

Round 2

1. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

An object is dropped from an altitude of one Earth radius above Earth's surface. In terms of M , the mass of Earth, and R , Earth's radius, what is the speed of the object just before it hits Earth?

Bonus Answer: $\sqrt{GM/R}$ (READ AS: square root of GM over R)

Bonus: Short Answer

Two particles, each of mass m , are a distance d apart. If an external force brings a third particle, with mass $2m$, from far away to a resting point midway between the two particles, what is the work done by this force?

Bonus Answer: $-8Gm^2/d^2$

2. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

The mass of the planet Yor'Ectum is $1/100$ that of Earth and its radius is $1/4$ that of Earth. If a person weighs 600N on Earth, what would he weigh on Yor'Rectum?

Bonus Answer: 96N

Bonus: Multiple Choice

The escape speed at the surface of Earth is approximately 8 km/s . What is the mass, in units of Earth's mass, of a planet with twice the radius of Earth for which the escape speed is twice that for Earth?

- W) 2
- X) 4
- Y) 8
- Z) $1/2$

Bonus Answer: Y

3. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A cube with 2-m sides and a bulk modulus of $4 \times 10^5\text{ N/m}^2$ (READ 4 times 10 to the sixth newton meters squared). When it's subjected to a pressure of $2 \times 10^5\text{ Pa}$, what is the resulting volume of the cube?

- W) 0.5m^3
- X) 2m^3
- Y) 3m^3
- Z) 4m^3

Toss Up Answer: Z

Bonus: Multiple Choice

A 4.0-m long steel beam with a cross-sectional area of $1.0 \times 10^{-2}\text{ m}^2$ and a Young's modulus of $2.0 \times 10^{11}\text{ N/m}^2$ is wedged horizontally between two vertical walls. In order to wedge the beam, it is compressed by 0.020mm . If the coefficient of static friction between the beam and the walls is 0.70 , what is the maximum mass (including its own) it can bear without slipping?

- W) 700kg
- X) 710kg
- Y) 900kg

Z) 910kg

Bonus Answer: X

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4. 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 be replaced by a single force acting at which point?

W) the center of mass

X) the geometrical center

Y) the center of gravity

Z) a point on the boundary

Toss Up Answer: Y

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Bonus: Short Answer

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

Bonus Answer: 80, 160

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5. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

A charged particle is moving in a UNIFORM magnetic field. If the direction of motion of the charged particle is parallel to the magnetic field, describe the shape of the charged particle's path.

Bonus Answer: Straight line

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Bonus: Multiple Choice

For a parallel-plate capacitor with plate area "A" and plate separation "d", the capacitance is proportional to which of the following?

W) A/d squared

X) A times d

Y) A divided by d

Z) d divided by A

Bonus Answer: Y

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6. MATHEMATICS

Writer: Ashneel Das

Toss Up: Short Answer

Solve for x in the equation: log base 2 of x = 64

Bonus Answer: 6

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Bonus: Short Answer

If $3x/4 + 5x/8 = 10$, what is x?

Bonus Answer: 80/11

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7. MATHEMATICS

Writer: Ashneel Das

Toss Up: Multiple Choice

Solve the following equation for x: $3|x-3| = 6$

- W) 1
- X) 5
- Y) 1 and 5
- Z) 0

Toss Up Answer: Y

Bonus: Short Answer

Three times a number is 6 less than 4 times the same number. What is the number?

Bonus Answer: 6

8. MATHEMATICS

Writer: Ashneel Das

Toss Up: Short Answer

If $f(x) = 5$ what is $f'(x)$?

Bonus Answer: 0

Bonus: Short Answer

If $f(x) = 5x^3 + 10x^2 + 7x + 4$, what is $f'(x)$?

Bonus Answer: $15x^2 + 20x + 7$

9. MATHEMATICS

Writer: Calvin Aw

Toss Up: Short Answer

How many distinct arrangements of the letters in SCIENCE are there?

Bonus Answer: 1260

Bonus: Short Answer

How many diagonals are in a regular decagon?

Bonus Answer: 35

10. BIOLOGY

Writer: Shanjeed Ali

Toss Up: Multiple Choice

What does it mean when an organism that can self-fertilize is true breeding?

- W) the organism will produce offspring that are genetically identical to it
- X) the organism's offspring will all be genetically identical to each other
- Y) the organism is heterozygous for the gene that controls that trait
- Z) the organism's offspring will have the same phenotype for a certain trait

Toss Up Answer: Z

Bonus: Short Answer

Gregor Mendel is known as the father of modern genetics due to his work with pea plants. Which of the following traits did he study: plant height, pod color, leaf shape, flower position?

Bonus Answer: All except leaf shape

11. BIOLOGY

Writer: Shanjeed Ali

Toss Up: Short Answer

Ruminants have the ability to digest what substance due to microorganisms in the stomach?

Bonus Answer: Cellulose

Bonus: Short Answer

What is the main site of methane production in ruminants?

Bonus Answer: Rumen, accept first chamber/stomach

12. BIOLOGY

Writer: Shanjeed Ali

Toss Up: Multiple Choice

Which of the following is not an phyla in the kingdom animalia?

W) Chordata

X) Lycophyta

Y) Bryozoa

Z) Cnidaria

Toss Up Answer: X

Bonus: Short Answer

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

Bonus Answer: Rodentia

13. 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

14. 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

15. 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

16. 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

17. 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 separase 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

18. 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

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

19. 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

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

21. 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

22. 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

23. EARTH and SPACE

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Which of the following is a local base level?

- W) Lake
- X) point bar
- Y) alluvial fan
- Z) floodplain

Toss Up Answer: Z

Bonus: Multiple Choice

The dry lake beds in many deserts are

- W) playas
- X) pediments
- Y) bajadas
- Z) mesas

Bonus Answer: W

24. EARTH and SPACE

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

The metamorphic rock formed from limestone is:

- W) quartzite
- X) slate
- Y) greenstone
- Z) marble

Toss Up Answer: Z

Bonus: Multiple Choice

The direct impact of running water is called

- W) bed load
- X) meander cutoff
- Y) base level
- Z) hydraulic action

Bonus Answer: Z

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25. EARTH and SPACE

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

The most abundant sedimentary rocks are

- W) Limestone
- X) Mudrocks
- Y) Arkoses
- Z) Evaporites

Toss Up Answer: X

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Bonus: Short Answer

Dolostone is formed by the addition of what to limestone?

Bonus Answer: Magnesium

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