

Round 1

1. PHYSICS

Writer: Stuyvesant

Toss Up: Multiple Choice

Radiocarbon is produced in the atmosphere as a result of?

W) collision between fast neutrons and nitrogen nuclei present in the atmosphere

X) action of ultraviolet light from the sun on atmospheric oxygen

Y) action of solar radiations particularly cosmic rays on carbon dioxide present in the atmosphere

Z) lightning discharge in atmosphere

Toss Up Answer: W

Bonus: Multiple Choice

What type of radiation is both the most penetrating and the most effectively stopped if blocked by a hydrogen-rich material?

W) Alpha

X) Beta

Y) Gamma

Z) Neutron

Bonus Answer: Z

2. PHYSICS

Writer: American Heritage

Toss Up: Multiple Choice

Which of Maxwell's laws implies that magnetic monopoles do not exist?

W) Gauss's Law for fields

X) Gauss's Law for magnetism

Y) Maxwell-Faraday equation

Z) Kirchoff's Voltage Laws

Toss Up Answer: X

Bonus: Short Answer

Giving your answer in volts per meter, how strong is the electric field between the plates of an 8- μF air-gap capacitor, if they are 2.0 mm apart and each has a charge of 72 μC ?

Bonus Answer: 4500 V/m

3. PHYSICS

Writer: American Heritage

Toss Up: Short Answer

A reflecting telescope has a radius of curvature of 3.0m for its objective mirror and a radius of curvature of -1.50m for its eyepiece mirror. If the distance between the two mirrors is 0.90m, how far in front of the eyepiece should you place the photographic film to record the image of a star?

Bonus Answer: 3m

Bonus: Short Answer

Name the principle that states that two images are just resolvable when the center of the diffraction disk of one image is directly over the first minimum in the diffraction pattern of the other.

Bonus Answer: Rayleigh criterion

4. MATHEMATICS

Writer: American Heritage

Toss Up: Short Answer

If $f(x) = \sqrt{(e^x \tan(x) + 1)}$, find $f(x) \cdot f'(x)$ [read as If $f(x)$ equals the square root of quantity e to the power of x times tangent of x plus one, closed quantity, find f of x times f prime of x].

Bonus Answer: $[e^x(\tan x + \sec^2 x)]/2$. Accept: $(e^x \tan x + e^x \sec^2 x)/2$, or $e^x(\tan^2 x + \tan x + 1)/2$

Bonus: Short Answer

If $f(x)$ is an even function such that the integral from 0 to 4 of $f(x)dx$ equals 31, and the integral from 0 to 8 of $f(x)dx$ equals 42, evaluate the integral from -4 to -8 of $f(x)dx$

Bonus Answer: 9

5. MATHEMATICS

Writer: American Heritage

Toss Up: Short Answer

A car travels at 20mph for the first half of its trip, and 30 mph for the second half. What is the average speed for the trip in miles per hour?

Bonus Answer: 24 mph

Bonus: Short Answer

Christopher takes 4 hours to paint a wall by himself. Tyger being lazy takes 6 hours to paint the same wall by himself. If Christopher and Tyger work together, but take a 1 hour break to play Super Smash Bros, how long does it take them to finish the wall?

Bonus Answer: 3 hours and 24 minutes (Accept 17/5 hours)

6. MATHEMATICS

Writer: American Heritage

Toss Up: Short Answer

Evaluate the intergral from negative pi to pi of $(x^2) \cdot \sin x \, dx$

Bonus Answer: 0

Bonus: Multiple Choice

Evaluate the limit as x approaches zero of the fraction with numerator $e^x - \cos(x)$ and denominator $\sin(x)$.

W) 1

X) 0

Y) -1

Z) DNE

Bonus Answer: X

7. MATHEMATICS

Writer: Stuyvesant

Toss Up: Multiple Choice

What statistical average is most appropriate to use when the quantities being averaged when one or more of the quantities are not necessarily bounded?

W) Geometric Mean

X) Median

Y) Harmonic Mean

Z) Arithmetic Mean

Toss Up Answer: Z

Bonus: Short Answer

You pick two cards at random without replacement from a standard, 52 card deck. Compute the probability that exactly one is a heart.

Bonus Answer: 13/34

8. MATHEMATICS

Writer: Stuyvesant

Toss Up: Multiple Choice

Which of the following expressions in x grows fastest?

W) $(3)^x$

X) $2^{(2x)}$

Y) $(x)^2$

Z) $10^{(3/2)^x}$

Toss Up Answer: X

Bonus: Short Answer

Given $504 = 2^3 \times 3^2 \times 7$ [504 equals 2 cubed times 3 squared times 7], compute the sum of the positive divisors of 504.

Bonus Answer: 1560

9. BIOLOGY

Writer: American Heritage

Toss Up: Multiple Choice

To which hormone do Leydig cells respond to by producing testosterone?

W) LH

X) FSH

Y) ACTH

Z) Oxytocin

Toss Up Answer: W

Bonus: Multiple Choice

A man goes to a doctor complaining of infertility. After running some tests, the doctor determines that the man has normal hormone levels, but the sperm he produces are dying before reaching maturity due to inadequate nourishment. Which of the following kinds of cells is mostly likely responsible for his infertility?

W) Leydig cells

X) Sertoli cells

Y) Peritubular myoid cells

Z) Germ cells

Bonus Answer: X

10. BIOLOGY

Writer: American Heritage

Toss Up: Short Answer

Name the only one of the 20 basic amino acids to contain an indole functional group.

Bonus Answer: Tryptophan

Bonus: Short Answer

Which enzyme in the energy investment phase of glycolysis is allosterically regulated in a negative feedback loop?

Bonus Answer: Phosphofructokinase

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11. BIOLOGY

Writer: American Heritage

Toss Up: Multiple Choice

Which of the following molecules comes first in the citric acid cycle?

W) α -Ketoglutarate

X) Succinyl-CoA

Y) Malate

Z) Isocitrate

Toss Up Answer: Z

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Bonus: Short Answer

When it occurs in the cell, the citric acid cycle typically produces what energy rich molecule besides ATP, NADH, and FADH₂?

Bonus Answer: GTP

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12. BIOLOGY

Writer: Stuyvesant

Toss Up: Short Answer

In eukaryotes, which enzyme proofreads while DNA replication takes place?

Bonus Answer: DNA Polymerase (accept DNA Polymerase III)

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Bonus: Short Answer

What is the general name for a point mutation in which a single nucleotide change results in a codon that codes for a different amino acid?

Bonus Answer: Missense Mutation

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13. BIOLOGY

Writer: Stuyvesant

Toss Up: Multiple Choice

Modern research has shown that silent mutations can be harmful in all of the following ways except:

W) Causing a short pause during codon-anticodon pairing in translation

X) Reducing the stability of the mRNA's 3D structure

Y) Causing improper splicing of the primary transcript

Z) Slowing the rate of transport of mRNA across the nuclear membrane

Toss Up Answer: Z

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Bonus: Short Answer

What was the first codon-amino acid pair to be identified? (Give both the codon and the amino acid)

Bonus Answer: UUU and phenylalanine

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14. CHEMISTRY

Writer: American Heritage

Toss Up: Short Answer

What type of hybridization occurs in the molecule sulfur hexafluoride?

Bonus Answer: d² sp³

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Bonus: Multiple Choice

Which of the following best describes a bonding molecular orbital

- W) A molecular orbital lower in energy than the atomic orbitals of which it is composed
- X) A molecular orbital higher in energy than the atomic orbitals of which it is composed
- Y) A molecular orbital equal in energy to the atomic orbitals of which it is composed
- Z) A molecular orbital with exactly twice the energy of the atomic orbitals of which it is composed

Bonus Answer: W

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15. CHEMISTRY

Writer: American Heritage

Toss Up: Multiple Choice

Which of the following compounds is soluble in water at room temperature?

- W) AgSO₄
- X) CaS
- Y) CaSO₄
- Z) PbF₂

Toss Up Answer: X

Bonus: Short Answer

A solution is prepared with an unknown solvent, and NaNO₃. 4L of the solvent are mixed with 42 moles of NaNO₃ to produce a 7 molar solution. Find the density of the solvent in grams per centimeter cubed.

Bonus Answer: 1.5 g/cm³

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16. CHEMISTRY

Writer: American Heritage

Toss Up: Multiple Choice

Which of the following elements has the highest first ionization energy?

- W) Boron
- X) Nitrogen
- Y) Carbon
- Z) Oxygen

Toss Up Answer: X

Bonus: Multiple Choice

Livermorium (element 116) was synthesized by bombarding curium (element 96) with what other element?

- W) Neon
- X) Argon
- Y) Titanium
- Z) Calcium

Bonus Answer: Z

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17. CHEMISTRY

Writer: Stuyvesant

Toss Up: Multiple Choice

What form of hybridization is found in Sulfur Hexafluoride?

- W) sp³
- X) sp³d²
- Y) sp³d³

Z) sp⁴d³

Toss Up Answer: X

Bonus: Multiple Choice

Which of the following amino acids is aromatic?

- W) Tryptophan
- X) Glutamic Acid
- Y) Methionine
- Z) Lysene

Bonus Answer: W

18. CHEMISTRY

Writer: Stuyvesant

Toss Up: Multiple Choice

Which of the following is the ionic charge of the Dimercury ion?

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

Toss Up Answer: Y

Bonus: Short Answer

What is the electron configuration of Iron(III)? Include its full electron configuration.

Bonus Answer: 1s² 2s² 2p⁶ 3s² 3p⁶ 3d⁵

19. EARTH and SPACE

Writer: American Heritage

Toss Up: Short Answer

Sapphires are made by refining which mineral?

Bonus Answer: Corundum

Bonus: Multiple Choice

Which of the following statements about corundum is not true?

- W) It is an aluminum oxide
- X) It is 8.0 on the Moh's hardness scale
- Y) It is naturally transparent
- Z) It is the source material for rubies

Bonus Answer: X

20. EARTH and SPACE

Writer: American Heritage

Toss Up: Short Answer

What 16th century astronomer first observed Saturn's ring system, which now has its largest gap named after him?

Bonus Answer: Cassini

Bonus: Multiple Choice

Which of the following is true about Titan?

- W) Its surface has never been explored
- X) One side always faces Saturn
- Y) It is the largest moon in the solar system
- Z) It has lakes of water on its surface

Bonus Answer: X

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21. EARTH and SPACE

Writer: American Heritage

Toss Up: Short Answer

The proton-proton chain reaction occurs in most stars with mass equal to or less than our sun. Name 3 of the products (assuming consumption of 4 protons).

Bonus Answer: Helium nucleus, gamma ray, neutrino, positron. (Accept energy for gamma ray)

Bonus: Multiple Choice

If a star does not undergo nuclear fusion through the proton-proton chain, what other mechanism is it most likely using?

- W) CNO
- X) FNT
- Y) FPL
- Z) CNT

Bonus Answer: W

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22. EARTH and SPACE

Writer: Stuyvesant

Toss Up: Multiple Choice

Which of the following rocks is responsible for the formation of black sand?

- W) Quartzite
- X) Schist
- Y) Slate
- Z) Basalt

Toss Up Answer: Z

Bonus: Short Answer

What is the scale used to measure the hardness of minerals?

Bonus Answer: Moh Scale (accept: Moh)

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23. ENERGY

Writer: American Heritage

Toss Up: Short Answer

What is the name for the science of converting the energy harnessed by solar panels into usable electricity?

Bonus Answer: photovoltaics

Bonus: Short Answer

What law states that the cost of solar panels tends to fall 20% every time cumulative shipping volume doubles?

Bonus Answer: Swanson's Law

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24. ENERGY

Writer: American Heritage

Toss Up: Multiple Choice

Which of the following kinds of coal has the highest carbon content?

- W) Lignite
- X) Bituminous coal
- Y) Anthracite
- Z) Peat

Toss Up Answer: Y

Bonus: Short Answer

What is the name of the theoretical limit on the efficiency of a heat engine?

Bonus Answer: Carnot limit

25. ENERGY

Writer: American Heritage

Toss Up: Multiple Choice

What percentage of energy is lost as heat in an incandescent bulb?

- W) 70%
- X) 80%
- Y) 85%
- Z) 90%

Toss Up Answer: Z

Bonus: Short Answer

Which South American country is the largest producer of coal?

Bonus Answer: Colombia
