

## Round 2

### 1. PHYSICS

Writer: Centennial

Toss Up: Short Answer

A body orbits another with a pericenter of 100km and an apocenter of 500km, and travels 40m/s at the apocenter. To the nearest m/s, what is the speed at the pericenter?

Bonus Answer: 200 m/s

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Bonus: Short Answer

The central body is changed to one with double the mass, and the shape and size of the orbit are kept constant. By what factor will the speed of the orbiting object change?

Bonus Answer: Sqrt(2) times faster

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### 2. PHYSICS

Writer: Centennial

Toss Up: Short Answer

What is the resonant frequency, to the nearest hertz, of an LC circuit with  $L=0.1\text{H}$  and  $C=150\mu\text{F}$ ?

Bonus Answer: 41 Hz

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Bonus: Short Answer

An RLC circuit has  $R=200\Omega$ ,  $L=0.5\text{H}$ , and  $C=50\mu\text{F}$ . Is this circuit (1) overdamped, (2) underdamped, or (3) critically damped?

Bonus Answer: (3) critically damped

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### 3. PHYSICS

Writer: Stuyvesant

Toss Up: Short Answer

A molecule with a magnetic moment of  $83\text{ N}\cdot\text{m/T}$  (read as Newton-meters per Tesla) experiences what amount of torque in  $\text{N}\cdot\text{m}$  (read as Newton-meter) when subjected to an external magnetic force of 120 teslas?

Bonus Answer:  $9960\text{ N}\cdot\text{m}$

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Bonus: Multiple Choice

A certain capacitor, in series with a  $720\text{-}\Omega$  resistor, is being charged. At the end of 10 ms (milliseconds) its charge is half the final value. The capacitance is about:

W)  $9.6\text{ }\mu\text{F}$

X)  $14\text{ }\mu\text{F}$

Y)  $20\text{ }\mu\text{F}$

Z)  $7.2\text{F}$

Bonus Answer: Y

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### 4. PHYSICS

Writer: Stuyvesant

Toss Up: Short Answer

Maxwell's equations are to electric and magnetic fields as what equation is to the wave function for a particle?

Bonus Answer: Shrodinger's

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Bonus: Multiple Choice

A non-relativistic free electron has kinetic energy  $K$ . If its wavelength doubles, what is its kinetic energy in terms of  $K$ ?

W)  $4K$

X)  $K/4$

Y)  $K$

Z)  $K/2$

**Bonus Answer: X**

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## 5. MATHEMATICS

**Writer: Centennial**

**Toss Up: Short Answer**

What is the name for the group of four datasets with nearly identical summary statistics, but drastically different scatterplots?

**Bonus Answer: Anscombe's quartet**

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**Bonus: Short Answer**

X is a random variable with a uniform distribution with width  $w$  of values. In terms of  $w$ , what is the standard deviation of X?

**Bonus Answer:  $\sqrt{w^2/12}$**

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## 6. MATHEMATICS

**Writer: Centennial**

**Toss Up: Short Answer**

If X and Y are independent random variables with standard deviations of  $a$  and  $b$  respectively, what is the standard deviation of the quantity  $X+2Y$ ?

**Bonus Answer:  $\sqrt{a^2+4b^2}$**

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**Bonus: Short Answer**

If X and Y are independent random variables with expected values  $c$  and  $d$  respectively, what is the expected value of the quantity  $X+2Y$ ?

**Bonus Answer:  $c+2d$**

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## 7. MATHEMATICS

**Writer: Stuyvesant**

**Toss Up: Multiple Choice**

Simplify  $(\sin 15^\circ \cos 75^\circ - \cos 15^\circ \sin 75^\circ) / (\cos 15^\circ \cos 75^\circ + \sin 15^\circ \sin 75^\circ)$

W) negative square root of 3

X)  $1/2$

Y)  $-1/2$

Z) square root of 6 minus square root of 2 all over 2

**Toss Up Answer: W**

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**Bonus: Short Answer**

Compute  $(2+2\sqrt{3}i)^6$ . [the quantity  $2+2$  times the square root of 3 time  $i$  to the 6th power]

**Bonus Answer: 4096**

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## 8. MATHEMATICS

**Writer: Stuyvesant**

**Toss Up: Multiple Choice**

If the test scores of Mr. Coco's Calculus test are assumed to have a normal distribution, and if the mean test score was 91, what can be said about the median test score of that test?

W) The median was lower than 91

- X) The median was higher than 91
- Y) The median was 91
- Z) The median cannot be determined

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

The z-score for Steven's physics test grade was found to be 0.375. If he scored a 94 on the test, and the standard deviation was 8, what was the mean test score on the physics test?

- W) 91
- X) 95
- Y) 92
- Z) 98

**Bonus Answer: W**

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## 9. BIOLOGY

**Writer: Granada Hills**

**Toss Up: Multiple Choice**

What part of the brain controls the ability to understand speech?

- W) Olfactory
- X) Frontal
- Y) Broca's Area
- Z) Wernicke's Area

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Which neural tissue facilitates neural messages from the left to the right hemispheres?

**Bonus Answer: Corpus Callosum**

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## 10. BIOLOGY

**Writer: Granada Hills**

**Toss Up: Multiple Choice**

The organ that produces glucagon is under what organ-system?

- W) Musculo-Skeletal
- X) Nervous
- Y) Endocrine
- Z) Circulatory

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Most pharmaceutical insulin is produced using what species of bacteria?

**Bonus Answer: E. Coli**

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## 11. BIOLOGY

Writer: Centennial

Toss Up: Short Answer

Which subunit of Na<sup>+</sup>/K<sup>+</sup>-ATPase binds the Na<sup>+</sup> ion?

Bonus Answer: The alpha subunit

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Bonus: Multiple Choice

Which of the following effects would a toxin that blocked voltage-gated potassium channels be most likely to cause?

W) A decrease in the strength of the action potential

X) A decrease in the length of the refractory period

Y) An increase in the speed of the action potential

Z) An increase in the strength of the action potential

Bonus Answer: Z

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## 12. BIOLOGY

Writer: Centennial

Toss Up: Short Answer

Name all of the following that are usually characteristics of monocots: (1) Petals in multiples of three, (2) taproot present, (3) vascular bundles arranged in a ring, (4) parallel veins

Bonus Answer: (1) Petals in multiples of three, and (4) parallel veins

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Bonus: Short Answer

Name all of the following that are monocots: corn, crabgrass, red bean

Bonus Answer: Corn and crabgrass

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## 13. BIOLOGY

Writer: Stuyvesant

Toss Up: Short Answer

Which amino acid would constitute a disulfide bridge?

Bonus Answer: Cysteine

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Bonus: Short Answer

What is the name of the cellular machinery that removes introns?

Bonus Answer: Spliceosome

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## 14. 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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## 15. CHEMISTRY

Writer: Granada Hills

Toss Up: Short Answer

Helium has a molar mass of 4 grams per mole and effuses at a rate of 10 moles per minute. If you have an unknown gas with a molar mass of 16 grams per mole, How many moles per minute would it effuse at?

Bonus Answer: 5

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Bonus: Short Answer

By name or number, indicate all of the following choices that would undergo SN1.

I. 2-bromo-2-methylpropane

II. CH<sub>3</sub>CHCHCH<sub>2</sub>Cl

III. Polyethylene

Bonus Answer: I only

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## 16. CHEMISTRY

Writer: Granada Hills

Toss Up: Multiple Choice

What is the name of the group of the periodic table that includes selenium?

W) Halogens

X) Noble gases

Y) Alkali metals

Z) Chalcogens

Toss Up Answer: Z

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Bonus: Short Answer

What is the general name of the compounds that are highly toxic and are formed from reacting ammonia with baking soda?

Bonus Answer: Chloramines

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## 17. CHEMISTRY

Writer: Centennial

Toss Up: Short Answer

63/37 leaded solder is this type of mixture, which melts at once instead of melting as components.

Bonus Answer: Eutectic

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Bonus: Short Answer

Apart from tin whiskers, lead-free solder also suffers from this problem at low temperatures.

Bonus Answer: Tin pest

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## 18. CHEMISTRY

Writer: Centennial

Toss Up: Short Answer

What is the most significant component in duralumin, other than aluminum?

**Bonus Answer: Copper**

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**Bonus: Short Answer**

The addition of copper makes the alloy susceptible to which process, from which pure aluminum is usually protected?

**Bonus Answer: Corrosion**

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## 19. EARTH and SPACE

**Writer: Centennial**

**Toss Up: Multiple Choice**

Which of the giant planets has the least massive moon system?

- W) Jupiter
- X) Saturn
- Y) Uranus
- Z) Neptune

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Which moon is the only one in the Solar System to have a retrograde orbit?

**Bonus Answer: Triton**

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## 20. EARTH and SPACE

**Writer: Centennial**

**Toss Up: Multiple Choice**

Which of the following compounds made up most of Mt. St. Helens' ash?

- W) Magnesium oxide
- X) Aluminum oxide
- Y) Silicon dioxide
- Z) Sodium oxide

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What mineral forms the dome of Mt. St. Helens?

**Bonus Answer: Dacite**

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## 21. EARTH and SPACE

**Writer: Centennial**

**Toss Up: Multiple Choice**

Which of the following was eventually proposed to explain the Pioneer anomaly?

- W) Radiation pressure
- X) Outgassing from spacecraft parts
- Y) Solar wind
- Z) Previously undiscovered planets

**Toss Up Answer: W**

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**Bonus: Short Answer**

What phenomenon was used to measure the speed of the Pioneer spacecraft?

**Bonus Answer: Doppler Effect**

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## 22. EARTH and SPACE

**Writer: Stuyvesant**

**Toss Up: Short Answer**

By name or number, list the following classes of stars from hottest to coolest:

1. Class K
2. Class O
3. Class A
4. Class B

**Bonus Answer: 2,4,3,1**

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**Bonus: Short Answer**

What are the brightest events in the universe?

**Bonus Answer: Gamma Ray Bursts**

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**23. ENERGY**

**Writer: Centennial**

**Toss Up: Multiple Choice**

Which of the following is closest to the capacity of the largest offshore wind farm?

- W) 60 MW
- X) 600 MW
- Y) 6000 MW
- Z) 60000 MW

**Toss Up Answer: X**

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**Bonus: Short Answer**

In which country is the largest offshore wind farm?

**Bonus Answer: The United Kingdom**

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**24. ENERGY**

**Writer: Centennial**

**Toss Up: Multiple Choice**

Which of the following compounds is not usually a major component of fly ash?

- W) Silicon dioxide
- X) Aluminum oxide
- Y) Magnesium oxide
- Z) Calcium oxide

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What is the name for the ash that, unlike fly ash, does not escape up the chimney?

**Bonus Answer: Bottom ash**

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**25. ENERGY**

**Writer: Stuyvesant**

**Toss Up: Multiple Choice**

Which country generates the highest percentage of its energy from nuclear power?

- W) Britain
- X) China
- Y) France
- Z) Denmark

**Toss Up Answer: Y**

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**Bonus: Short Answer**

By name or number, list the operating temperatures from lowest to highest of these types of fuel cells:

1. MCFC
2. PAFC
3. PEMFC
4. SOFC

**Bonus Answer: 3,2,1,4**

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