

Round 33

1. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A wheel starts from rest and has an angular acceleration that is given by $\alpha(t) = (6 \text{ rad/s}^4)t^2$ (READ AS: 6 radians per seconds to the fourth times t squared). What is the angle the wheel turns through after time t?

W) $[(1/8)t^4]$ rad

X) $[(1/4)t^4]$ rad

Y) $[(1/2)t^4]$ rad

Z) $[t^4]$ rad

Toss Up Answer: Y

Bonus: Short Answer

String is wrapped around the periphery of a 5.0-cm radius cylinder, free to rotate on its axis. The string is pulled straight out at a constant rate of 10 cm/s and does not slip on the cylinder. As each small segment of string leaves the cylinder, what does its acceleration change by?

Bonus Answer: 0.2 m/s²

2. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

What is the unit of the quantity $1/(4\pi\epsilon_0)$ (READ AS: 1 over 4 times Pi times epsilon naught)?

Bonus Answer: N*m²/C² (READ AS: newton meters squared over coulomb squared)

Bonus: Short Answer

An time-varying electric field is given by $(24t^2 \text{ N/C})\mathbf{i} + (30t \text{ N/C})\mathbf{j} + (16/t \text{ N/C})\mathbf{k}$. What is its flux at time $t=2$ as it passes through a region in the y-z plane whose area is given by $A(t)=2t$?

Bonus Answer: 112 N/C

3. MATHEMATICS

Writer: Hanna Yang

Toss Up: Multiple Choice

If 8 moles dig 8 holes in 8 years, how many holes can 4 moles dig in 1461 days?

W) 1

X) 2

Y) 4

Z) 8

Toss Up Answer: X

Bonus: Short Answer

If 9 moles dig 24 holes in 10 days, how many holes can 3 moles dig in 5 days?

Bonus Answer: 4

4. MATHEMATICS

Writer: Hanna Yang

Toss Up: Short Answer

What is the name of the principle that states that 5 avocados cannot be placed in 4 holes without 2 of them being placed in the same one?

Bonus Answer: Pigeonhole Principle

Bonus: Short Answer

In triangle ABC with integer side lengths, $AB = 7$, $BC = 14$, and $AC < 9$. Find AC.

Bonus Answer: 8 (Triangle Inequality)

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5. MATHEMATICS

Writer: Ivan Zhang

Toss Up: Multiple Choice

What is the square root of 2 (to the nearest tenths)?

W) 1.7

X) 1.5

Y) 1.3

Z) 1.4

Toss Up Answer: Z

Bonus: Short Answer

What is the equation of a circle with circumference 6π that is positioned 3 points above the x axis and 4 points before the y axis?

Bonus Answer: $(x-4)^2 + (y+3)^2 = 9$

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6. MATHEMATICS

Writer: Ivan Zhang

Toss Up: Multiple Choice

What is asymptote of the function: $f(x) = 1/x$?

W) $y = 0$

X) $x = 0$

Y) $x = 0, y = 1$

Z) $x = 0, y = 0$

Toss Up Answer: Z

Bonus: Short Answer

Plugging the divergent series, $1 + 2 + 3 + 4 + \dots$, into the Riemann Zeta Function results in which number?

Bonus Answer: $-1/12$

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7. MATHEMATICS

Writer: Larry Wong

Toss Up: Short Answer

What is the distance in space between the points with coordinates $(-3, 6, 7)$ and $(2, -1, 4)$?

Bonus Answer: 9.11

Bonus: Multiple Choice

The diameter and height of a right circular cylinder are equal. If the volume of the cylinder is 2, what is the height of the cylinder?

W) 1.37

X) 1.08

Y) 0.86

Z) 0.8

Bonus Answer: W

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8. MATHEMATICS

Writer: Larry Wong

Toss Up: Multiple Choice

If $\log_x (1/8) = -3/2$, then x is equal to

W) -4

X) 4

Y) $1/4$

Z) 10

Toss Up Answer: X

Bonus: Multiple Choice

f is a function such that $f(x) < 0$. The graph of the new function g defined by $g(x) = |f(x)|$ is a reflection of the graph of f

W) on the y axis

X) on the x axis

Y) on the line $y = x$

Z) on the line $y = -x$

Bonus Answer: X

9. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Which cyclin-Cdk complex triggers the cell's passage past the G2 checkpoint into mitosis?

Bonus Answer: MPF (ACCEPT: mitosis promoting factor, maturation promoting factor)

Bonus: Short Answer

In which cell cycle phase does the most important checkpoint, also called the restriction point, occur?

Bonus Answer: G1 (ACCEPT: between G1 and S)

10. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

The MPF protein complex turns itself off in the cell cycle by

W) activating a process that destroys its cyclin components

X) activating an enzyme that stimulates cyclin

Y) binding to chromatin

Z) activating the anaphase-promoting complex

Toss Up Answer: W

Bonus: Short Answer

The cyclin component of MPF is destroyed toward the end of which cell cycle phase?

Bonus Answer: M phase (ACCEPT: mitosis, mitotic phase)

11. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which of the following types of cells do not exhibit density-dependent inhibition concerning reproduction?

W) neurons

X) cells in your liver

- Y) cells in a malignant tumor
- Z) cells surrounding your stomach

Toss Up Answer: Y

Bonus: Short Answer

Which cell part is most directly responsible for detecting the cell density of its surrounding area in order for the cell to exhibit density-dependent inhibition?

Bonus Answer: extracellular matrix

12. 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

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

13. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Asexual prokaryotic cell division occurs via which process?

Bonus Answer: binary fission

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

14. 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

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

15. 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)

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

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

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

17. BIOLOGY

Writer: Shanjeed Ali

Toss Up: Multiple Choice

Which of the following is not a phylum in the kingdom animalia?

- W) Chordata
- X) Lycopphyta
- Y) Bryozoa
- Z) Cnidaria

Toss Up Answer: X

Bonus: Short Answer

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

Bonus Answer: Rodentia

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18. 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

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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19. 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

Bonus: Short Answer

A container holds 500. mL of CO₂ at 20.° C and 742 torr. What will be the volume of the CO₂ if the pressure is increased to 795 torr?

Bonus Answer: 467 ml

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20. CHEMISTRY

Writer: Ahmad Alnasser

Toss Up: Short Answer

Write the formula name for the strongest acid?

Bonus Answer: H₂SO₄

Bonus: Short Answer

List in order of strength the following strong acid: (1) H₃PO₄ (2) HBr (3) HCl (4) H₂SO₄

Bonus Answer: 1 3 2 4

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21. CHEMISTRY

Writer: Olivia Gallager

Toss Up: Short Answer

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

Bonus Answer: electrons

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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22. 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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23. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Which one of these is NOT true?

W) All planets revolve in the same direction.

X) All planets rotate in the same direction.

Y) The orbits of the planets are all ellipses.

Z) The orbits of the planets are nearly in the same plane.

Toss Up Answer: X

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Bonus: Multiple Choice

Coal is believed to have been principally formed in which of the following types of environment?

W) river beds

X) swamps

Y) volcanic regions

Z) deserts

Bonus Answer: X

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24. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

The principal mineral in most sand beaches is

W) quartz

X) orthoclase

Y) magnetite

Z) muscovite

Toss Up Answer: W

Bonus: Short Answer

What geological event will allow you to see Bishop's ring?

Bonus Answer: a volcanic eruption

25. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

In which state is the oldest North American lake located?

W) California

X) Minnesota

Y) Ohio

Z) Utah

Toss Up Answer: W

Bonus: Short Answer

What is the densest naturally occurring element?

Bonus Answer: Osmium
