

## Round 20

### 1. PHYSICS

Writer: William Xiang

Toss Up: Short Answer

Suppose that the fundamental dimensions are taken to be: force (F), velocity (V), and time (T). Find the dimensions of potential energy in simplest form.

Bonus Answer: FVT

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Bonus: Multiple Choice

A projectile of mass 0.50kg is fired with an initial speed of 10 m/s at an angle of 60 degrees above the horizontal. The potential energy of the projectile-Earth system (relative potential energy when the projectile is at ground level) is:

W) 25 J

X) 18.75 J

Y) 12.5 J

Z) 6.25 J

Bonus Answer: X

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### 2. PHYSICS

Writer: William Xiang

Toss Up: Short Answer

Name all of the following that are NOT correct units for work: Joule, Newton\*meter, Watt, ft\*lb, Volt

Bonus Answer: Watt, Volt

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Bonus: Multiple Choice

An 80-N crate slides with constant speed a distance of 5.0 m downward along a rough slope that makes an angle of 30 degrees with the horizontal. The work done by the force of gravity is:

W) -400 J

X) -200 J

Y) 200 J

Z) 400 J

Bonus Answer: Y

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### 3. PHYSICS

Writer: William Xiang

Toss Up: Short Answer

Name all of the following that are vector quantities: Weight, Distance, Velocity, Energy, Watt

Bonus Answer: Weight, Velocity

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Bonus: Multiple Choice

A man wishes to pull a crate 15 m across a rough floor by exerting a force of 100 N. The coefficient of kinetic friction is 0.25. For the man to do the least work, the angle between the force and the horizontal should be

W) 0 degrees

X) 14 degrees

Y) 43 degrees

Z) 66 degrees

Bonus Answer: W

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## 4. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

Which of the following bodies has the largest kinetic energy?

W) Mass 3M and speed V

X) Mass 3M and speed 2V

Y) Mass 2M and speed 3V

Z) Mass M and speed 4V

Toss Up Answer: Y

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Bonus: Multiple Choice

AN object is constrained by a cord to move in a circular path of radius 0.5m on a horizontal frictionless surface. The cord will break if its tension exceeds 16N. The maximum kinetic energy the object can have is:

W) 4J

X) 8J

Y) 17J

Z) 32J

Bonus Answer: W

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## 5. MATHEMATICS

Writer: Ivan Zhang

Toss Up: Multiple Choice

A function with the zero  $1 + 23i$  must have a multiplicity of at least?

W) 1

X) 23

Y) 4

Z) 2

Toss Up Answer: Z

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Bonus: Short Answer

Find the zeros of the function:  $0 = x^4 - 81$

Bonus Answer:  $3i, -3i, 3, -3$

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## 6. MATHEMATICS

Writer: Andrew Chen (Senior)

Toss Up: Short Answer

A square is inscribed within a circle with a radius of 2.5 cm. To the nearest tenths place what is the area of the square?

Bonus Answer:  $12.5 \text{ cm}^2$

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Bonus: Multiple Choice

Given the parabola  $y = 4x^2 + 2x - 10$  what is the equation of the line tangent to it at the point (0,-10)?

W)  $y = 2x + 10$

X)  $y = 2x - 5$

Y)  $y = 5x - 8$

Z)  $y = 2x - 10$

Bonus Answer: Z

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## 7. MATHEMATICS

Writer: Benjamin Avrahami

Toss Up: Short Answer

In simplest form, express the surface area to volume ratio of a cube with side length  $s$ .

Bonus Answer:  $6:s$

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Bonus: Short Answer

Calculate the harmonic mean of the first two perfect numbers and 10.

Bonus Answer:  $4 * \sqrt{105}$

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## 8. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

In the Christmas carol "The 12 Days of Christmas", the singer says that for every day of Christmas, their significant other gives them a quantity of a new gift equal to the current day of Christmas, plus the previous gifts given. For example, on the second day onward, the singer receives 2 turtledoves on each day until the end of Christmas. What is the greatest quantity of a single gift given during the 12 days?

W) 36

X) 40

Y) 42

Z) 48

Toss Up Answer: Y

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Bonus: Short Answer

How many total gifts are given in the 12 days of Christmas?

Bonus Answer: 364

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## 9. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

ATP is directly produced from glycolysis by which of the following?

W) respiration

X) oxidative phosphorylation

Y) substrate level phosphorylation

Z) pyruvate oxidation

Toss Up Answer: Y

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Bonus: Short Answer

What enzyme is responsible for converting fructose6-phosphate to fructose 1,6-biphosphate in the energy investment phase of glycolysis?

Bonus Answer: phosphofructokinase

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## 10. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which of the following is not an electron carrier involved cellular respiration?

W) NADH

X) FADH<sub>2</sub>

Y) NADPH

Z) NAD<sup>+</sup>

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

For each turn of the Krebs cycle, how many electron carriers are produced?

- W) 3 FADH<sub>2</sub> and 1 NADH
- X) 6 NADH and 2 FADH<sub>2</sub>
- Y) 3 NAD<sup>+</sup> and 1 FAD
- Z) 3 NADH and 1 FADH<sub>2</sub>

**Bonus Answer: Z**

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## 11. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

How many molecules of carbon dioxide are produced per turn of the Krebs cycle?

**Bonus Answer: 2**

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**Bonus: Multiple Choice**

A molecule of carbon dioxide is released in the Krebs cycle during the oxidation of which molecule?

- W) citrate
- X) succinyl CoA
- Y) malate
- Z) alpha-Ketoglutarate

**Bonus Answer: Z**

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## 12. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Multiple Choice**

Why are carbohydrates and fats considered high energy foods?

- W) They have a lot of oxygen atoms.
- X) They can have very long carbon skeletons.
- Y) They have a lot of electrons associated with hydrogen.
- Z) They are easily reduced.

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Substrate-level phosphorylation accounts for approximately what percentage of the ATP formed by the reactions of glycolysis?

- W) 0
- X) 2
- Y) 10
- Z) 100

**Bonus Answer: Z**

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## 13. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Multiple Choice**

The majority of ATP molecules generated from cellular respiration comes from which process?

- W) glycolysis
- X) pyruvate oxidation
- Y) the Krebs cycle
- Z) chemiosmosis

**Toss Up Answer: Z**

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**Bonus: Short Answer**

How many ATP molecules on average does chemiosmosis produce per glucose?

**Bonus Answer: Accept: 26, 28, or both.**

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## 14. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Multiple Choice**

The majority of photosynthesis occurs in which part of the leaf?

- W) the veins
- X) the lower palisade layer
- Y) the upper palisade layer
- Z) the stomata

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What is the final electron receptor in photosynthetic light reactions?

**Bonus Answer: NADP+ (Accept: NADPH)**

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## 15. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

The kinases that perform cellular activities throughout the cell cycle are allosterically regulated by what molecules?

**Bonus Answer: cyclins**

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**Bonus: Multiple Choice**

Synapsis begins during which stage of prophase I?

- W) leptotene
- X) zygotene
- Y) diplotene
- Z) diakinesis

**Bonus Answer: X**

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## 16. BIOLOGY

**Writer: Calvin Vuong**

**Toss Up: Short Answer**

What cytoskeletal component forms the cleavage furrow during cytokinesis?

**Bonus Answer: Microfilaments (Accept: actin)**

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**Bonus: Short Answer**

Microtubules are composed of what subunits?

Bonus Answer: tubulin (accept: alpha and beta tubulin dimers)

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## 17. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which transmembrane structures are responsible for communicating signals between the extracellular matrix and the internal microfilament cytoskeleton?

- W) integrins
- X) fibronectins
- Y) proteoglycan complexes
- Z) plasmodesmata

Toss Up Answer: W

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Bonus: Multiple Choice

The plasmodesmata of plant cells are most similar to which animal cell structure?

- W) the plasma membrane
- X) desmosomes
- Y) gap junctions
- Z) desmotubules

Bonus Answer: Y

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## 18. CHEMISTRY

Writer: Seiji Yawata

Toss Up: Multiple Choice

Which of the following compounds does not exist?

- W) PF<sub>5</sub>
- X) P<sub>4</sub>O<sub>10</sub>
- Y) P<sub>4</sub>O<sub>6</sub>
- Z) PH<sub>5</sub>

Toss Up Answer: Y

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Bonus: Short Answer

Order the following hydrogen halides from the one with the lowest boiling point to one with the highest: HI, HCl, HBr, HF

Bonus Answer: HCl, HBr, HI, HF (2, 3, 1, 4)

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## 19. CHEMISTRY

Writer: Seiji Yawata

Toss Up: Multiple Choice

Which of the following is the most acidic?

- W) o-methoxy benzoic acid
- X) benzoic acid
- Y) m-methoxy benzoic acid
- Z) p-methoxy benzoic acid

Toss Up Answer: W

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Bonus: Short Answer

What is the equivalent weight of HNO<sub>3</sub> in the reaction: Cu reacts with HNO<sub>3</sub>, forming Cu(NO<sub>3</sub>)<sub>2</sub>, NO and water.

Bonus Answer: 84

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## 20. CHEMISTRY

Writer: Seiji Yawata

Toss Up: Multiple Choice

The last electron of lanthanum enters in the:

- W) d orbital
- X) s orbital
- Y) p orbital
- Z) f orbital

Toss Up Answer: W

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Bonus: Multiple Choice

Which of the following is true for B<sub>3</sub>N<sub>3</sub>H<sub>6</sub>

- W) Its name is Nitroborane
- X) All the atoms are sp-hybridised
- Y) It has 3 lone pairs of electrons
- Z) It is isostructural with benzene

Bonus Answer: Z

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## 21. CHEMISTRY

Writer: Seiji Yawata

Toss Up: Multiple Choice

Which of the following statements is true?

- W) Hydrogen peroxide has a planar structure
- X) Tritium is radioactive and emits alpha particles
- Y) H<sub>2</sub> is insoluble in water
- Z) Hydrogen constitutes 70% of the Earth's crust by mass

Toss Up Answer: Y

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Bonus: Multiple Choice

Which of the following gas mixtures is not applicable to Dalton's law of Partial Pressures?

- W) CO<sub>2</sub> and N<sub>2</sub>
- X) CO<sub>2</sub> and CO
- Y) SO<sub>2</sub> and O<sub>2</sub>
- Z) N<sub>2</sub> and CO

Bonus Answer: Y

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## 22. CHEMISTRY

Writer: Andrew Chen (Senior)

Toss Up: Short Answer

Given the equation  $\text{HCl (aq)} + \text{NaOH (aq)} \rightarrow \text{NaCl (aq)} + \text{H}_2\text{O (l)}$  and that 10.00 mL of 1.5 M HCl was reacted with 20.00 mL of 0.80 M of NaOH, which compound is the limiting reactant?

Bonus Answer: HCl ( Hydrochloric acid)

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Bonus: Multiple Choice

In organic chemistry what is the name of the functional group consisting of a central carbon singly bonded to two carbon atoms and doubly bonded to an oxygen atom?

- W) amine
- X) amide
- Y) ether
- Z) ketone

**Bonus Answer: Z**

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## 23. EARTH and SPACE

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What comet was the first one recognized by astronomers to be periodic, with a period of roughly 76 years?

**Bonus Answer: Halley's Comet**

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**Bonus: Short Answer**

Located between the A and B rings of Saturn, what famous region stretches 4800 km and is characterized by a lack of material?

**Bonus Answer: Cassini Division**

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## 24. EARTH and SPACE

**Writer: Shamaul Dilmohamed**

**Toss Up: Multiple Choice**

Which famous astronomer created the "dirty snowball" hypothesis for comets, saying that comets were icy objects containing some dust and rock?

- W) Fred Whipple
- X) Fred Hoyle
- Y) Carl Sagan
- Z) Clyde Tombaugh

**Toss Up Answer: W**

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**Bonus: Short Answer**

Which comet was dubbed the comet of the 20th century, reaching an absolute magnitude value of -0.8 at perihelion?

**Bonus Answer: Comet Hale-Bopp**

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## 25. EARTH and SPACE

**Writer: Shamaul Dilmohamed**

**Toss Up: Multiple Choice**

Which of the following has the lowest specific heat?

- W) Copper
- X) Granite
- Y) Marble
- Z) Dry air

**Toss Up Answer: W**

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**Bonus: Short Answer**

Order the following rock particles from the biggest to the smallest: 1. Sand 2. Silt 3. Pebbles 4. Clay

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

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