

## Round 21

### 1. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

Whose law defines the relationship between angle of incidence and of refraction?

W) Snell's

X) DeBroglie's

Y) Kepler's

Z) Carnot's

Toss Up Answer: W

---

Bonus: Short Answer

What are the names of Hydrogen's three isotopes?

Bonus Answer: Protium, Deuterium, Tritium (accept: Hydrogen, Deuterium, Tritium)

---

### 2. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What is the relationship between the surface area and the volume of a solid?

Bonus Answer: The surface area is the derivative of the volume/ the volume is the integral of the surface area when the constant is 0

---

Bonus: Multiple Choice

When the inner diagonal of a cube is 7 times root 3 inches, what is the surface area of the cube?

W) 216 square inches

X) 294 square inches

Y) 343 square inches

Z) 512 square inches

Bonus Answer: X

---

### 3. EARTH and SPACE

Writer: Zoe Orlin

Toss Up: Multiple Choice

Moonquakes occur due to

W) Asteriods

X) Tidal stresses

Y) Rotation irregularities

Z) Moonquakes do not happen

Toss Up Answer: X

---

Bonus: Short Answer

By magnitude, where did the largest earthquake ever happen?

Bonus Answer: Chile

---

### 4. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A 5 kg ball is ejected from a spring and it rolls 8m up a frictionless incline at 30 degrees before coming to a stop.

Assuming that  $g = 10 \text{ m/s}^2$  (READ AS 10 meters per second squared) and that the spring constant is 100N/m, how

far does the spring has to be compressed initially?

- W) 1m
- X) 2m
- Y) 4m
- Z) 6m

**Toss Up Answer: X**

---

**Bonus: Short Answer**

The potential energy of a 1kg particle is represented by  $U(x,y,z) = 2xy + 3z^2$  (READ AS: U of x, y, z equals 2xy plus 3 z squared). What is the magnitude of the force acting on the particle at position (0,4,1)?

**Bonus Answer: 10 N**

---

## 5. EARTH and SPACE

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

The Cascadia Subduction Zone separates the North American Plate and the

- W) Caribbean Plate
- X) Juan de Fuca Plate
- Y) Okhotsk Plate
- Z) Cocos Plate

**Toss Up Answer: X**

---

**Bonus: Short Answer**

During which geologic period did Pangaea start breaking up?

**Bonus Answer: Jurassic**

---

## 6. BIOLOGY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Insulin release results in all of the following physiological effects EXCEPT:

- W) Decreased glycogen stores in liver cells.
- X) Activation of glycogen synthase.
- Y) Inhibition of glycogen phosphorylase.
- Z) Increased fat production from glycerol and fatty acids in adipose tissue.

**Toss Up Answer: W**

---

**Bonus: Multiple Choice**

All of the following are stimulated by the sympathetic nervous system EXCEPT:

- W) increased heart rate.
- X) increase secretion of the sweat glands.
- Y) vasodilation in the skeletal muscles
- Z) increased peristalsis in the gastrointestinal tract.

**Bonus Answer: Z**

---

## 7. MATHEMATICS

**Writer: Shamaul Dilmohamed**

**Toss Up: Multiple Choice**

Given two attempts, what is the probability in a ratio of getting a multiple choice question correct, if there are 5 choices?

- W) 1:3
- X) 1:4
- Y) 2:3
- Z) 2:4

**Toss Up Answer: Y**

---

**Bonus: Multiple Choice**

What percentage of data falls within 2 standard deviations of the mean, assuming a normal distribution?

- W) 34.10%
- X) 47.70%
- Y) 68.20%
- Z) 95.40%

**Bonus Answer: Z**

---

**8. BIOLOGY**

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

What molecules prevent DNA strands from reziping after helicase unzips the strands during DNA replication?

**Bonus Answer: single stranded binding proteins**

---

**Bonus: Short Answer**

DNA ligase joins what in the lagging strand of DNA during DNA replication?

**Bonus Answer: Okazaki fragments**

---

**9. PHYSICS**

**Writer: Aaron Gee**

**Toss Up: Short Answer**

In the SI system of measure, what is the unit of capacitance?

**Bonus Answer: FARAD**

---

**Bonus: Short Answer**

How much work in joules is done by friction on a sled weighing 100 newtons during a 10 meter displacement? The coefficient of sliding friction is 0.1.

**Bonus Answer: 100**

---

**10. BIOLOGY**

**Writer: Ahmad Alnasser**

**Toss Up: Short Answer**

Both fungus-farming ants and their fungi can synthesize the same structural polysaccharide from the  $\beta$ -glucose. What is this polysaccharide?

**Bonus Answer: Chitin**

---

**Bonus: Short Answer**

Plasmogamy can directly result in which of the following? 1. cells with a single haploid nucleus 2. heterokaryotic cells 3. dikaryotic cells 4. cells with two diploid nuclei

**Bonus Answer: 2 and 3**

---

## 11. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What is the 3rd mersenne prime?

Bonus Answer: 31

---

Bonus: Multiple Choice

How many terms does the 15th integral of  $\sin x$  dx have?

W) 1

X) 2

Y) 15

Z) 16

Bonus Answer: Z

---

## 12. CHEMISTRY

Writer: Shanjeed Ali

Toss Up: Short Answer

Mixing 250 mL of 2.0 M sulfuric acid with 2 liters of 0.5 M sodium hydroxide will produce a solution with what pH?

Bonus Answer: 7

---

Bonus: Short Answer

Which of the following are strong bases: lithium hydroxide, strontium hydroxide, cesium hydroxide, barium hydroxide?

Bonus Answer: All except cesium hydroxide

---

## 13. EARTH and SPACE

Writer: Justin Lam

Toss Up: Multiple Choice

Which of the following is an extrusive igneous rock?

W) Granite

X) Obsidian

Y) Slate

Z) Diorite

Toss Up Answer: X

---

Bonus: Multiple Choice

Which of the following minerals is the hardest?

W) Quartz

X) Talc

Y) Feldspar

Z) Corundum

Bonus Answer: Z

---

## 14. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

What is the limit as  $x$  approaches 0 of  $x \times \ln x$ ?

- W) -1  
X) 1  
Y) 0  
Z) The limit does not exist.

**Toss Up Answer: Y**

---

**Bonus: Short Answer**

What is the derivative of  $\operatorname{arcsec} x$ ?

**Bonus Answer:  $1/(x(x^2-1)^{.5})$**

---

## 15. EARTH and SPACE

**Writer: Matthew Lee**

**Toss Up: Short Answer**

Potential evapotranspiration as measured on a town's water budget is most directly affected by what variable?

**Bonus Answer: Air temperature**

---

**Bonus: Multiple Choice**

Why is adiabatic warming on the leeward side of a mountain range rapid?

- W) because of a decreased relative humidity  
X) because of cloud formation  
Y) because of a lower temperature on the windward side of the mountain range  
Z) because of adiabatic expansion

**Bonus Answer: W**

---

## 16. 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 always be replaced by a single force acting at which point, regardless of the uniformity of the gravitational field which acts upon it?

- W) the center of mass  
X) the geometrical center  
Y) the center of gravity  
Z) a point on the boundary

**Toss Up Answer: Y**

---

**Bonus: Short Answer**

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

**Bonus Answer: 40, 80**

---

## 17. BIOLOGY

**Writer: Shanjeed Ali**

**Toss Up: Short Answer**

What are the purine bases in DNA?

**Bonus Answer: Adenine and guanine**

---

**Bonus: Short Answer**

What are the pyrimidine bases in RNA?

Bonus Answer: Cytosine and uracil

=====

## 18. CHEMISTRY

Writer: Andrew Chen (Senior)

Toss Up: Short Answer

Please balance the given equation \_\_\_\_  $\text{CO}_3^{2-} + 2\text{H}^+ \rightarrow$  \_\_\_\_  $\text{H}_2\text{O} +$  \_\_\_\_  $\text{CO}_2$

Bonus Answer: 1,1,1

-----

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

=====

## 19. PHYSICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

The driver of a car moving at a speed of 10 m/s sees a child and immediately applies brakes to bring the car to rest in 150 meters. If the combined mass of the car and the driver is 1200 kg, the magnitude of the retarding force on the vehicle is:

- W) 300 N
- X) 350 N
- Y) 400 N
- Z) 450 N

Toss Up Answer: Y

-----

Bonus: Short Answer

A body is projected upwards with twice the escape velocity on Earth, 11.2 km/s. Ignoring the presence of other heavenly bodies, what is the speed of the body at infinity? Give your answer in km/s rounded to one decimal point.

Bonus Answer: 19.4 km/s

=====

## 20. 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

-----

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**

=====

## 21. BIOLOGY

**Writer: George Papastefanou**

**Toss Up: Multiple Choice**

Rett syndrome displays which of the following inheritance patterns?

- W) Autosomal Dominant  
X) Autosomal Recessive  
Y) X-Linked Dominant  
Z) X-Linked Recessive

**Toss Up Answer: Y**

=====

**Bonus: Short Answer**

In the genetic disorder known as cri-du-chat, what chromosome is affected?

**Bonus Answer: Chromosome 5**

=====

## 22. CHEMISTRY

**Writer: Josh Tish**

**Toss Up: Multiple Choice**

Which of the following is a nonelectrolyte in aqueous solution?

- W)  $\text{H}_2\text{SO}_4$   
X)  $\text{NaC}_2\text{H}_3\text{O}_2$   
Y)  $\text{K}_2\text{CO}_3$   
Z)  $\text{CH}_2\text{O}$

**Toss Up Answer: Z**

=====

**Bonus: Multiple Choice**

An aqueous solution of potassium sulfate has a freezing point of  $-2.24^\circ\text{C}$ . What is its molality?

( $K_f = 1.86^\circ\text{C}\cdot\text{m}^{-1}$ )

- W) 0.401 m  
X) 0.602 m  
Y) 1.20 m  
Z) 4.17 m

**Bonus Answer: W**

=====

## 23. BIOLOGY

**Writer: Ivan Zhang**

**Toss Up: Multiple Choice**

What is the name given to the crosses that occur when maternal and paternal DNA intertwine?

- W) polymerase  
X) chiasmata  
Y) zona pellucida  
Z) cambium

**Toss Up Answer: X**

---

**Bonus: Short Answer**

What is the name given to the follicle cells surrounding an egg that has left the ovary?

**Bonus Answer: corona radiata**

---

**24. CHEMISTRY**

**Writer: Prangon Ghose**

**Toss Up: Multiple Choice**

Which would be the easiest way to burn an iron nail?

W) Hold an iron nail with crucible tongs, and heat strongly in the flame of a bunsen burner.

X) Use the above method with an oxyacetylene torch to reach highest temperatures.

Y) Grind the nail into very small, dust-sized particles and spray them into a flame.

Z) Dissolve the nail in acid to make the oxide.

**Toss Up Answer: Y**

---

**Bonus: Multiple Choice**

What is a reasonable and safe substitute for zinc in reduction reactions in aqueous solutions?

W) S

X) F<sub>2</sub>

Y) K

Z) Cd

**Bonus Answer: Z**

---

**25. PHYSICS**

**Writer: Shantanu Jha**

**Toss Up: Multiple Choice**

What type of radiation is both the most penetrating and the most effectively stopped if blocked by a hydrogen-rich material?

W) Alpha

X) Beta

Y) Gamma

Z) Neutron

**Toss Up Answer: Z**

---

**Bonus: Multiple Choice**

What type of radiation originates from the electron cloud?

W) Alpha

X) Beta

Y) X-Ray

Z) Gamma

**Bonus Answer: Y**

---