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1. Physics

Toss Up: Short Answer

A 40 kilogram girl climbs a vertical distance of 5 meters in twenty seconds at a constant velocity. How much work has the girl done?

Toss Up Answer: 2000 joules / 1960 joules (accept either)

Bonus: Short Answer

A machine performs 8 Joules of work in 2 seconds. How much power is delivered by this machine?

Bonus Answer: 4 Watts

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2. Mathematics

Toss Up: Short Answer

What is the name of the principle that states that 5 avocados cannot be placed in 4 holes without 2 of them being placed in the same one?

Toss Up Answer: Pigeonhole Principle

Bonus: Short Answer

In triangle ABC with integer side lengths, $AB = 7$, $BC = 14$, and $AC < 9$. Find AC.

Bonus Answer: 8 (Triangle Inequality)

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3. Physics

Toss Up: Short Answer

A car accelerates from rest at 4 (m/s)^2 . What is the distance traveled by the car in 3 seconds?

Toss Up Answer: 18 meters (m)

Bonus: Multiple Choice

A motor scooter travels east at a speed of 13 m/s. The driver then reverses direction and heads west at 17 m/s. What was the change in velocity of the scooter?

W) 13 m/s

X) 17 m/s

Y) 30 m/s

Z) 4 m/s

Bonus Answer: Y

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4. Chemistry

Toss Up: Multiple Choice

Which is the strongest type of intermolecular force?

W) Hydrogen bonding

X) Dipole-dipole

Y) Van der Waals

Z) Metallic bonding

Toss Up Answer: W

Bonus: Short Answer

By name or number, which of the following elements can form hydrogen bonds?

Oxygen, Chlorine, Fluorine, Nitrogen, Sulfur

Bonus Answer: Oxygen, Fluorine, Nitrogen or (1, 3, and 4)

5. Earth and Space Science

Toss Up: Multiple Choice

Which of the following are sheet silicates?

W) Micas and clay minerals

X) pyroxenees and amphiboles

Y) olivine and feldspar

Z) staurolite and quartz

Toss Up Answer: W

Bonus: Multiple Choice

The most common intermediate volcanic rock is

W) Andesite

X) Basalt

Y) Rhyolite

Z) Diorite

Bonus Answer: W

6. Mathematics

Toss Up: Short Answer

Find the derivative of: $4x^3 + 18x + 2$

Toss Up Answer: $8x^2 + 18$

Bonus: Short Answer

At what point is the slope of the tangent line to the parabola $y = 3x^2 + 5x + 23$ equal to 0?

Bonus Answer: $(-5/6, 251/12)$

7. Earth and Space Science

Toss Up: Short Answer

Name the layers of the atmosphere, from lowest to highest altitude.

Toss Up Answer: Troposphere, Stratosphere, Mesosphere, Thermosphere

Bonus: Short Answer

Through what city does the prime meridian run through?

Bonus Answer: Greenwich, England (accept: Greenwich)

8. Chemistry

Toss Up: Short Answer

During glycolysis, electrons removed from glucose are passed to

Toss Up Answer: NAD⁺

Bonus: Multiple Choice

A biological redox reaction always involves

- W) an ester
- X) an alcohol
- Y) a reducing agent
- Z) a soap

Bonus Answer: Y

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9. Biology

Toss Up: Short Answer

Nitrogen fixation refers to the direct conversion of atmospheric nitrogen gas into:

Toss Up Answer: ammonia (ACCEPT: NH₃, ammonium, NH₄⁺)

Bonus: Short Answer

The transformation of nitrates to gaseous nitrogen is accomplished by microorganisms in a series of biochemical reactions. The process is known as:

Bonus Answer: denitrification

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10. Earth and Space Science

Toss Up: Short Answer

A time difference of 5 hours separates London and New York City. What is the longitude of New York City?

Toss Up Answer: 75 degrees west (accept 74 if they actually know that by heart)

Bonus: Short Answer

Any location north of the equator has latitude equal to the angle what star makes above the horizon at said location?

Bonus Answer: Polaris (accept: The North Star)

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11. Chemistry

Toss Up: Multiple Choice

A precipitation reaction is an example of which of the following reactions?

- W) Combustion
- X) Substitution
- Y) Single Displacement
- Z) Double Displacement

Toss Up Answer: Z

Bonus: Short Answer

By name or number, which of the following would be a precipitate in aqueous solution?

1. Silver sulfide
2. Potassium nitrate
3. Strontium hydroxide
4. Lead(II) fluoride

Bonus Answer: Silver sulfide, Lead(II) fluoride OR (1, 4 only)

12. Physics

Toss Up: Multiple Choice

A force F of strength 20 N acts on an object of mass 3 kg as it moves a distance of 4 m. If F is perpendicular to the 4 m displacement, the work it does is equal to

- W) 0 J
- X) 60 J
- Y) 80 J
- Z) 600 J

Toss Up Answer: W

Bonus: Short Answer

Under the influence of a force, an object of mass 4 kg accelerates from 3 m/s to 6 m/s in 8 s. How much work was done on the object during this time?

Bonus Answer: 54 J

13. Chemistry

Toss Up: Short Answer

What is the chemical formula of tetraphosphorus decaoxide?

Toss Up Answer: P_4O_{10}

Bonus: Short Answer

What is the bond order of the central atom in CO_3^{2-} ?

Bonus Answer: $4/3$ (accept: $1\frac{1}{3}$)

14. Biology

Toss Up: Multiple Choice

Bottom-heavy age structure diagrams are characteristic of populations in:

- W) Developed countries
- X) Developing countries
- Y) Stable populations
- Z) Populations with high numbers of elderly

Toss Up Answer: X

Bonus: Short Answer

What is the expression for doubling time of a population given that it grows at constant annual rate of $r\%$?

Bonus Answer: $70/r$

15. Physics

Toss Up: Short Answer

A Tesla is an SI derived unit that can be expressed as $kg^a \cdot C^b \cdot s^c$. What are the values of a , b and c ?

Toss Up Answer: 1, -1, -1

Bonus: Short Answer

A positron moves through a region in which the electric field is uniform in the x-direction and the magnetic field is uniform in the y-direction. What is the direction of the terminal velocity of the positron?

Bonus Answer: Positive z direction

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16. Mathematics

Toss Up: Short Answer

On a blueprint, if $\frac{3}{4}$ of an inch represents 1 foot, then 2 inches will represent what distance, in feet, expressed as the most reduced simple fraction?

Toss Up Answer: $\frac{8}{3}$

Bonus: Short Answer

Assuming that the probability of A is 0.3, the probability of B is 0.3, and the probability of A union B is 0.5, providing your answer as decimals to the nearest 10th, what are the probabilities respectively of A intersection B and the complement of the quantity A union B?

Bonus Answer: 0.1 and 0.5

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17. Biology

Toss Up: Short Answer

What is considered the most unifying concept in biology?

Toss Up Answer: Evolution

Bonus: Multiple Choice

You capture a Pikachu and make it hold a Light Ball. You breed this Pikachu and the resulting Pokemon inherits the move Volt Tackle. This phenomenon of inheriting traits due to the actions of individuals or acquired traits reflects what theory?

W) Darwinian Natural Selection

X) Lamarckian Inheritance

Y) Oak-azaki Fragments

Z) Parental Mimicry

Bonus Answer: X

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18. Earth and Space Science

Toss Up: Multiple Choice

Which of the following minerals has the highest number on the Mohs hardness scale?

W) Apatite

X) Fluorite

Y) Quartz

Z) Orthoclase

Toss Up Answer: Y

Bonus: Short Answer

What are the three most abundant elements in Earth's crust?

Bonus Answer: Oxygen, Silicon, Aluminum

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19. Mathematics

Toss Up: Multiple Choice

Which of the following has the largest amplitude?

W) $9\sin(x) - 2$

X) $2\cos(6x) + 5$

Y) $\cos(2x)$

Z) $4\sin(10x)$

Toss Up Answer: W

Bonus: Short Answer

What power of 2 is closest to 255?

Bonus Answer: 8

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20. Biology

Toss Up: Multiple Choice

Animals and fungi are both characterized as heterotrophic. The distinguishing factor of animal heterotrophy from fungal heterotrophy is that only animals derive their nutrition by

W) consuming living, rather than dead, prey.

X) preying on animals

Y) ingesting it

Z) using enzymes for digestion

Toss Up Answer: Y

Bonus: Multiple Choice

At which developmental stage should one be able to first distinguish a diploblastic embryo from a triploblastic embryo?

W) fertilization

X) gastrulation

Y) coelom formation

Z) cleavage

Bonus Answer: X

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21. Physics

Toss Up: Short Answer

A Carnot heat engine operates between 400K and 500 K. What is its efficiency?

Toss Up Answer: 20%

Bonus: Multiple Choice

A Carnot heat engine and an irreversible heat engine both operate between the same high temperature and low temperature reservoirs. They absorb the same energy from the high temperature reservoir as heat. Which statement is true?

W) The irreversible engine does more work.

X) The Carnot engine transfers less energy to the low temperature reservoir as heat.

Y) The irreversible engine has the greater efficiency.

Z) The irreversible engine cannot absorb the same energy from the high temperature reservoir as heat without violating the second law of thermodynamics.

Bonus Answer: X

22. Mathematics

Toss Up: Multiple Choice

What is the derivative of the curve $y = x^3$ at the origin?

W) 0

X) 3

Y) 2

Z) $3/2$

Toss Up Answer: W

Bonus: Short Answer

Find dy/dx of $y = \sin^2 x$

Bonus Answer: $2 (\sin x) (\cos x)$

23. Biology

Toss Up: Short Answer

What is the name given to the jellylike substance filling the chamber behind the lens of the human eye?

Toss Up Answer: vitreous humor

Bonus: Short Answer

Name the clear watery liquid that surrounds the brain and spinal cord and fills the four cavities or ventricles of the brain.

Bonus Answer: Cerebrospinal Fluid

24. Chemistry

Toss Up: Multiple Choice

If the rate of a reaction decreases fourfold when the concentration of a reactant is halved, what is the order of the reaction with respect to that reactant?

W) zero order

X) first order

Y) second order

Z) third order

Toss Up Answer: Y

Bonus: Short Answer

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

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

25. Earth and Space Science

Toss Up: Multiple Choice

The metamorphic rock formed from limestone is:

W) quartzite

X) slate

Y) greenstone

Z) marble

Toss Up Answer: Z

Bonus: Multiple Choice

The direct impact of running water is called

W) bed load

X) meander cutoff

Y) base level

Z) hydraulic action

Bonus Answer: Z

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