

Round 13

1. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

The hydrolysis of t-bromobutane, C_4H_9Br , by hydroxide, OH^- , ions in aqueous solution follows an SN_1 reaction mechanism in which the rate-determining step is the loss of a bromide, Br^- , ion, followed by rapid reaction with hydroxide ions. Which of the following rate laws is consistent with this mechanism?

- W) Rate = $k[C_4H_9Br]$
- X) Rate = $k[C_4H_9Br][OH^-]$
- Y) Rate = $k[C_4H_9Br]^2$
- Z) Rate = $k[OH^-]$

Toss Up Answer: W

Bonus: Multiple Choice

Which of the following would be correct units for the rate constant of a reaction that is second order overall?

- W) s^{-1}
- X) $mol^{-1} dm^3 s^{-1}$
- Y) $mol cm^{-3} s^{-1}$
- Z) $mol^{-2} dm^6 s^{-1}$

Bonus Answer: X

2. MATHEMATICS

Writer: Hanna Yang

Toss Up: Multiple Choice

For which of the following values of x is $(x^2+x+4)/(x)$ an integer?

- W) 3
- X) 4
- Y) 5
- Z) 6

Toss Up Answer: X

Bonus: Short Answer

Find the remainder when $343x^3+49x^2+14x+1$ is divided by $7x - 1$.

Bonus Answer: 5

3. CHEMISTRY

Writer: Aaron Gee

Toss Up: Multiple Choice

Which of the following is NOT a colligative property?

- W) vapor pressure
- X) osmotic pressure
- Y) boiling point elevation
- Z) color of solution

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the following is a type of colloid that is classified as a

sol at room temperature?

W) gelatin

X) milk

Y) whipped cream

Z) marshmallow

Bonus Answer: W

=====

4. BIOLOGY

Writer: Mohammed Jamil

Toss Up: Multiple Choice

Which statement about carbohydrate biosynthesis during the dark reactions of photosynthesis (i.e. the Calvin cycle reactions) is NOT TRUE?

W) RUBISCO is a an enzyme required for carbon dioxide fixation.

X) NADPH is the source of electrons for glucose synthesis.

Y) ATP is the energy source for glucose synthesis.

Z) The reactions occur in the photosynthetic membranes of chloroplasts.

Toss Up Answer: Z

=====

Bonus: Short Answer

In the basic equation of photosynthesis for the synthesis of one molecule of a sugar such as glucose, how many molecules of carbon dioxide are required and how many molecules of oxygen are produced?

Bonus Answer: 6,6

=====

5. 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

=====

Bonus: Short Answer

What is the empirical formula of C₆H₁₁?

Bonus Answer: C₆H₁₁

=====

6. PHYSICS

Writer: Benjamin Avrahami

Toss Up: Multiple Choice

How many elements are in between the first two radioactive elements on the Periodic Table?

W) 15

X) 16

Y) 17

Z) 18

Toss Up Answer: Y

=====

Bonus: Short Answer

What is the name for the line dividing the metals and the nonmetals on the periodic table?

Bonus Answer: Amphoteric line or semimetal line or metalloid line

=====

7. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Short Answer

Find $x/y + y/x$ in simplest form if $x=7$ and $y=3$

Bonus Answer: 58/21

Bonus: Short Answer

Positive integers a and b satisfy $ab \mid a^2 + 4ab + 4b^2$ [" a divides a squared plus four a plus four b squared"]. The smallest possible value of $a+b$ is 2, which occurs when $a=b=1$ [" a equals b equals 1"]. What is the second smallest possible value of $a+b$?

Bonus Answer: 6: $a=4$, $b=2$

=====

8. CHEMISTRY

Writer: Shanjeed Ali

Toss Up: Short Answer

What will happen solubility of oxygen gas as temperature increases?

Bonus Answer: Decrease

Bonus: Short Answer

Which elements are found in the form of diatomic gases at room temperature?

Bonus Answer: Hydrogen, oxygen, fluorine, chlorine, nitrogen

=====

9. PHYSICS

Writer: Jason Mohabir

Toss Up: Multiple Choice

NMR spectroscopy is

W) diffraction

X) absorption

Y) radiation

Z) emission

Toss Up Answer: X

Bonus: Multiple Choice

NMR is based on

W) nuclear fission

X) charge of nucleus

Y) magnetically moment of the nucleus

Z) electrical moment of the nucleus

Bonus Answer: Y

=====

10. BIOLOGY

Writer: Mohammed Jamil

Toss Up: Multiple Choice

What is a fluid analogous to blood in most invertebrates

W) Interstitial fluid

X) Hemolymphs

Y) Hemocyanin

Z) Plasma

Toss Up Answer: X

Bonus: Multiple Choice

Which of the following do not have a double circulatory system

W) Lizard

X) Human

Y) A bird

Z) A fish

Bonus Answer: Z

11. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What element is in all alloys classified as amalgam?

Bonus Answer: Mercury (accept: Hg)

Bonus: Short Answer

You have a solution of 5 molar Sodium Phosphate and need to prepare a solution of 500 millimolar Sodium Phosphate.

How much water would you add to 100 milliliter of the original 5 molar solution to produce the 500 millimolar solution?

Bonus Answer: 900 MILLILITERS (or 0.9 LITERS)

12. BIOLOGY

Writer: Matthew Lee

Toss Up: Multiple Choice

What enzyme, which can be inhibited or activated, serves as the point in which the cell is committed to performing glycolysis?

W) Hexokinase

X) Phosphoglucosomerase

Y) Phosphoglycerokinase

Z) Phosphofructokinase

Toss Up Answer: Z

Bonus: Multiple Choice

The electrons from the electron carrier FADH₂ are initially shuttled to which complex in the electron transport chain?

W) complex I

X) complex II

Y) complex III

Z) complex IV

Bonus Answer: X

13. MATHEMATICS

Writer: Ivan Zhang

Toss Up: Short Answer

What are all the rational roots of the polynomial $y^3 + 10y^2 + 123y + 5$?

Bonus Answer: There are none.

Bonus: Short Answer

What is the area of a equilateral triangle inscribed in a circle with a radius of 6?

Bonus Answer: (27(radical 3))

14. EARTH and SPACE

Writer: Shanjeed Ali

Toss Up: Short Answer

The Ring of Fire surrounds which ocean?

Bonus Answer: Pacific Ocean

Bonus: Multiple Choice

What kind of volcano is Mauna Loa?

W) cone

X) shield

Y) subglacial

Z) stratovolcano

Bonus Answer: X

15. PHYSICS

Writer: Prangon Ghose

Toss Up: Short Answer

A ball with mass 0.2 kg is thrown at a wall with velocity 20 m/s and rebounds with a velocity of 15 m/s. What is the impulse of the net force imposed on the ball?

Bonus Answer: 7 kgm/s

Bonus: Short Answer

In a jousting game, a student of 60 kg with velocity 5 m/s is rolled towards a student of 30 kg at rest. When they collide, their poles conserve all of their kinetic energy as potential energy and redistribute it. What is the final velocity of the 30 kg student to the tenth place?

Bonus Answer: 6.6 m/s

16. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Where in the H-R Diagram would Betelgeuse be found?

W) Upper Left Corner

X) Lower Left Corner

Y) Upper Right Corner

Z) Lower Right Corner

Toss Up Answer: Y

Bonus: Multiple Choice

At what distance is absolute magnitude the same as apparent magnitude?

W) 1 AU

X) 100 AU

Y) 1 parsec

Z) 10 parsecs

Bonus Answer: Z

=====

17. MATHEMATICS

Writer: Andrew Chen (Senior)

Toss Up: Multiple Choice

Simplify the following expression: $(x^3+27)/(x+3)$ if $x=12$

W) 125

X) 117

Y) 136

Z) 109

Toss Up Answer: X

Bonus: Short Answer

Find all the real solutions of $x^4-18=-2$

Bonus Answer: $x=2$, $x=-2$

=====

18. 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%

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

=====

19. EARTH and SPACE

Writer: Prangon Ghose

Toss Up: Multiple Choice

Which planet's tilt of the axis is closest to that of Mars?

W) Mercury

X) Venus

Y) Earth

Z) Jupiter

Toss Up Answer: Y

Bonus: Multiple Choice

Which planet rotates the fastest in our solar system?

W) Earth

- X) Jupiter
- Y) Pluto
- Z) Uranus

Bonus Answer: X

=====

20. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

A 40 kilogram girl climbs a vertical distance of 5 meters in twenty seconds at a constant velocity. How much work has the girl done?

Bonus Answer: 2000 joules / 1960 joules (accept either)

Bonus: Short Answer

A machine performs 8 Joules of work in 2 seconds. How much power is delivered by this machine?

Bonus Answer: 4 Watts

=====

21. BIOLOGY

Writer: Ivan Zhang

Toss Up: Multiple Choice

What enzyme in the digestive system first breaks down starches?

- W) protease
- X) secretin
- Y) cholecystokinin
- Z) amylase

Toss Up Answer: Z

Bonus: Short Answer

What cavity is used cnidarians in digestion?

Bonus Answer: gastrovascular cavity

=====

22. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

A beam of white light hits the sharp end of a glass prism and is broken up into monochromatic components. Which of the following phenomenon is this a direct example of?

- W) Refraction
- X) Dispersion
- Y) Rarefaction
- Z) Diffraction

Toss Up Answer: X

Bonus: Short Answer

A projectile whose mass is 9.4 kg is fired vertically upward. On its upward flight, an energy of 68 kJ is dissipated because of air resistance. How much higher would it have gone if the air resistance had been made negligible? Round to the nearest ten meters.

Bonus Answer: 740 m

=====

23. BIOLOGY

Writer: Justin Lam

Toss Up: Multiple Choice

Which of the following polysaccharides is commonly found in the exoskeleton of insects?

- W) Cellulose
- X) Chitin
- Y) Starch
- Z) Glycogen

Toss Up Answer: X

Bonus: Multiple Choice

In which stage of cellular respiration is glucose broken down into two pyruvate molecules?

- W) Krebs Cycle
- X) Electron Transport Chain
- Y) Glycolysis
- Z) Oxidative Phosphorylation

Bonus Answer: Y

24. EARTH and SPACE

Writer: Zoe Orlin

Toss Up: Short Answer

what is a front?

Bonus Answer: boundary between two air masses

Bonus: Short Answer

How does a cold front form?

Bonus Answer: cold air moves in and pushes warm air up

25. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Name all of the following genetic disorders that exhibit dominant inheritance.

1. achondroplasia
2. polydactyly
3. cri-du-chat syndrome
4. Huntington's disease

Bonus Answer: 1, 2, 4

Bonus: Short Answer

Name all of the following genetic disorders that result from chromosomal abnormalities.

1. Down syndrome
2. color blindness
3. cri-du-chat
4. Klinefelter's Syndrome

Bonus Answer: 1, 3, 4
