

Round 13

1. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

A heat engine does positive work W as it absorbs energy Q_h (READ AS: $Q_{\text{sub } h}$) from a heat reservoir and transfers energy Q_c (READ AS: $Q_{\text{sub } c}$) to a cold reservoir. What is the efficiency of the heat engine in terms of Q_h , Q_c , and W ?

Bonus Answer: W/Q_h

Bonus: Multiple Choice

For Christmas, Bobby Tables got a heater with a coefficient of performance of 10. If the heater transfers 50 kilojoules of heat into the room in 2 seconds, what is the power of the heater in kilowatts?

- W) 1
- X) 2.4
- Y) 2.1
- Z) 2.5

Bonus Answer: Z

2. PHYSICS

Writer: Andrew Chen (Senior)

Toss Up: Short Answer

Given a 5 meter length of gold wire with a radius of 0.05 meters with a resistivity of 2.2×10^{-8} , find the resistance in the wire.

Bonus Answer: 4.4×10^{-5} ohms

Bonus: Multiple Choice

Given the following quantities chose the answer that contains only vector quantities.

- W) Length, force, momentum
- X) Momentum, temperature, work
- Y) displacement, acceleration, velocity
- Z) entropy, pressure, mass

Bonus Answer: Y

3. PHYSICS

Writer: Banpreet Singh

Toss Up: Short Answer

A flatbed truck is carrying a crate along a level road. The coefficient of static friction between the load and the bed is 0.4. The truck accelerates forward and the crate stays in its place on the truck bed. In what direction is the force that the bed exerts on the crate?

Bonus Answer: Forward

Bonus: Multiple Choice

James and John dive from an overhang into the lake below. James simply drops straight down from the edge. John takes a running start and jumps with an initial horizontal velocity of 25 m/s. Compare the time it takes each to reach the lake below.

- W) Cannot be determined without knowing the mass of both James and John.
- X) James and John will reach the surface of the lake at the same time.
- Y) John reaches the lake first.

Z) James reaches the lake first.

Bonus Answer: X

=====

4. PHYSICS

Writer: Banpreet Singh

Toss Up: Multiple Choice

For general projectile motion, the horizontal component of a projectile's acceleration

W) continuously increases

X) is zero

Y) remains a non-zero constant

Z) continuously decreases

Toss Up Answer: X

=====

Bonus: Multiple Choice

If the acceleration of an object is directed parallel to the velocity vector,

W) the object is not moving

X) the object is turning

Y) the object is slowing down

Z) the object is speeding up

Bonus Answer: Z

=====

5. MATHEMATICS

Writer: Henry Zheng

Toss Up: Short Answer

What is the 5th term in the geometric progression whose first three terms are 64, 16, 4?

Bonus Answer: 1/4 or 0.25

=====

Bonus: Short Answer

Giving your answer in centimeters to the nearest whole number, if one leg of an isosceles right triangle is 100 centimeters long, how long is the hypotenuse?

Bonus Answer: 141

=====

6. MATHEMATICS

Writer: Henry Zheng

Toss Up: Short Answer

Solve the following equation for x: $-3|x| = -15$ (read as: minus 3 times the absolute value of x equals minus 15).

Bonus Answer: 5 and -5

=====

Bonus: Short Answer

One-half of a number added to one third of the same number is 68 less than the number. What is the number?

Bonus Answer: 408

=====

7. MATHEMATICS

Writer: Henry Zheng

Toss Up: Short Answer

If a 6-foot tall person who is standing next to a vertical pole casts a shadow of 8 feet and the pole casts a shadow of 40 feet, how many feet tall is the pole?

Bonus Answer: 30

Bonus: Short Answer

Solve the following equation for x: $(x+9) / (x+10) = 20 / 18$ (read as: the quantity x plus nine over the quantity x plus ten is equal to twenty over eighteen)

Bonus Answer: -19

8. MATHEMATICS

Writer: Henry Zheng

Toss Up: Multiple Choice

Which of the following numbers is evenly divisible by 4?

W) 1722

X) 2636

Y) 4114

Z) 6126

Toss Up Answer: X

Bonus: Short Answer

Rounded to the nearest centimeter, if side A of a right triangle measures 2 centimeters and side B measures 10 centimeters, what is the length of the hypotenuse?

Bonus Answer: 10

9. BIOLOGY

Writer: Justin Lam

Toss Up: Short Answer

In photosynthesis, what are the three products released from hydrolysis?

Bonus Answer: Hydrogen or Hydrogen Ions (H⁺) , Oxygen or Oxygen Gas , and Electrons

Bonus: Multiple Choice

Which of the following carbohydrates the human body can NOT digest?

W) Fructose

X) Cellulose

Y) Sucrose

Z) Dextrose

Bonus Answer: X

10. BIOLOGY

Writer: Justin Lam

Toss Up: Multiple Choice

Which of the following stages in cellular respiration generates the most ATP (Adenosine triphosphate) ?

W) Krebs Cycle

X) Glycolysis

Y) Electron Transport Chain

Z) Pyruvate Oxidation

Toss Up Answer: Y

Bonus: Short Answer

In cellular respiration, there are two main electron carriers produced. What are their chemical formulas?

Bonus Answer: NADH and FADH₂ (Some may mention the "empty forms" of these electron carriers: NAD⁺ and FAD ; those answers are acceptable as well).

=====

11. BIOLOGY

Writer: Hanna Yang

Toss Up: Short Answer

What is the name of the process wherein osteoblasts lay down new bone material?

Bonus Answer: Ossification, Osteogenesis, Bone Tissue Formation

Bonus: Short Answer

What is the name of the structure within a bone that creates a network containing blood vessels?

Bonus Answer: Haversian Canals

=====

12. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

An individual suffers brain damage that results in respiratory failure. Which region of the brain was most likely damaged?

- W) Substantia nigra
- X) Pons
- Y) Red nucleus
- Z) Reticular formation

Toss Up Answer: X

Bonus: Multiple Choice

A man and a woman get married and soon learn that they both have a rare, genetically inherited recessive disorder that makes them prone to dizziness. Worried about the fate of their children, they seek the advice of a genetic counselor. She sequences their genomes and assures them that none of their children will have the disorder. What information would she have to obtain from the sequencing procedure that allows her to make this claim?

- W) The dizziness phenotype in the man is due to a mutation in a gene other than the gene responsible for the woman's phenotype.
- X) The dizziness disorder is an autosomal recessive trait.
- Y) The man and the woman are related genetically causing the same dizziness phenotype.
- Z) It is impossible for the man and the woman to have unaffected children - the genetic counselor is wrong.

Bonus Answer: W

=====

13. BIOLOGY

Writer: Josh Tish

Toss Up: Short Answer

After 12 weeks of gestation, what is the principal source of estrogen and progesterone to a human fetus?

Bonus Answer: corpus luteum

Bonus: Multiple Choice

Fat enters the venous system from the digestive system via the:

- W) hepatic artery

- X) hepatic vein
- Y) thoracic duct
- Z) hepatic portal system

Bonus Answer: Y

=====

14. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

What is the probability of obtaining offspring with the AAbbCCdd genotype from parents with the genotypes AaBbCcDd and AABbCcDd (assume independent assortment of all gene pairs)?

- W) 1/64
- X) 1/128
- Y) 3/128
- Z) none of the above

Toss Up Answer: X

Bonus: Multiple Choice

A red pigment is extracted from a marine alga. Which best supports the hypothesis that the pigment is involved in photosynthesis? The red pigment:

- W) has an absorption spectrum similar to the photosynthetic action spectrum for that same marine alga
- X) contains iron which is a transition element similar to magnesium.
- Y) has a molecular structure similar to that of chlorophyll.
- Z) is also found in land plants together with a variety of other pigments and specific enzymes that are related to the action spectrum for photosynthesis.

Bonus Answer: W

=====

15. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Which of the following are characteristics of both bacteria and fungi?

- W) Cell wall, unicellularity, and mitochondria
- X) Cell wall, DNA, and plasma membrane
- Y) Nucleus, organelles, and unicellularity
- Z) Nucleus, RNA, and cell wall

Toss Up Answer: X

Bonus: Multiple Choice

Terminally differentiated cells are most often found in which phase of the cell cycle?

- W) G0
- X) G1
- Y) G2
- Z) S

Bonus Answer: W

=====

16. BIOLOGY

Writer: Hanna Yang

Toss Up: Multiple Choice

Which of the following cells come from megakaryocytes?

W) Erythrocytes

X) Leukocytes

Y) Blood Thrombocytes

Z) Osteocytes

Toss Up Answer: Y

Bonus: Multiple Choice

Which of the following diseases is caused by a point mutation?

W) Huntington's Disease

X) Hemophilia B

Y) Cystic Fibrosis

Z) Tay-Sachs Disease

Bonus Answer: X

17. BIOLOGY

Writer: Nten Nylam

Toss Up: Short Answer

What hormone is released in response to low blood sugar levels?

Bonus Answer: glucagon

Bonus: Multiple Choice

Which of the following changes occur upon the activation of the sympathetic nervous system?

W) Heart rate increases

X) Rate of digestion increases

Y) Pupils constrict

Z) Glucose is converted to glycogen

Bonus Answer: W

18. 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) NH_4OH

Toss Up Answer: Z

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)

19. 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

20. CHEMISTRY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which of the following is an example of a strong nucleophile but a weak base?

W) CH₃OH

X) OH⁻

Y) I⁻

Z) F⁻

Toss Up Answer: Y

Bonus: Short Answer

By name or number, which of the following are second order reactions? Sn1, Sn2, E1, E2

Bonus Answer: Sn2 and E2 only (accept 2, 4 only)

21. CHEMISTRY

Writer: Siam Muquit

Toss Up: Short Answer

By name or number, which of the following is associated with inversion of stereochemistry? Sn1, Sn2, E1, E2

Bonus Answer: Sn2 only (2 only)

Bonus: Short Answer

Which rule states that in E1 and E2 reactions, the more substituted double bond is more likely to occur?

Bonus Answer: Saytzeff rule

22. CHEMISTRY

Writer: Jason Weng

Toss Up: Multiple Choice

If 2 moles of Ar and 5 moles of Xe are placed into one container. What is the partial pressure of Ar if the container is at 14 atm?

W) 2 atm

X) 5 atm

Y) 4 atm

Z) 10 atm

Toss Up Answer: Y

Bonus: Short Answer

How much faster is the effusion of helium gas compared to ammonia gas, to the nearest whole number?

Bonus Answer: 2

23. EARTH and SPACE

Writer: Yevgeniy Gorbachev

Toss Up: Multiple Choice

The square of a body's orbital period is proportional to:

W) The semi-major axis of the orbit

X) The square of the quotient of the apocenter and pericenter heights of the orbit

Y) The cube of the semi-major axis of the orbit

Z) The cube of the major axis of the orbit

Toss Up Answer: Y

Bonus: Short Answer

Specific orbital energy does not vary with time according to...

Bonus Answer: Orbital Energy Conservation Equation (also acceptable: vis-viva equation)

24. 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

25. EARTH and SPACE

Writer: Justin Lam

Toss Up: Multiple Choice

Which of the following gases make up the majority of Earth's atmosphere?

W) Oxygen

X) Argon

Y) Carbon dioxide

Z) Nitrogen

Toss Up Answer: Z

Bonus: Short Answer

What is the name for the scientific theory that describes the movement of plates across the Earth's lithosphere?

Bonus Answer: Plate tectonics
