

## Round 13

### 1. CHEMISTRY

Writer: George Papastefanou

Toss Up: Short Answer

Using noble gas abbreviation, what is the electron configuration of a silver atom?

Bonus Answer: [Kr] 4d<sup>10</sup> 5s<sup>1</sup>

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Bonus: Short Answer

What is the most electropositive element in group 1A?

Bonus Answer: Francium

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### 2. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

A Carnot heat engine operates between 400K and 500 K. What is its efficiency?

Bonus Answer: 20%

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Bonus: Multiple Choice

A Carnot heat engine and an irreversible heat engine both operate between the same high temperature and low temperature reservoirs. They absorb the same energy from the high temperature reservoir as heat. Which statement is true?

W) The irreversible engine does more work.

X) The Carnot engine transfers less energy to the low temperature reservoir as heat.

Y) The irreversible engine has the greater efficiency.

Z) The irreversible engine cannot absorb the same energy from the high temperature reservoir as heat without violating the second law of thermodynamics.

Bonus Answer: X

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### 3. CHEMISTRY

Writer: George Papastefanou

Toss Up: Short Answer

What is the last element of the periodic table to occur naturally on Earth?

Bonus Answer: Plutonium, element 94

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Bonus: Short Answer

Which element is most abundant in the entire Earth?

Bonus Answer: Iron (do not accept Oxygen, that's just the crust)

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### 4. EARTH and SPACE

Writer: Shanjeed Ali

Toss Up: Short Answer

In the stratosphere, what happens to the temperature as altitude increases?

Bonus Answer: increases

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Bonus: Short Answer

What does radar stand for?

Bonus Answer: RAdio Detection And Ranging

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## 5. CHEMISTRY

Writer: Siam Muquit

Toss Up: Multiple Choice

A precipitation reaction is an example of which of the following reactions?

W) Combustion

X) Substitution

Y) Single Displacement

Z) Double Displacement

Toss Up Answer: Z

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Bonus: Short Answer

By name or number, which of the following would be a precipitate in aqueous solution? Silver sulfide, Potassium nitrate, Strontium hydroxide, Lead(II) fluoride

Bonus Answer: Silver sulfide, Lead(II) fluoride OR (1, 4 only)

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## 6. MATHEMATICS

Writer: Shihab Karim

Toss Up: Multiple Choice

If the diameter of a circle is 6 inches, what is the area of the circle?

W)  $36\pi$

X)  $9\pi$

Y)  $12\pi$

Z)  $6\pi$

Toss Up Answer: X

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Bonus: Short Answer

Find the equation of the line that passes through the point (3,4) and is perpendicular to the line  $y = 3x - 2$ ?

Bonus Answer:  $y = -(1/3)x + 5$

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## 7. EARTH and SPACE

Writer: George Papastefanou

Toss Up: Multiple Choice

The North Pacific Gyre is mostly located within what latitudinal zone?

W) The North Frigid Zone

X) The Torrid Zone

Y) The Horse Latitudes

Z) The North Temperate Zone

Toss Up Answer: Z

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Bonus: Short Answer

What ocean current keeps Western Europe relatively warm for its latitude?

Bonus Answer: North Atlantic Current (accept North Atlantic Drift, but not Gulf Stream)

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## 8. CHEMISTRY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which of these is a weak electrolyte?

W)  $C_6H_{12}O_6$

X)  $MgCl_2$

Y)  $NaC_2H_3O_2$

Z)  $\text{NH}_4\text{OH}$

**Toss Up Answer: Z**

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**Bonus: Short Answer**

By name or number, which of the following can conduct electricity in solution? Hydrocarbons, salts, weak acids, strong acids?

**Bonus Answer: Salts, weak acids, strong acids (2, 3, and 4 only)**

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## 9. EARTH and SPACE

**Writer: Jan Wojcik**

**Toss Up: Short Answer**

Name the wave that you would typically feel during an earthquake if you were standing on the ground after feeling the first primary wave.

**Bonus Answer: S-wave (secondary wave)**

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**Bonus: Short Answer**

An earthquake is measured to have a Richter scale value of around 4. Another earthquake is measured to have a Richter scale value of 7. How much smaller is the first earthquake to the second earthquake?

**Bonus Answer: 1000 times smaller (accept 1000)**

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## 10. CHEMISTRY

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

What is the pH of distilled water?

W) 6.5

X) 6.7

Y) 7

Z) Depends on the temperature

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

What is one of the hydrolysis product when Magnesium carbide is hydrolysed with water?

W) Propadiene

X) Propyne

Y) Methane

Z) There is insufficient information

**Bonus Answer: Z**

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## 11. PHYSICS

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

What kind of friction will act on a rolling, round object at an instant if the surface is horizontal and rough and no other force acts in the horizontal direction?

W) Static Friction

X) Kinetic Friction

Y) Rolling Friction

Z) No Friction

**Toss Up Answer: Y**

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**Bonus: Short Answer**

If the acceleration due to gravity is  $10 \text{ m/s}^2$ , find the force required to move an object of mass 200 kilograms up an incline of 1 in 50 with an acceleration of  $2 \text{ m/s}^2$  and a frictional force of 20 N.

**Bonus Answer: 420 N**

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**12. BIOLOGY**

**Writer: William Xiang**

**Toss Up: Multiple Choice**

Which of the following enzymes are not utilized by the human body to break down carbohydrates?

- W) Amylase
- X) Maltase
- Y) Lactase
- Z) Lipase

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Which of the following is a valid difference between animal and plant cells?

- W) Animal cells have a cell membrane whereas plant cells do not.
- X) Animal cells contain mitochondria whereas plant cells cannot.
- Y) Animal cells can contain multiple vacuoles whereas plant cells cannot.
- Z) Animal cells are larger than plant cells.

**Bonus Answer: Y**

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**13. PHYSICS**

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

There are two small, thermally isolated rooms A and B. The heat capacitance of room A is 40 units of energy and room A contains 32 units of energy. The heat capacitance of room B is 100 units of energy and room B contains 50 units of energy. When the two rooms are thermally connected, in which direction will energy flow, on average?

- W) Energy will not flow
- X) Can't tell
- Y) Room A to Room B
- Z) Room B to Room A

**Toss Up Answer: Y**

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**Bonus: Short Answer**

A piece of aluminium with mass 800 g is heated up to 1000 degrees C. Given the specific heat capacity of aluminium is  $900 \text{ J/(kg K)}$ , calculate the amount of heat (in Joules) given out if the piece is cooled down to 200 degrees C.

**Bonus Answer: 576,000 J**

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**14. BIOLOGY**

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Which of the following is not a strong acid?

- W)  $\text{H}_2\text{SO}_4$
- X)  $\text{HNO}_3$
- Y)  $\text{HClO}$

Z)  $\text{HClO}_4$

**Toss Up Answer: Y**

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**Bonus: Short Answer**

In a 1M solution of  $\text{HClO}_4$ , what are the two ions and what are their concentrations?

**Bonus Answer: 1 M  $\text{H}^+$  , 1 M  $\text{ClO}_4^-$**

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## 15. PHYSICS

**Writer: Charles Zhang**

**Toss Up: Multiple Choice**

A 2 kg ball is dropped from 10m. Another 2 kg ball is thrown upwards at 5 m/s. What is the acceleration of the center of mass of these two balls?

W) 2g

X) g

Y) 5g

Z) 10g

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Two astronauts are in gravity-free space. Astronaut A is 120 kg and Astronaut B is 90 kg. If A pushes B away, with B moving at 0.5 m/s, what is Astronaut A's final speed rounded to the tenth?

W) 0

X) 0.38

Y) 0.5

Z) 0.68

**Bonus Answer: X**

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## 16. BIOLOGY

**Writer: Elias Milborn**

**Toss Up: Short Answer**

What is the largest internal organ in the human body

**Bonus Answer: liver**

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**Bonus: Multiple Choice**

Plants that grow under average temperature and moisture are called:

W) halophytes

X) xerophytes

Y) hydrophytes

Z) mesophytes

**Bonus Answer: Z**

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## 17. PHYSICS

**Writer: George Zhou**

**Toss Up: Multiple Choice**

A metallic cylindrical conductor is used to produce some heat by applying a constant voltage between its two ends. You want to double the heat released. Which of the following is the most appropriate thing to be done?

W) The length should be doubled

- X) The radius should be doubled  
Y) Both the length as well as the radius should be halved  
Z) Both the length as well as the radius should be doubled

**Toss Up Answer: Z**

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**Bonus: Short Answer**

A parallel plate capacitor of capacitance 10 micro F is charged to 50 micro C using a battery, and is then disconnected from the circuit. How much energy in micro joules is required to pull apart the plates such that the distance between them is doubled?

**Bonus Answer: 125**

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## 18. BIOLOGY

**Writer: Siam Muquit**

**Toss Up: Multiple Choice**

Polio is caused by which type of microbe?

- W) Bacteria  
X) Fungus  
Y) Prion  
Z) Virus

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Which human body system does polio most directly affect?

**Bonus Answer: Nervous system (accept Central nervous system)**

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## 19. PHYSICS

**Writer: Seiji Yawata**

**Toss Up: Short Answer**

A Tesla is an SI derived unit that can be expressed as  $\text{kg}^a \cdot \text{C}^b \cdot \text{s}^c$ . What are the values of a, b and c?

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

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**Bonus: Short Answer**

A positron moves through a region in which the electric field is uniform in the x-direction and the magnetic field is uniform in the y-direction. What is the direction of the terminal velocity of the positron?

**Bonus Answer: Positive z direction**

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## 20. BIOLOGY

**Writer: Matthew Lee**

**Toss Up: Short Answer**

What is the arrangement of microtubules in a motile cilium called?

**Bonus Answer: 9 + 2 ('nine plus two')**

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**Bonus: Short Answer**

What are the common large motor proteins that move flagella and motile cilia called?

**Bonus Answer: dyneins (accept: dynein)**

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## 21. MATHEMATICS

**Writer: Shihab Karim**

**Toss Up: Short Answer**

What is the imaginary unit "i" when raised to the power 30?

**Bonus Answer: -1**

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**Bonus: Short Answer**

What is the sum of the first 50 positive integers?

**Bonus Answer: 1275**

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## 22. BIOLOGY

**Writer: Matthew Lee**

**Toss Up: Short Answer**

What is the main fiber that makes up the extracellular matrix?

**Bonus Answer: Collagen**

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**Bonus: Multiple Choice**

Which of the following allow for cell signaling?

I. Desmosomes II. Gap Junctions III. Tight Junctions IV. Plasmodesmata

W) I, II, III

X) II and IV

Y) II and III

Z) I and IV

**Bonus Answer: X**

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## 23. MATHEMATICS

**Writer: George Papastefanou**

**Toss Up: Short Answer**

What is the tangent of  $(27(\pi)/4)$

**Bonus Answer: -1**

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**Bonus: Short Answer**

With a 5 percent compound interest rate, how long, to the nearest year, will it take a sum of money to double?

**Bonus Answer: 14 years**

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## 24. BIOLOGY

**Writer: Matthew Lee**

**Toss Up: Multiple Choice**

Which of the following pairs of scientists elucidated the current model of the cell membrane?

W) Frye and Edidin

X) Davson and Danielli

Y) Singer and Nicholson

Z) Gorter and Grendel

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Which of the following allow the protist *Paramecium caudatum* to survive in their hypotonic environments? I. Plasma membrane II. Cell Wall

III. Pseudopodia IV. Contractile Vacuole

**Bonus Answer: I and IV**

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## 25. BIOLOGY

**Writer: Matthew Lee**

**Toss Up: Short Answer**

What molecule is the phosphorylated intermediate of the ATP-coupled reaction derived from?

The reaction is glutamic acid + ammonia  $\rightarrow$  glutamine. The free energy change is +3.4 kcal/mol.

**Bonus Answer: Glutamic Acid**

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**Bonus: Short Answer**

The evolution of enzymes was traced in an experiment with *E. coli*. What enzyme was mutated in the experiment?

**Bonus Answer: beta-galactosidase**

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