

## Round 2

### 1. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

An object is dropped from an altitude of one Earth radius above Earth's surface. In terms of  $M$ , the mass of Earth, and  $R$ , Earth's radius, what is the speed of the object just before it hits Earth?

**Bonus Answer:**  $\sqrt{GM/R}$  (READ AS: square root of GM over R)

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**Bonus: Short Answer**

Two particles, each of mass  $m$ , are a distance  $d$  apart. If an external force brings a third particle, with mass  $2m$ , from far away to a resting point midway between the two particles, what is the work done by this force?

**Bonus Answer:**  $-8Gm^2/d^2$

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### 2. MATHEMATICS

Writer: Ashneel Das

Toss Up: Short Answer

Solve for  $x$  in the equation:  $\log_{\text{base } 2} \text{ of } x = 64$

**Bonus Answer:** 6

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**Bonus: Short Answer**

If  $3x/4 + 5x/8 = 10$ , what is  $x$ ?

**Bonus Answer:**  $80/11$

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### 3. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

The mass of the planet Yor'Ectum is  $1/100$  that of Earth and its radius is  $1/4$  that of Earth. If a person weighs 600N on Earth, what would he weigh on Yor'Rectum?

**Bonus Answer:** 96N

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**Bonus: Multiple Choice**

The escape speed at the surface of Earth is approximately 8 km/s. What is the mass, in units of Earth's mass, of a planet with twice the radius of Earth for which the escape speed is twice that for Earth?

- W) 2
- X) 4
- Y) 8
- Z)  $1/2$

**Bonus Answer:** Y

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### 4. MATHEMATICS

Writer: Ashneel Das

Toss Up: Multiple Choice

Solve the following equation for  $x$ :  $3|x-3| = 6$

- W) 1
- X) 5
- Y) 1 and 5
- Z) 0

**Toss Up Answer:** Y

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**Bonus: Short Answer**

Three times a number is 6 less than 4 times the same number. What is the number?

**Bonus Answer: 6**

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**5. PHYSICS**

**Writer: Charles Zhang**

**Toss Up: Multiple Choice**

A cube with 2-m sides and a bulk modulus of  $4 \times 10^5 \text{ N/m}^2$  (READ 4 times 10 to the sixth newton meters squared).

When it's subjected to a pressure of  $2 \times 10^5 \text{ Pa}$ , what is the resulting volume of the cube?

W)  $0.5 \text{ m}^3$

X)  $2 \text{ m}^3$

Y)  $3 \text{ m}^3$

Z)  $4 \text{ m}^3$

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

A 4.0-m long steel beam with a cross-sectional area of  $1.0 \times 10^{-2} \text{ m}^2$  and a Young's modulus of  $2.0 \times 10^{11} \text{ N/m}^2$  is wedged horizontally between two vertical walls. In order to wedge the beam, it is compressed by 0.020mm. If the coefficient of static friction between the beam and the walls is 0.70, what is the maximum mass (including its own) it can bear without slipping?

W) 700kg

X) 710kg

Y) 900kg

Z) 910kg

**Bonus Answer: X**

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**6. MATHEMATICS**

**Writer: Ashneel Das**

**Toss Up: Short Answer**

If  $f(x) = 5$  what is  $f'(x)$ ?

**Bonus Answer: 0**

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**Bonus: Short Answer**

If  $f(x) = 5x^3 + 10x^2 + 7x + 4$ , what is  $f'(x)$ ?

**Bonus Answer:  $15x^2 + 20x + 7$**

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**7. PHYSICS**

**Writer: Charles Zhang**

**Toss Up: Multiple Choice**

To determine if a rigid body is in equilibrium the vector sum of the gravitational forces acting on the particles of the body can be replaced by a single force acting at which point?

W) the center of mass

X) the geometrical center

Y) the center of gravity

Z) a point on the boundary

**Toss Up Answer: Y**

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**Bonus: Short Answer**

A uniform 120-N plank is supported by two forces acting at one end and at a point halfway to the plank center. What are the magnitudes of these two forces?

**Bonus Answer: 80, 160**

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## 8. MATHEMATICS

**Writer: Calvin Aw**

**Toss Up: Short Answer**

How many distinct arrangements of the letters in SCIENCE are there?

**Bonus Answer: 1260**

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**Bonus: Short Answer**

How many diagonals are in a regular decagon?

**Bonus Answer: 35**

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## 9. PHYSICS

**Writer: Aaron Gee**

**Toss Up: Short Answer**

A charged particle is moving in a UNIFORM magnetic field. If the direction of motion of the charged particle is parallel to the magnetic field, describe the shape of the charged particle's path.

**Bonus Answer: Straight line**

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**Bonus: Multiple Choice**

For a parallel-plate capacitor with plate area "A" and plate separation "d", the capacitance is proportional to which of the following?

- W)  $A/d$  squared
- X)  $A$  times  $d$
- Y)  $A$  divided by  $d$
- Z)  $d$  divided by  $A$

**Bonus Answer: Y**

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## 10. BIOLOGY

**Writer: Shanjeed Ali**

**Toss Up: Multiple Choice**

What does it mean when an organism that can self-fertilize is true breeding?

- W) the organism will produce offspring that are genetically identical to it
- X) the organism's offspring will all be genetically identical to each other
- Y) the organism is heterozygous for the gene that controls that trait
- Z) the organism's offspring will have the same phenotype for a certain trait

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Gregor Mendel is known as the father of modern genetics due to his work with pea plants. Which of the following traits did he study: plant height, pod color, leaf shape, flower position?

**Bonus Answer: All except leaf shape**

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## 11. CHEMISTRY

**Writer: Nicholas Parker Ng**

**Toss Up: Multiple Choice**

Permalloy steel is an alloy which is 21.2% Fe by mass. How many grams of Fe are present in 1 kg of steel?

W) 212 g

X) 21.2 g

Y) 4.7 g

Z) .212 g

**Toss Up Answer: W**

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**Bonus: Short Answer**

Astatine, having atomic number 85 on the periodic table, is a radioactive member of the halogens. Give the full electron configuration of At. Arrange the orbitals in order of increasing energy. (Do not use noble gas abbreviations, such as [Xe], for this problem.)

**Bonus Answer: 1s22s22p63s23p64s23d104p65s24d105p66s24f145d106p5**

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## 12. BIOLOGY

**Writer: Shanjeed Ali**

**Toss Up: Short Answer**

Ruminants have the ability to digest what substance due to microorganisms in the stomach?

**Bonus Answer: Cellulose**

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**Bonus: Short Answer**

What is the main site of methane production in ruminants?

**Bonus Answer: Rumen, accept first chamber/stomach**

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## 13. CHEMISTRY

**Writer: Olivia Gallager**

**Toss Up: Short Answer**

Mass spectrometers shoot which subatomic particle at a sample to ionize it?

**Bonus Answer: electrons**

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**Bonus: Multiple Choice**

Radium-226 is most likely to undergo which type of nuclear decay?

W) electron capture

X) alpha

Y) beta

Z) positron

**Bonus Answer: X**

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## 14. BIOLOGY

**Writer: Shanjeed Ali**

**Toss Up: Multiple Choice**

Which of the following is not an phyla in the kingdom animalia?

W) Chordata

X) Lycophyta

Y) Bryozoa

Z) Cnidaria

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the order of the house mouse, mus musculus?

**Bonus Answer: Rodentia**

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## 15. CHEMISTRY

**Writer: Ahmad Alnasser**

**Toss Up: Short Answer**

Write the formula name for the strongest acid?

**Bonus Answer: H<sub>2</sub>SO<sub>4</sub>**

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**Bonus: Short Answer**

List in order of strength the following strong acid: (1) H<sub>3</sub>PO<sub>4</sub> (2) HBr (3) HCl (4) H<sub>2</sub>SO<sub>4</sub>

**Bonus Answer: 1 3 2 4**

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## 16. BIOLOGY

**Writer: Shanjeed Ali**

**Toss Up: Multiple Choice**

Which of the following is not true about genetically modified food?

W) genetically modified organisms are generally safe for human consumption

X) over 80 % of corn grown in the US is genetically modified

Y) genetically modified crops require larger amounts of pesticides

Z) genetically modified crops can yield greater harvests for less cost

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Bt corn is genetically modified to produce a certain protein that is poisonous to certain insects. What is the genus of the source of the genetic material that produces this corn?

**Bonus Answer: Bacillus**

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## 17. CHEMISTRY

**Writer: Ahmad Alnasser**

**Toss Up: Multiple Choice**

Boyle's Law relates:

W) pressure to volume

X) pressure to mols

Y) volume to mols

Z) temperature to volume

**Toss Up Answer: W**

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**Bonus: Short Answer**

A container holds 500. mL of CO<sub>2</sub> at 20.° C and 742 torr. What will be the volume of the CO<sub>2</sub> if the pressure is increased to 795 torr?

**Bonus Answer: 467 ml**

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## 18. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

The synaptonemal complex forms in which phase of meiosis?

**Bonus Answer: Prophase I (DO NOT ACCEPT: prophase, prophase II)**

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**Bonus: Multiple Choice**

Which of the following best describes the frequency of crossing over in animals?

- W) ~50 per chromosome pair
- X) ~2 per meiotic cells
- Y) ~1 per pair of sister chromatids
- Z) at least 1-2 per chromosome pair

**Bonus Answer: Z**

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## 19. CHEMISTRY

**Writer: Olivia Gallager**

**Toss Up: Short Answer**

Given 2,3-dichloropentane, what is the resulting molecule if potassium hydroxide is reacted with it at 200 degrees celsius?

**Bonus Answer: 2 pentyne**

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**Bonus: Short Answer**

Which single atom is the difference between an organic acid functional group and an aldehyde functional group?

**Bonus Answer: O, Oxygen**

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## 20. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

At which stage of mitosis are chromosomes usually photographed in order to produce a karyotype?

**Bonus Answer: metaphase**

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**Bonus: Short Answer**

Name all of the following that a homologous pairs of chromosomes share in common.

- I. length
- II. loci of genes
- III. characteristics encoded by their genes
- IV. DNA sequence

**Bonus Answer: I, II, III only**

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## 21. EARTH and SPACE

**Writer: Nicholas Parker Ng**

**Toss Up: Multiple Choice**

Which of the following is a local base level?

- W) Lake
- X) point bar
- Y) alluvial fan
- Z) floodplain

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

The dry lake beds in many deserts are

- W) playas
- X) pediments
- Y) bajadas
- Z) mesas

**Bonus Answer: W**

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## **22. BIOLOGY**

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

Asexual prokaryotic cell division occurs via which process?

**Bonus Answer: binary fission**

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**Bonus: Multiple Choice**

Mitosis in protists differ from other forms of eukaryotic mitosis in which way?

W) Microtubules attach to the chromosome kinetochores.

X) Chromosomes are condensed in prophase.

Y) The nuclear envelope is not disassembled and remains intact throughout the process.

Z) Sister chromatids cross over.

**Bonus Answer: Y**

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## **23. EARTH and SPACE**

**Writer: Nicholas Parker Ng**

**Toss Up: Multiple Choice**

The metamorphic rock formed from limestone is:

W) quartzite

X) slate

Y) greenstone

Z) marble

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

The direct impact of running water is called

W) bed load

X) meander cutoff

Y) base level

Z) hydraulic action

**Bonus Answer: Z**

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## **24. BIOLOGY**

**Writer: Calvin Vuong**

**Toss Up: Multiple Choice**

Fluctuations in the concentration of which of the following molecules is most responsible for transitioning between the phases of the cell cycle?

W) Cyclin-dependent kinases

X) potassium ions

Y) sucrose

Z) cyclins

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

What occurs after the M phase checkpoint in the cell cycle?

- W) Cohesins alter separate to allow chromatids to separate.
- X) Separase enzyme cleaves cohesins and allows chromatids to separate.
- Y) Kinetochores are able to bind to spindle microtubules.
- Z) Daughter cells are allowed to pass into G1.

**Bonus Answer: X**

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**25. EARTH and SPACE**

**Writer: Nicholas Parker Ng**

**Toss Up: Multiple Choice**

The most abundant sedimentary rocks are

- W) Limestone
- X) Mudrocks
- Y) Arkoses
- Z) Evaporites

**Toss Up Answer: X**

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**Bonus: Short Answer**

Dolostone is formed by the addition of what to limestone?

**Bonus Answer: Magnesium**

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