Saturday Packet By David Jiang

TOSS-UP

1) Physics – *Short Answer* The function $x = 3t + 5t^5$ is the function for a particle's position in meters at a given time in seconds. In meters per second squared, what is the particle's acceleration at t = 3?

ANSWER: 2700 $\frac{m}{s^2}$

BONUS

1) Physics – *Short Answer* The function $x = at^2 + bt^3$ is the function for a particle's position in m at a given time in seconds. What would the units have to be for a and b respectively?

ANSWER: $\frac{m}{s^2}$ and $\frac{m}{s^3}$

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TOSS-UP

2) Energy – *Short Answer* A new optical sensor developed at Lawrence Berkeley National Lab is able to detect and depict data from buildings damaged by earthquakes immediately after the earthquake has happened. What process is the reason behind buildings tilting and sinking during an earthquake?

ANSWER: SOIL LIQUEFACTION

BONUS

2) Energy – *Multiple Choice* Researchers at Lawrence Berkeley National Lab have recently discovered a new plastic named polydiketoenamine. This plastic is set to replace what plastic that is most commonly used to create water bottles with repeating $C_{10}H_8O_4$ units?

W) High-Density Polyethylene
X) Poly Vinyl Chloride
Y) Polyethylene Terephthalate
Z) Styrofoam

ANSWER: Y) POLYETHYLENE TEREPHTHALATE
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TOSS-UP

3) Chemistry – *Multiple Choice* Which of the following pairs arises from phonons attracting another electron to form a weakly bonded electron pair according to BCS theory?

W)Doublet
X)Cooper Pair
Y)Valence Pair
Z)Bose Einstein Pair

ANSWER: X) COOPER PAIR

BONUS

3) Chemistry – *Short Answer* The following reaction: $2ICl(g) \Leftrightarrow I2(g) + Cl2(g)$ has a pressure constant of 10^-8 Initially, in closed vessel ICl has a partial pressure of 0.250 atm and the partial pressure of both I2 and Cl2 is 0.375 atm. What is the partial pressure in atm of ICl once the system reaches equilibrium to the nearest hundredth?

ANSWER: 0.01

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TOSS-UP

4) Biology – *Short Answer* How many members of the ring does a molecule of cyclized fructose have?

ANSWER: 5

BONUS

4) Biology – *Multiple Choice* What carbohydrate is similar to that of glycogen, however is found in plants?

W)Cellulose
X)Glutamate
Y)Amylopectin
Z)Maltose

ANSWER: Y) Amylopectin
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TOSS-UP

5) Math – *Short Answer* Completely factor the following polynomial: $2x^2 + 8x + 8$

ANSWER: $2(x + 2)^2$ (Do not accept: 2(x+2)(x+2)

BONUS

5) Math – *Short Answer* How many integers between 98 and 122 are odd?

ANSWER: –2

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TOSS-UP

6) Earth and Space – *Short Answer* Identify all the following 3 things that are possible results from an earthquake. 1) Tsunami 2) Fires 3) Landslides

ANSWER: 1, 2, 3 (ACCEPT: ALL)

BONUS

6) Earth and Space – *Short Answer* What inosilicate is used to refer to a dark amphibole often found in igneous and metamorphic rocks?

ANSWER: HORNBLENDE
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TOSS-UP

7) Energy – *Multiple Choice* Researchers at Lawrence Berkeley National Lab have recently detailed the first technique to isolate active microbes in a soil sample. These scientists found single cell organisms that bind to a specific amino acid that is responsible for angiogenesis. What is this amino acid?

W) Methionine
X) Glycine
Y) Lysine
Z) Valine

ANSWER: W) METHIONINE

BONUS

7) Energy – *Short Answer* Researchers around the world have worked toward the detection of gravitational waves called LIGO which won the 2017 Nobel Physics Prize. The first star collision that these scientists detected were from the merging of what two types of stars?

ANSWER: Neutron Stars

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TOSS-UP

8) Biology – *Short Answer* A glycoside is formed from what kind of bond, that is often described as a covalent bond that joins carbohydrates together?

ANSWER: GLYCOSIDIC BONDS

BONUS

8) Biology – *Multiple Choice* Which of the following amino acids has a hydrophilic polar side chain?

W) Glycine
X) Alanine
Y) Valine
Z) Serine

ANSWER: Z) SERINE
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TOSS-UP

9) Physics – *Short Answer* A ball is thrown off a cliff that's 40 meters tall. Assuming gravity is 10 $\frac{m}{s^2}$, and the ball has a velocity of 40 m/s when the ball is half way down, what is the drop velocity of the ball?

ANSWER: 40

BONUS

9) Physics – *Multiple Choice* What is the minimum absolute magnitude of displacement for the sum of 4 vectors with magnitude x, 2x, 4x, and 8x.

W) x
X) -15x
Y) 15x
Z) 0

ANSWER: W) X

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TOSS-UP

10) Chemistry – *Multiple Choice* What Atom acts as the oxidizing agent in the following reaction: $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$?

w)Mn
x)O
y)H
z)Cl

ANSWER: W)Mn

BONUS

10) Chemistry – *Short Answer* What is the unit for the Rate Constant for a first order reaction?

ANSWER: 1/S (Accept: Inverse Seconds)
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TOSS-UP

11) Math – *Multiple Choice* How many zeroes are there at the end of 50 factorial?

W) 0
X) 12
Y) 24
Z) 50

ANSWER: X) 12

BONUS

11) Math – *Multiple Choice* For how many integer values of n is 100*(2/3)^n equal to the value of an integer?

W) Infinitely many
X) 0
Y) 2
Z) 3

ANSWER: Z) 3

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TOSS-UP

12) Earth and Space – *Short Answer* The two end members of the olivine solid solution series, Mg2SiO4 and Fe2SiO4, have drastically different melting points, at 1900 C and 1200 C respectively. What property of the metal cations causes this drastic difference?

ANSWER: IONIC RADIUS

BONUS

12) Earth and Space – *Multiple Choice* What volcanic rock is used as an abrasive in beauty salons, notably mainly used for its porous texture and low density?

W) Basalt
X) Pumice
Y) Rhyolite
Z) Andesite

ANSWER: X) PUMICE
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TOSS-UP

13) Biology – *Multiple Choice* What organelle is responsible for the breakdown of fatty acid chains through the process of beta oxidation?

W) Peroxisome
X) Lysosome
Y) Rough Endoplasmic Reticulum
Z) Smooth Endoplasmic Reticulum

ANSWER: Z) Peroxisome

BONUS

13) Biology – *Multiple Choice* Which of the following is an explanation for the lack of membrane bound organelles in mature erythrocytes?

W) During mitosis erythrocytes lose membrane bound organelles due to unexpected errors happening in anaphase.
X) Through evolution, erythrocytes have gotten rid of vestigial membrane bound organelles.
Y) Erythrocytes lose organelles as it matures in order to make way for hemoglobin.
Z) Erythrocytes do not have a lack of organelles

ANSWER: Y) ERYTHROCYTES LOSE ORGANELLES AS IT MATURES IN ORDER TO MAKE WAY FOR HEMOGLOBIN

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TOSS-UP

14) Energy – *Multiple Choice* Researchers at Lawrence Berkeley National Lab have recently pieced together the largest US-Based dark matter detector. Approximately what percent of the universe is composed of dark matter?

W) 10%
X) 25%
Y) 50%
Z) 85%

ANSWER: X) 25%

BONUS

14) Energy – *Short Answer* Scientists at Pacific Northwest National Laboratory have discovered a new Metal Oxide that is quoted as able to "activate electrical current flow by itself". This new technology will be able to help the advancement of what kind of materials commonly made out of semimetals?

ANSWER: SEMICONDUCTOR

TOSS-UP

15) Physics – Short Answer What boson has a positive charge and is responsible for mediating the weak nuclear force?

ANSWER: W+ BOSON (DO NOT ACCEPT: W- BOSON, Z BOSON)

BONUS

15) Physics – *Short Answer* What type of mechanics operates based on the difference of kinetic energy and potential energy of the system, which through Noether's Theorem explains symmetries?

ANSWER: Lagrangian Mechanics

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TOSS-UP

16) Earth and Space – *Short Answer* Chemical erosion is most commonly attributed to what feature of the erodant?

ANSWER: ACIDITY (ACCEPT: PH)

BONUS

16) Earth and Space – *Short Answer* What substance is postulated to be responsible for keeping galaxies rotating and not flying apart?

ANSWER: DARK MATTER
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TOSS-UP

17) Chemistry – *Multiple Choice* What chemical principle is responsible for divers receiving compression sickness?

W) Boyle's Law
X) Henry's Law
Y) Deep Sea Compression Law
Z) Dalton's Law

ANSWER: X) HENRY'S LAW

BONUS

17) Chemistry – *Short Answer* Give the standard state of matter for the following 3 elements 1) Carbon 2) Bromine 3)Mercury

ANSWER: SOLID, LIQUID, LIQUID

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TOSS-UP

18) Math – *Short Answer* Rounding your answer to the nearest thousandth, what is the hypotenuse of a right isosceles triangle with legs of length 1 cm?

ANSWER: 1.414

BONUS

18) Math – *Multiple Choice* What is the value of 10 choose 1 + 10 choose 2 + 10 choose 3 … 10 choose 9?

W) 1018
X) 1022
Y) 1024
Z) 1028

ANSWER: X) 1022
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TOSS-UP

19) Chemistry – *Short Answer* How many translational and rotational degrees of freedom does an atom of Ne have respectively?

ANSWER: 3, 0

BONUS

19) Chemistry – *Multiple Choice* Which of the following statements about colloids is not true?

W) The Tyndall effect is an effect that comes from the fact that colloids can reflect light.
X) A stable emulsion requires an emulsifying agent to be present.
Y) Foams are only the suspension of gas in a solid.
Z)The properties of stained glasses can be explained by an aqueous suspension of metal clusters.

ANSWER: Y) FOAMS ARE ONLY THE SUSPENSION OF GAS IN A SOLID.

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TOSS-UP

20) Physics – *Short Answer* A toy rolls off a table at 3 $\frac{m}{s}$, if it travels 3 meters along the x axis before hitting the ground, and gravity is 10 $\frac{m}{s^2}$. How tall is the table?

ANSWER: 5m

BONUS

20) Physics – *Short Answer* Two resistors in parallel have an equivalent resistance of 6 ohms. One of the resistors has a resistance of 10 ohms. What is the resistance, in ohms, of the second resistor?

ANSWER: 15
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TOSS-UP

21) Earth and Space – *Multiple Choice* Fracking is a process to obtain what common resource?

W) Coal
X) Natural gas
Y) Uranium ore
Z) Water

ANSWER: X) NATURAL GAS

BONUS

21) Earth and Space – *Short Answer* What nasa space probe flew past the dwarf planet Pluto in July 2015?

ANSWER: New Horizons

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TOSS-UP

22) Biology – *Short Answer* Identify all of the following 3 organisms that are able to form structures called spores? 1) Archaea 2) Eukaryotes 3) Prokaryotes

ANSWER: 2, 3

BONUS

22) Biology – *Short Answer* What biome is under permafrost however due to global warming has been defrosting recently, and is also the world's youngest biome?

ANSWER: TUNDRA
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TOSS-UP

23) Math – *Short Answer* What is the largest perfect square in which all of its digits are also odd?

ANSWER: 9

BONUS

23) Math – *Short Answer* Simplify using log rules to a single log as a common fraction: log_2(x)+log_8(x^2) (log base 2 of x plus log base 8 of x squared)

ANSWER: 5LOG_2(x)/3