

## Round 18

### 1. PHYSICS

Writer: Yevgeniy Gorbachev

Toss Up: Short Answer

Given a fuel flow rate of 5 kg/s and a thrust of 20 kN, what is the exhaust velocity of the thruster? Assume standard gravity to be 10 m/s<sup>2</sup>.

Bonus Answer: 4 km/s (also acceptable: 4000 m/s)

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Bonus: Short Answer

If one of the engines of a single stage has a specific impulse of 40 seconds and a fuel flow rate of 2 kg/s, and the other engine has a specific impulse of 100 seconds and a fuel flow rate of 10 kg/s, what is the total thrust of the stage? Assume standard gravity to be 10 m/s<sup>2</sup>.

Bonus Answer: 10800 N

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### 2. PHYSICS

Writer: Elias Milborn

Toss Up: Short Answer

A train moving 35 meters per second emits a whistle with a frequency of 900 hertz. Assuming that the speed of sound in air is 350 meters per second, what is the frequency, in hertz, measured by a stationary observer in front of the train?

Bonus Answer: 1000

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Bonus: Multiple Choice

Which of the following has the highest vapor pressure at STP?

- W) mercury
- X) ethyl alcohol
- Y) methyl alcohol
- Z) acetone

Bonus Answer: Z

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### 3. PHYSICS

Writer: Elias Milborn

Toss Up: Multiple Choice

When a resistor, inductor, and capacitor are connected in series to an AC generator, the current through the capacitor must be in phase with the voltage across which of the following?

- W) The capacitor
- X) The inductor
- Y) The entire circuit
- Z) The inductor

Toss Up Answer: Z

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Bonus: Short Answer

Which lower case letter is commonly used to denote planck's constant?

Bonus Answer: h

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### 4. PHYSICS

Writer: Elias Milborn

Toss Up: Multiple Choice

As an object falls to the earth with air resistance present, what happens to the acceleration of the object?

- W) It remains a constant  $9.8 \text{ m/s}^2$   
X) It increases from 0 to  $9.8 \text{ m/s}^2$   
Y) It remains at a constant  $0 \text{ m/s}^2$   
Z) It decreases from  $9.8$  to  $0 \text{ m/s}^2$

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Mary and Joe are on a merry-go-round. Mary is seated near the center of rotation and Joe is on the outer edge. Which of the following BEST describes their motion?

- W) Mary has a greater acceleration than Joe  
X) Joe has a greater acceleration than Mary  
Y) neither Joe nor Mary are accelerating  
Z) both Mary and Joe have the same acceleration

**Bonus Answer: X**

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## 5. MATHEMATICS

**Writer: Justin Lam**

**Toss Up: Multiple Choice**

Which of the following are prime factors of the number 5304?

- W) 19  
X) 7  
Y) 5  
Z) 13

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What integer satisfies the equation  $y = x^3 - 1$  [Read as:  $x$  to the third power subtracted by 1] when  $y = 0$  ?

**Bonus Answer:  $x = 1$**

(Explanation: The factors of the equation is  $y = (x - 1)(x^2 + x + 1)$ . We want to find an integer solution, so we take the factor  $x - 1$  and set it to zero. By adding one to both sides, we see that  $x = 1$ .)

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## 6. MATHEMATICS

**Writer: Justin Lam**

**Toss Up: Short Answer**

On which point does  $y = 10x + 8$  and  $y = x + 5$  intersect?

**Bonus Answer:  $(-1/3, 14/3)$**

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**Bonus: Short Answer**

How many roots does the cubic equation  $y = x^3 - 4x^2 + 4x$  have?

**Bonus Answer: It has 2 roots.**

(Explanation: It intersects the  $x$ -axis twice, once at  $x = 0$  and once at  $x = 2$ .)

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## 7. MATHEMATICS

**Writer: Justin Lam**

**Toss Up: Short Answer**

What is the volume of a sphere if the radius is 7 inches? (use  $22/7$  for  $\pi$ ) You may either use fractions or decimals rounded to the nearest hundredth as your answer.

**Bonus Answer:  $V = 4312/3$  cubic inches**

or  $V = 1437.33$  cubic inches  
(they must include the correct units)

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**Bonus: Short Answer**

Find the surface area of a rectangular prism if the length is 2 inches, the width is 3 inches, and the height is 2 inches.

**Bonus Answer:  $V = 32$  square inches**

(they must include the correct units)

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**8. MATHEMATICS**

**Writer: Nten Nylam**

**Toss Up: Multiple Choice**

A card is randomly drawn from a 52 card deck, what is the probability that the card is either a spade or a 4?

W)  $4/13$

X)  $7/52$

Y)  $17/52$

Z)  $2/13$

**Toss Up Answer: W**

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**Bonus: Short Answer**

What is the value of  $(10! / 3!) \times 0!$

**Bonus Answer: 604,800**

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**9. BIOLOGY**

**Writer: Yae June Lee**

**Toss Up: Short Answer**

How many turns in the Calvin Cycle can it produce one PGAL molecule?

**Bonus Answer: 2**

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**Bonus: Short Answer**

What diffuses through the ATP synthases in the process of photosynthesis?

**Bonus Answer: Hydrogen ions/protons. The protons in the thylakoids membrane is diffused out by the process of chemiosmosis.**

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**10. BIOLOGY**

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Which of these does not result in recombinant bacteria?

W) Transformation

X) Insertion

Y) Transduction

Z) Conjugation

**Toss Up Answer: X**

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**Bonus: Short Answer**

What serves as an intermediate in transduction?

**Bonus Answer: Virus (accept viruses)**

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**11. BIOLOGY**

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

What is the typical size range for a prokaryote?

W) .1 - 1.0 micrometer

X) .5 - 5.0 micrometer

Y) 1-10 micrometer

Z) 10-100 micrometer

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the name for the factor that allows a bacteria to become a donor during conjugation?

**Bonus Answer: F factor (accept fertility factor)**

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## 12. BIOLOGY

**Writer: Yae June Lee**

**Toss Up: Short Answer**

What is another name for pinocytosis

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**Bonus Answer: Cell drinking.**

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**Bonus: Multiple Choice**

Sugar molecules can enter cells through

W) Exocytosis

X) Facilitated diffusion.

Y) Osmosis.

Z) ATP Synthase.

**Bonus Answer: X**

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## 13. BIOLOGY

**Writer: Olivia Gallager**

**Toss Up: Short Answer**

Which scientist, born in 1920, is known for the discovery of DNA's double helical structure using X-ray crystallography?

**Bonus Answer: Rosalind Franklin**

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**Bonus: Short Answer**

True or false?: Viruses can have DNA.

**Bonus Answer: true.**

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## 14. BIOLOGY

**Writer: Benjamin Avrahami**

**Toss Up: Short Answer**

Which animal phylum was the first to develop true coelems?

**Bonus Answer: Annelids (or earthworms)**

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**Bonus: Multiple Choice**

Which one of these molecules helps break down some of your food?

W) Hydrochloric Acid

X) Pepsinogen

Y) Trypsin

Z) Mucus

**Bonus Answer: Y**

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## **15. BIOLOGY**

**Writer: Benjamin Avrahami**

**Toss Up: Multiple Choice**

Which one of these is an enzyme?

- W) Inositol
- X) Lyase
- Y) Alanine
- Z) Butyric Acid

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Which molecule is not involved in the Calvin cycle?

- W) OAA
- X) RuBP
- Y) G3P
- Z) PGA

**Bonus Answer: W**

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## **16. BIOLOGY**

**Writer: Ahmad Alnasser**

**Toss Up: Multiple Choice**

When electrons move closer to a more electronegative atom, what happens?

- W) The more electronegative atom is reduced, and energy is consumed.
- X) The more electronegative atom is reduced, and energy is released.
- Y) The more electronegative atom is oxidized, and energy is released.
- Z) The more electronegative atom is oxidized, and energy is consumed.

**Toss Up Answer: X**

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**Bonus: Short Answer**

Where does glycolysis take place in eukaryotic cells?

**Bonus Answer: Cytosol**

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## **17. BIOLOGY**

**Writer: Ahmad Alnasser**

**Toss Up: Multiple Choice**

How many carbon atoms are fed into the citric acid cycle as a result of the oxidation of one molecule of pyruvate?

- W) 3
- X) 1
- Y) 2
- Z) 6

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

In the absence of oxygen, yeast cells can obtain energy by fermentation, resulting in the production of

W) reduction of acetaldehyde to ethanol (ethyl alcohol).

X) oxidation of pyruvate to acetyl CoA.

Y) oxidation of ethanol to acetyl CoA

Z) reduction of ethanol to pyruvate.

**Bonus Answer: W**

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## 18. CHEMISTRY

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

Which element breaks the octet rule?

W) Ga

X) Xe

Y) Cu

Z) F

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the empirical formula of C<sub>6</sub>H<sub>11</sub>?

**Bonus Answer: C<sub>6</sub>H<sub>11</sub>**

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## 19. CHEMISTRY

**Writer: Olivia Gallager**

**Toss Up: Short Answer**

For E2 reactions to occur, the Hydrogen has to be what to the leaving group?

**Bonus Answer: antiperiplanar**

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**Bonus: Short Answer**

List the following formations in order of lowest stability to highest: Trans, Geminal, Cis

**Bonus Answer: cis, geminal, trans**

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## 20. CHEMISTRY

**Writer: Andrew Chen (Senior)**

**Toss Up: Multiple Choice**

In the following redox reaction:  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$  which compound is the oxidizing agent?

W) O<sub>2</sub>

X) CH<sub>4</sub>

Y) CO<sub>2</sub>

Z) H<sub>2</sub>O

**Toss Up Answer: W**

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**Bonus: Short Answer**

Given the organic molecule C<sub>6</sub>H<sub>14</sub> how many different structural isomers can be formed?

**Bonus Answer: Five**

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## 21. CHEMISTRY

**Writer: Andrew Chen (Senior)**

**Toss Up: Multiple Choice**

Certain compounds are insoluble in solution. Which of the following choices below is soluble in aqueous solution?

W) BaSO<sub>4</sub>

- X) AgCl
- Y) AgNO<sub>3</sub>
- Z) NiCO<sub>3</sub>

**Toss Up Answer: Y**

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**Bonus: Short Answer**

There is a variety of lab techniques that could be used to separate precipitates from the supernatant liquid. Which of the following lab techniques: centrifuge, distillation, chromatography, and titration can be used to separate them.

**Bonus Answer: Centrifuge (1)**

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## 22. CHEMISTRY

**Writer: Andrew Chen (Senior)**

**Toss Up: Short Answer**

Please balance the given equation \_\_\_\_ CO<sub>3</sub><sup>2-</sup> + 2H<sup>+</sup> ----> \_\_\_\_ H<sub>2</sub>O + \_\_\_\_ CO<sub>2</sub>

**Bonus Answer: 1,1,1**

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**Bonus: Multiple Choice**

There are various pieces of chemical equipment. What is a piece of glassware designed specifically for usage in creating solutions?

- W) Erlenmeyer flask
- X) Florence flask
- Y) Volumetric flask
- Z) Graduated cylinder

**Bonus Answer: Y**

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## 23. EARTH and SPACE

**Writer: Benjamin Avrahami**

**Toss Up: Multiple Choice**

Since Pumice and Rhyolite are both extrusive felsic rocks, they both have:

- W) Vesicles and low density
- X) No vesicles and silicon
- Y) Magnesium and high density
- Z) Low density and aluminum

**Toss Up Answer: Z**

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**Bonus: Short Answer**

By name or number, order these materials from lowest specific heat to highest specific heat: Ice, (liquid) water, water vapor, iron

**Bonus Answer: Iron, water vapor, ice, liquid water (4, 3, 1, 2)**

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## 24. EARTH and SPACE

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

Which of the following is a sedimentary rock?

- W) slate
- X) marble
- Y) basalt
- Z) sandstone

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the name for the outer shadow cast during eclipses, which gives rise to a partial eclipse?

**Bonus Answer: Penumbra**

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**25. EARTH and SPACE**

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

In oceans, waves and surf current are generated by:

- W) El Nino
- X) salinity and temperature gradients
- Y) the intertropical convergence zone
- Z) wind

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

During which of the following geological subdivisions was glaciation minimal on Earth?

- W) Quaternary Period
- X) Holocene Epoch
- Y) Cretaceous Period
- Z) Pleistocene Epoch

**Bonus Answer: Y**

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