Materials Science C

Science Olympiad North Regional Tournament at the University of Florida

DO NOT WRITE ON THIS. THIS IS A TEST SET.

You may use TWO calculators of any type dedicated to computation and TWO 8.5" x 11" sheets of paper that may contain information on both sides from any source.
You may remove your goggles and lab coats when completing the test portion of this event.
Answer all questions in the test book. A periodic table is included as the last page of this test. You may separate the pages of this test and the answer booklet, however, if you choose to do so, please ensure that your team name and number is written at the top of each page. Failure to include this information on each page of the answer booklet may result in a scoring error.
This event has a maximum score of 80 points with 3 Tie-breaker questions. You may write on the test, however, any work done in the test booklet will not be scored.

Team Name: _____ Team Number: _____

Section 1: Lab Component

1) Obtain a well plate and laminated paper. You will be testing evaporation rates of 5 liquids. You will graph three alcohols, also an alkane and water will be observed for comparison purposes and will not be placed in your graph so data of these will not need to be as precise.
2) Place one drop of water in the well plate and note the time it was placed in the well plate on the wall clock. Exact seconds will not need to be recorded as this data will only be used for qualitative comparison.
3) Use the well plates as your evaporation surface and only one drop of each alcohol for your data. You may wish to practice dispensing a single drop into the storage container first as obtaining one drop can be a bit challenging if you have not done it before. Time how long it takes each drop to completely evaporate.
4) Create a graph of evaporation rates versus molar mass for methanol (CH_3OH), ethanol (CH_3CH_2OH) and n-propanol ($CH_3CH_2CH_2OH$).
5) Graph your results. What is the trend you see? _____ (2 points) Propose a reason for the trend you observed. (4 points)

   _____

   _____
6) Given what you have graphed, predict the amount of time you expect it should take for butanol ($CH_3CH_2CH_2CH_2OH$) to evaporate. Show your work, you are allowed to use linear regression but you must show your wok including all values). (6 points)

7) If hexane has the same type of intermolecular attractions as the alcohols you should be able to use your graph to determine the possible evaporation rate of hexane C_6H_{14}. Write the predicted evaporation time for hexane from your alcohol graph. Use a drop of hexane. Explain any differences you observe between the predicted evaporation times from the graph and your actual results. (4 points)

8) The water drop may not have evaporated as of yet. Explain any differences you may see between waters predicted evaporation time from the alcohol graph and what you are actually observing. (4 points)

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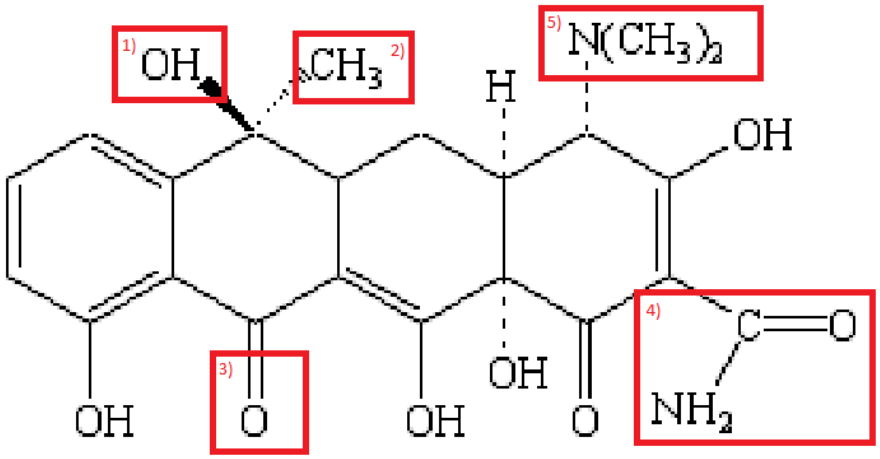
Section 2: Organic Chemistry

Identify the functional groups in the following molecule (1 point each)



Tetracycline

Draw the following molecules from their IUPAC names (2 points each)

6) Cyclobutylcyclobutylane

7) 1,3-dicyclobutylcyclohexane

8) 6-cyclopentyl-1-isopropyl-3-pentylcyclooctane

Draw the following molecule's line-angle structure from its condensed formula (3 points each)

9) $CH_3CCCH_2CH(CH_3)CH_2C(CH_3)_2CH(OH)CH_2CHCH_2$

10) $(CH_3)_2CHOCH_2CHCHCC(CH_2)_3C(CH_3)_2CH(OH)(CH_2)_2C(CH_3)_2CH_2$

End Section 3

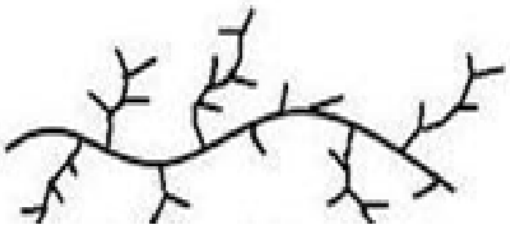
Score: ____/22

Team Name: _____ Team Number: _____

Section 3: Polymers

A

B



Questions 11-15 pertain to the two polymers depicted above. Answer the following questions by writing "Polymer A" or "Polymer B" in the Answer Booklet. Assume that both polymers are made of the same monomer. (2 points each)

6) Which polymer can be expected to be more flexible?

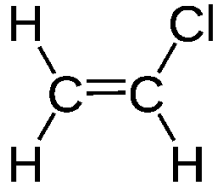
7) Which polymer can be expected to be more resistant to cutting/abrasion?

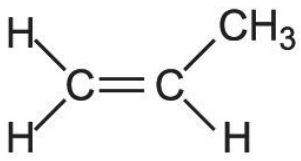
8) Which polymer can be expected to be denser?

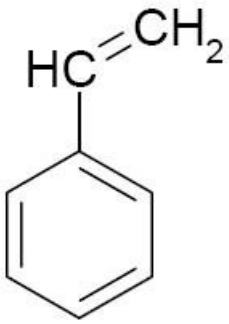
9) Which polymer would serve better in a bullet-proof vest?

10) If you know that the monomer is ethane, how would you name each compound?

Name the polymer produced by each of the following monomers. (2 points each)

11) 

18) 

12) 

19) Draw three units of acrylonitrile & *separately* draw its monomer. (4 points)

End Section 2

Score: ____/20

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Section 3: General Properties and Material Characterization

20) Classify the following materials by the type of material they are: (1 points each)

    a. Aluminum reinforced with silicon carbide particles.

    b. Polytetrafluoroethylene ("Teflon")

    c. Silicon dioxide

    d. Carbon fiber reinforced epoxy

    e. Copper

    f. Polyvinyl chloride

21) MULTIPLE CHOICE: Where is the fastest flow of a viscous liquid in a pipe? (1 point)
    a. At the entrance
    b. At the exit
    c. In the middle of the pipe
    d. At the edges of the pipe

22) MULTIPLE COICE: Yield strength is… (1 point)
    a. How much a material can bend but return to its original shape
    b. The strength at which a material fails under a suddenly applied load
    c. The strength at which a material permanently deforms
    d. The strength at which a material experiences tensile failure

23) Predict which of the following will be soluble in n-hexane (1 point each)

    a. Butanol

    b. Water

    c. Methane

    d. Propane

    e. *tert*-butane

    f. Cyclohexanol

24) MULTIPLE COICE: Platinum is soluble in which of the following: (1 point)
    a. Water
    b. Hexane
    c. Neither

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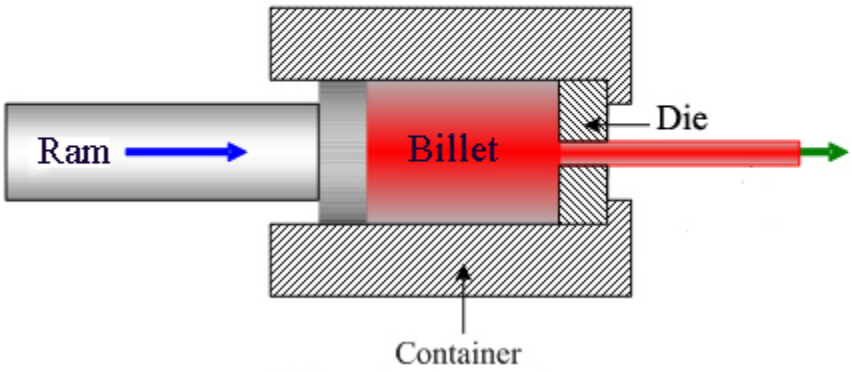

25) MULTIPLE COICE: What type of manufacturing process is displayed in the image above?
   a. Extrusion
   b. Injection molding
   c. Casting
   d. Fracturing

26) What type of plastic recycling is displayed above? (1 point)

27) MULTIPLE COICE: What effect can be observed in the ceramic above? (1 point)
   a. Firing
   b. Fracture
   c. Age
   d. Crazing

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Tiebreaker Questions (1 point each)

1) Return to the lab activity. Imagine if we were evaporating an isomer of ethanol called methoxymethane instead of ethanol. Would the boiling point of methoxymethane be higher, lower, or about the same, and why?
2) Draw the line-angle structures of pentane, 2-Methylbutane, and 2,2-dimethylpropane. Which will have the highest boiling point and why?
3) What is the name of the property of elastomers that allows them to resist permanent deformation? Name a use of an elastomer in the classroom.

Further ties will be broken by the quality of the answer in terms of detail and accuracy so be thorough!

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