

Round 3

1. PHYSICS

Writer: American Heritage

Toss Up: Multiple Choice

Jed and Sirajri both begin listening to a 60 minute album, Coloring Book by Chance the Rapper, at the same time. Jed then gets into a spaceship where he travels at 80% of the speed of light. Who finishes the album first, and how much of the album is left for the second person?

- W) Jed finishes 48 minutes before Sirajri
- X) Jed finishes 40 minutes before Sirajri
- Y) Sirajri finishes 48 minutes before Jed
- Z) Sirajri finishes 40 minutes before Jed

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the following statements about the standard model is false?

- W) The Z gauge boson is less massive than the W⁺ gauge boson
- X) There are 8 kinds of gluons
- Y) All 12 elementary particles in the standard model are fermions
- Z) The charm quark is a second generation particle

Bonus Answer: W

2. 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

3. 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

4. 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

5. 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

6. 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

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7. 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

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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

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8. 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

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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)

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9. 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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10. 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

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

11. 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

12. 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

13. CHEMISTRY

Writer: Stuyvesant

Toss Up: Short Answer

What is the name of the elements in Group 16?

Bonus Answer: Chalcogens (Accept: Chalcogen, Oxygen Family)

Bonus: Short Answer

When Carbonic acid is created what does it always decompose into?

Bonus Answer: Dihydrogen Monoxide and Carbon Dioxide (Accept: H₂O and CO₂, Water and CO₂)

14. 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

15. 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

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: 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

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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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18. 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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19. EARTH and SPACE

Writer: Stuyvesant

Toss Up: Short Answer

Which type of star will live for the longest period of time?

Bonus Answer: Red Dwarfs (they can live for 1 trillion years or so)

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Bonus: Multiple Choice

What resonance does Pluto have with Neptune which ensures that the celestial objects will never impact each other?

W) 2:1

X) 3:2

Y) 5:2

Z) 5:4

Bonus Answer: X

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20. 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)

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

22. 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

23. ENERGY

Writer: Stuyvesant

Toss Up: Multiple Choice

In a conventional light bulb, what is the ratio of light energy to the heat energy produced?

- W) 1:9
- X) 3:2

Y) 1:1

Z) 7:3

Toss Up Answer: W

Bonus: Multiple Choice

The arctic is estimated to hold what percent of the worlds what percent of the world's undiscovered oil and natural gas reserves?

W) 7%

X) 13%

Y) 22%

Z) 35%

Bonus Answer: Y

24. ENERGY

Writer: Stuyvesant

Toss Up: Short Answer

Which compound in the atmosphere contributes the most to the greenhouse effect?

Bonus Answer: Water (accept: H₂O or dihydrogen monoxide)

Bonus: Short Answer

What is China's largest renewable energy source?

Bonus Answer: Hydropower (accept: Hydro)

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
