- Y) e to the pi i
- Z) pi

Toss Up Answer: Z

Bonus: Short Answer

What conic section does this equation create? $25x^2 - 150x - 16y^2 - 128y + 481 = 0$

Bonus Answer: Two intersecting lines/ a degenerate hyperbola

6. MATHEMATICS**Toss Up: Multiple Choice**

What is the limit as x approaches 0 of x times ln x?

- W) -1
- X) 1
- Y) 0
- Z) The limit does not exist.

Toss Up Answer: Y

Bonus: Short Answer

What is the derivative of $\text{arcsec } x$?

Bonus Answer: $1/(x((x^2)-1)^{.5})$

7. MATHEMATICS**Toss Up: Short Answer**

What is the length of the longest diagonal of a unit cube?

Bonus Answer: root3

Bonus: Short Answer

What is the largest integer that cant be written as the sum of 3's and 4's?

Bonus Answer: 5

8. MATHEMATICS**Toss Up: Short Answer**

You are trying to give 5 apples to 3 friends. You can give any number of apples to each friend, including 0. How many ways are there to share the apples?

Bonus Answer: 56 (its $8C3$)

Bonus: Multiple Choice

If a cubic function equals 0 at exactly two points, which of the following must be true?

- W) the function passes through the origin
- X) there is a double root
- Y) the function is even
- Z) one of the roots is imaginary

Bonus Answer: X

=====

9. BIOLOGY

Toss Up: Multiple Choice

Which of the following genetic diseases is not matched correctly with the type of inheritance it has?

- W) Hemophilia; X-linked recessive
- X) PKU; Autosomal dominant
- Y) Sickle cell anemia; Autosomal recessive
- Z) Rett Syndrome; X-linked dominant

Toss Up Answer: X

=====

Bonus: Short Answer

What are the names for the two processes that, respectively, inhibit and promote gene expression by regulating access to a chromosome?

Bonus Answer: Methylation; Acetylation (only accept this order)

=====

10. BIOLOGY

Toss Up: Multiple Choice

Which of the following proteins is involved in forming the cleavage furrow of a cell during cytokinesis?

- W) G-coupled proteins
- X) Keratin
- Y) Myosin
- Z) Tubulin

Toss Up Answer: Y

=====

Bonus: Short Answer

Name the method in which a new species develops due to a population separated from one another by geographical isolation.

Bonus Answer: Allopatric speciation (OR geographic speciation)

=====

11. BIOLOGY

Toss Up: Multiple Choice

Which of the following is a neurotransmitter important for the functioning of myofilaments?

- W) Dopamine
- X) Acetylcholine
- Y) Serotonin
- Z) Acetaminophen

Toss Up Answer: X

=====

Bonus: Multiple Choice

Which of the following is not a layer of the epidermis in thin skin?

- W) Stratum corneum
- X) Stratum lucidum
- Y) Stratum spinosum

Z) Stratum basale

Bonus Answer: X

=====

12. BIOLOGY

Toss Up: Multiple Choice

Which of the following is a ground tissue with thick secondary cells walls reinforced with lignin?

- W) Collenchyma
- X) Parenchyma
- Y) Cleochyma
- Z) Sclerenchyma

Toss Up Answer: Z

=====

Bonus: Short Answer

What anatomical structure is a projection of the cell membrane used for phagocytosis?

Bonus Answer: Pseudopods/pseudopodia

=====

13. BIOLOGY

Toss Up: Multiple Choice

What structure is present in cilia and flagella?

- W) 9+0
- X) 9+1
- Y) 9+2
- Z) 9+3

Toss Up Answer: Y

=====

Bonus: Short Answer

Dicots feature vascular bundles arranged in what formation within the stem?

Bonus Answer: Arranged in a ring.

=====

14. CHEMISTRY

Toss Up: Short Answer

What is the oxidation state of chlorine in perchloric acid?

Bonus Answer: +7

=====

Bonus: Short Answer

The formula for the combustion of methane is $\text{CH}_4 + 2\text{O}_2 \text{ yields } \text{CO}_2 + 2\text{H}_2\text{O}$. Given that the heat of formation of methane gas is -75 kilojoules per mole, the heat of formation of carbon dioxide is -400 kilojoules per mole, and the heat of formation of water is -300 kilojoules per mole, find the heat of combustion for methane.

Bonus Answer: 925kJ/mol

=====

15. CHEMISTRY

Toss Up: Multiple Choice

Which noble gas is the most reactive?

- W) Xenon
- X) Radon
- Y) Helium
- Z) Argon

Toss Up Answer: W

=====

Bonus: Short Answer

How many carbon atoms are in a single molecule of trinitrotolulene, or TNT?

Bonus Answer: 7

=====

16. CHEMISTRY

Toss Up: Short Answer

Which nitrogen hydride is the most stable?

Bonus Answer: ammonia

Bonus: Multiple Choice

Why isn't silicon a suitable candidate for life like carbon is?

- W) Silicon is too heavy
- X) Silicon atoms are too big to form pi bonds
- Y) Silicon is more reactive
- Z) Silicon is rarer in the earth's crust

Bonus Answer: X

=====

17. CHEMISTRY

Toss Up: Multiple Choice

Which of the following, when added to hydrofluoric acid, would decrease its acidity?

- W) sodium fluoride
- X) ammonium nitrate
- Y) acetic acid
- Z) sodium nitrate

Toss Up Answer: W

Bonus: Short Answer

What is the name of the type of relatively unstable bonding found in many electron deficient compounds, such as BeH_2 ?

Bonus Answer: three center bond

=====

18. CHEMISTRY

Toss Up: Multiple Choice

Which element has 10 stable isotopes, the highest of any element?

- W) Lead
- X) Xenon
- Y) Tin
- Z) Copper

Toss Up Answer: Y

Bonus: Short Answer

Name the compound that has a formula of C_{60} .

Bonus Answer: buckminsterfullerene (or buckyballs)

=====

19. CHEMISTRY

Toss Up: Short Answer

In 1774, Joseph Priestly isolated what element by heating a powdered mercury compound?

Bonus Answer: Oxygen

Bonus: Multiple Choice

Which of these is the strongest electrolyte

- W) HNO₂
- X) (NH₂)₂CO
- Y) C₂H₅OH
- Z) NH₄

Bonus Answer: W

=====

20. EARTH and SPACE

Toss Up: Short Answer

What paradox asks why we haven't found extraterrestrial life yet?

Bonus Answer: Fermi Paradox

=====

Bonus: Short Answer

If a star is said to be 1.4 times more massive than the Sun, respectively, what threshold is it said to have passed, and what will it become in the future?

Bonus Answer: 1) Chandrasekhar limit, 2) supernova

=====

21. EARTH and SPACE

Toss Up: Short Answer

As of 2016, what is the innermost planet that has an orbital period longer than the average lifespan?

Bonus Answer: Uranus

=====

Bonus: Multiple Choice

What percentage of the total mass of the planets do Jupiter and Saturn make up?

- W) 50
- X) 75
- Y) 90
- Z) 95

Bonus Answer: Y

=====

22. EARTH and SPACE

Toss Up: Multiple Choice

When a star undergoes helium flash, it fuses helium into which of the following elements?

- W) Lithium
- X) Beryllium
- Y) Oxygen
- Z) Carbon

Toss Up Answer: Z

=====

Bonus: Short Answer

Order the following 4 elements in most to least abundant in the solar system: 1. Carbon, 2. Hydrogen, 3. Oxygen, 4. Helium

Bonus Answer: 2 (Hydrogen), 4(Helium), 3(Oxygen), 1(Carbon)

=====

23. EARTH and SPACE

Toss Up: Multiple Choice

Which radioactive isotope is most useful for determining the age of mastodont bones found in late Pleistocene

sediments?

W) U-238

X) C-14

Y) K-40

Z) Rb-87

Toss Up Answer: X

Bonus: Multiple Choice

The absolute age of a rock is the approximate number of years ago that the rock formed. The absolute age of an igneous rock can best be determined by

W) comparing the amounts of decayed and undecayed radioactive isotopes in the rock

X) comparing the sizes of the crystals found in the upper and lower parts of the rock

Y) examining the rock's relative position in a rock outcrop

Z) examining the environment in which the rock is found

Bonus Answer: W

24. EARTH and SPACE

Toss Up: Multiple Choice

Which of the following models of the Moon's origin is currently considered most likely?

W) The Moon was spun off by a rapidly spinning, molten Earth.

X) The Moon was a passing body that was captured by Earth's gravity.

Y) The Moon formed in place at the same time that Earth formed.

Z) The Moon was ejected from a molten Earth by a giant impact.

Toss Up Answer: Z

Bonus: Multiple Choice

In which parts of Earth's interior would melted or partially melted material be found?

W) stiffer mantle and inner core

X) stiffer mantle and outer core

Y) crust and inner core

Z) asthenosphere and outer core

Bonus Answer: Z

25. ENERGY

Toss Up: Multiple Choice

Which of the following is closest to the percentage of US electricity generated from natural gas in 2014?

W) 5%

X) 15%

Y) 25%

Z) 40%

Toss Up Answer: Y

Bonus: Multiple Choice

Which of these states contain the largest natural gas field in the US?

W) Pennsylvania

X) Texas

Y) Louisiana

Z) Colorado

Bonus Answer: W

=====