

# American Heritage

## 1. Biology

### 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**

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### 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**

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## 2. Earth and Space Science

### Toss Up: Short Answer

Sapphires are made by refining which mineral?

**Toss Up Answer: Corundum**

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### 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**

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## 3. Chemistry

### Toss Up: Short Answer

What type of hybridization occurs in the molecule sulfur hexafluoride?

**Toss Up 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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## 4. Mathematics

### 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  $x$ ].

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

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### 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

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## 5. Energy

### Toss Up: Short Answer

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

**Toss Up Answer:** photovoltaics

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### 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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## 6. Physics

### 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

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### Bonus: Short Answer

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

**Bonus Answer:** 4500 V/m

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## 7. Energy

### 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

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### Bonus: Short Answer

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

**Bonus Answer:** Carnot limit

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## 8. Physics

### 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?

**Toss Up Answer: 3m**

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**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**

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## 9. Mathematics

**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?

**Toss Up 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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## 10. Earth and Space Science

**Toss Up: Short Answer**

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

**Toss Up Answer: Cassini**

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**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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## 11. Biology

**Toss Up: Short Answer**

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

**Toss Up Answer: Tryptophan**

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**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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## 12. Chemistry

**Toss Up: Multiple Choice**

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

- W)  $\text{AgSO}_4$
- X)  $\text{CaS}$
- Y)  $\text{CaSO}_4$

Z)  $\text{PbF}_2$

**Toss Up Answer: X**

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**Bonus: Short Answer**

A solution is prepared with an unknown solvent, and  $\text{NaNO}_3$ . 4L of the solvent are mixed with 42 moles of  $\text{NaNO}_3$  to produce a 7 molar solution. Find the density of the solvent in grams per centimeter cubed.

**Bonus Answer:  $1.5 \text{ g/cm}^3$**

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**13. Energy**

**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**

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**Bonus: Short Answer**

Which South American country is the largest producer of coal?

**Bonus Answer: Colombia**

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**14. Physics**

**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**

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**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**

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**15. Mathematics**

**Toss Up: Short Answer**

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

**Toss Up 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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## 16. Earth and Space Science

**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).

**Toss Up Answer: Helium nucleus, gamma ray, neutrino, positron. (Accept energy for gamma ray)**

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**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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## 17. Biology

**Toss Up: Multiple Choice**

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

- W) \_-Ketogluatarate
- 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 FADH<sub>2</sub>?

**Bonus Answer: GTP**

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## 18. Chemistry

**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**

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**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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