

Round 3

1. PHYSICS

Toss Up: Short Answer

A toy train moves in a circle of 8 meters radius with a speed of 4 meters per second. What is the magnitude of the acceleration of the train?

Bonus Answer: 2 meters per second²

Bonus: Short Answer

A certain machine exerts a force of 200 newtons on a box whose mass is 30 kilograms. The machine moves the box a distance of 20 meters along a horizontal floor. What amount of work does the machine do on the box?

Bonus Answer: 4000 J (joules)

2. PHYSICS

Toss Up: Short Answer

A ball leaves a girl's hand with an upward velocity of 6 meters per second. What is the maximum height of the ball above the girl's hand?

Bonus Answer: 1.8 meters

Bonus: Short Answer

A boy throws a ball vertically upward with a velocity of 6 meters per second. How long does it take the ball to return to the boy's hand?

Bonus Answer: 1.22 seconds

3. PHYSICS

Toss Up: Multiple Choice

For an object moving in uniform circular motion, the direction of the instantaneous acceleration vector is:

- W) tangent to the path of motion
- X) equal to zero
- Y) directed radially outward
- Z) directed radially inward

Toss Up Answer: Z

Bonus: Multiple Choice

A Newton is equal to which of the following?

- W) kilogram-meter per second
- X) meter per second squared
- Y) kilogram-meter per second
- Z)) kilogram per meter-second

Bonus Answer: Y

4. PHYSICS

Toss Up: Multiple Choice

A pendulum which is suspended from the ceiling of a railroad car is observed to hang at an angle of 10 degrees to the right of vertical. Which of the following answers could explain this phenomena?

- W) The railroad car is at rest

- X) The railroad car is accelerating to the left.
Y) The railroad car is accelerating to the right.
Z) Huh?

Toss Up Answer: X

Bonus: Multiple Choice

Two forces have magnitudes of 11 newtons and 5 newtons. The magnitude of their sum could NOT be equal to which of the following values?

- W) 16
X) 5
Y) 9
Z) 7

Bonus Answer: X

5. PHYSICS

Toss Up: Multiple Choice

The work done by a friction force is

- W) always -
X) always 0
Y) either positive or negative depending upon the situation.
Z) always +

Toss Up Answer: W

Bonus: Multiple Choice

: As defined in physics, work is:

- W) scalar quantity
X) always a positive quantity
Y) a vector quantity
Z) always 0

Bonus Answer: W

6. MATHEMATICS

Toss Up: Short Answer

What type of number is defined as a number that is not a root of a polynomial with rational coefficients?

Bonus Answer: Transcendental numbers

Bonus: Short Answer

Of the following, which of these numbers are transcendental? π , e , i , ϕ , $e \times i$, $2^{\sqrt{2}}$

Bonus Answer: π , e , $e \times i$, $2^{\sqrt{2}}$

7. MATHEMATICS

Toss Up: Short Answer

The surface area of a sphere is how many times the area of a circle?

Bonus Answer: 4

Bonus: Short Answer

What is the area of a cone?

Bonus Answer: $(\pi)r^2h$

=====

8. MATHEMATICS

Toss Up: Multiple Choice

A statement about a relationship between natural quantities. The statement has been tested many times, and has not been contradicted. What is it?

- W) Fact
- X) Hypothesis
- Y) Law
- Z) Theory

Toss Up Answer: Y

=====

Bonus: Multiple Choice

A framework that includes many well-tested and verified hypotheses about one or more aspects of the natural world.

- W) Fact
- X) Hypothesis
- Y) Law
- Z) Theory

Bonus Answer: Z

=====

9. MATHEMATICS

Toss Up: Short Answer

What is the name for the rule that states that when you have a limit of indeterminate form as a fraction, it is equal to the limit of the derivative of the numerator over the derivative of the denominator?

Bonus Answer: L'hospital's rule

=====

Bonus: Short Answer

What famous function, named after a mathematician, takes the infinite sum of the reciprocals of the natural numbers raised to an argument?

Bonus Answer: Riemann zeta function

=====

10. BIOLOGY

Toss Up: Multiple Choice

A trend toward the decrease in the size of plants on the slopes of mountains as altitudes increase is an example of

- W) a cline
- X) a bottleneck
- Y) relative fitness
- Z) geographic variation

Toss Up Answer: W

=====

Bonus: Short Answer

If thermoregulation is considered to be a secondary function of the large ears of jackrabbits, then the primary function of the ears is

Bonus Answer: to detect predators

=====

11. BIOLOGY

Toss Up: Multiple Choice

What structure in plant cells is similar to gap junctions in animal cells?

- W) Cell wall
- X) Central Vacuole
- Y) Plasmodesmata
- Z) Thylakoid

Toss Up Answer: Y

Bonus: Multiple Choice

If, on average, 46% of the loci in a species' gene pool are heterozygous, then the average homozygosity of the species should be

- W) 23%
- X) 46%
- Y) 54%
- Z) There is not enough information to say.

Bonus Answer: Y

12. BIOLOGY

Toss Up: Short Answer

The enzyme catalase is associated with which cell organelle?

Bonus Answer: Peroxisome

Bonus: Short Answer

What dangerous product of fatty acid oxidation does catalase act on?

Bonus Answer: Hydrogen peroxide

13. BIOLOGY

Toss Up: Multiple Choice

Which is not a part of the nucleus?

- W) nuclear envelope
- X) nucleolus
- Y) chromatin
- Z) plasmodesmata

Toss Up Answer: Z

Bonus: Multiple Choice

Which is not a part of the cytoskeleton?

- W) microfilaments
- X) intermediate filaments
- Y) microtubules
- Z) gap junctions

Bonus Answer: Z

14. BIOLOGY

Toss Up: Multiple Choice

What is a technique for studying cell membrane structure and function?

W) cell fractionation

X) freeze fracture

Y) cell centrifugation

Z) inserting radioactive substances

Toss Up Answer: X

Bonus: Short Answer

Which type of microscope is useful for studying the internal structure of cells?

Bonus Answer: transmission electron microscope

15. BIOLOGY

Toss Up: Short Answer

What hormone regulates sleep cycles?

Bonus Answer: Melatonin

Bonus: Short Answer

What blood type is considered the universal donor?

Bonus Answer: O-, O-neg, O-negative

16. BIOLOGY

Toss Up: Short Answer

What is the material that makes up part of your nose and ears?

Bonus Answer: Cartilage

Bonus: Short Answer

How does one acquire an infection of the ear?

Bonus Answer: By a virus or bacteria

17. CHEMISTRY

Toss Up: Short Answer

What is the chemical formula of tetraphosphorus decaoxide?

Bonus Answer: P₄O₁₀

Bonus: Short Answer

What is the bond order of the central atom in CO₃⁽⁻²⁾?

Bonus Answer: 4/3 (accept: 1 1/3)

18. CHEMISTRY

Toss Up: Short Answer

In a rate law, what are the units of k when the order is 1?

Bonus Answer: s⁻¹

Bonus: Short Answer

In a rate law, what are the units of k when the order is 5?

Bonus Answer: L⁴ mol⁻⁴ s⁻¹

19. CHEMISTRY

Toss Up: Multiple Choice

Which of the following statements is NOT true for the element of sodium?

- W) It has an oxidation state of +1
- X) It forms a basic solution with water
- Y) It gives off a bright red color when burned
- Z) It reacts with a halogen to form a salt

Toss Up Answer: Y

Bonus: Short Answer

Which of the following are products made from the reaction $\text{H}_2\text{SO}_4(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow ?$ I) $\text{O}_2(\text{g})$ II) $\text{H}_2\text{O}(\text{l})$ III) $\text{BaSO}_4(\text{s})$

Bonus Answer: II and III

20. CHEMISTRY

Toss Up: Multiple Choice

Which of the following can be precisely determined for a chemical substance?

- W) Entropy
- X) Enthalpy
- Y) Free Energy
- Z) All of the Above

Toss Up Answer: W

Bonus: Short Answer

In a rate law, what are the units of k when the order is 3?

Bonus Answer: $\text{L}^2 \text{mol}^{-2} \text{s}^{-1}$

21. CHEMISTRY

Toss Up: Multiple Choice

The evaporation of any liquid is expected to have

- W) a positive ΔH and a negative ΔS
- X) a negative ΔH and a negative ΔS
- Y) a positive ΔH and a positive ΔS
- Z) a positive ΔH and a negative ΔS

Toss Up Answer: Y

Bonus: Multiple Choice

The rate of reaction will be large if

- W) ΔG is a large negative number
- X) ΔS is a large negative number
- Y) ΔH is a large negative number
- Z) None of the above

Bonus Answer: Z

22. CHEMISTRY

Toss Up: Multiple Choice

Which of these gases is expected to condense at the lowest pressure, assuming that the temperature is constant?

- W) Bromomethane
- X) Dibromomethane
- Y) Tetrabromomethane
- Z) They all condense at the same temperature

Toss Up Answer: Y

Bonus: Short Answer

Which attractive force is the major cause of condensation?

Bonus Answer: London Dispersion Forces (accept: London Forces)

23. EARTH and SPACE

Toss Up: Short Answer

If we could observe all forms of radiation, what would the brightest star be?

Bonus Answer: Betelgeuse

Bonus: Multiple Choice

In 12000 years, which star will take the place of our North Star?

W) Aldebaran

X) Vega

Y) Sirius

Z) Rigel

Bonus Answer: X

24. EARTH and SPACE

Toss Up: Short Answer

What phenomena best explains why the sky is blue?

Bonus Answer: Rayleigh Scattering

Bonus: Short Answer

What are the high intensity spots of light at the horizontal points of the 22 degree halo that may form around the sun due to ice crystals in the air called?

Bonus Answer: Parhelia (ALSO ACCEPT: Sun Dogs, Parhelion)

25. EARTH and SPACE

Toss Up: Short Answer

What physical quantity is the Schwarzschild radius of a Black Hole most dependent on?

Bonus Answer: Mass

Bonus: Multiple Choice

If the event horizon of a black hole is 10 km, then what is the radius of its photon sphere?

W) 10km

X) 15km

Y) 20km

Z) 25km

Bonus Answer: X
