May 4th 2014

**Texas Science Olympiad at Texas A&M University**

**Materials Science**

**Division C**

Team Number : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

School:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Student Names: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Total Points:

Rank:

Directions: Please do not start this test and lab until instructed to do so. Please raise your hand if you have any question.

A TEAM OF UP TO: 2 APPROXIMATE TIME: 50 minutes. Students are allowed to use any notes (must be punched & secured in a 3-ring binder) and/or non-programmable calculators. Calculators must not have external probes or sensors of any type attached to them.

A Periodic Table, any constants needed, and materials needed for modeling will be provided by Event Supervisors.

Safety Requirements: Students must wear the following: closed-toed shoes, ANSI Z87 indirect vent chemical splash goggles (see http://soinc.org), pants or skirts that cover the legs to the ankles, and additionally a long sleeved lab coat that reaches the wrists and the knees or a long sleeved shirt that reaches the wrists with a chemical apron that reaches the knees. Chemical gloves are optional. Students who unsafely remove their safety clothing/goggles or are observed handling any of the material or equipment in a hazardous/unsafe manner (e.g. tasting / touching chemicals, flushing solids down a drain and not rinsing them into a designated waste container provided by the supervisor) will be disqualified.

**Theoretical Exam and Answers:**

1. Identify the intermolecular forces from greatest to least:

a. London dispersion > H-bonding > ion-ion > dipole-dipole

b. ion-ion > dipole-dipole > H-bonding > London dispersion

c. ion-ion > H-bonding > dipole-dipole > London dispersion

d. dipole-dipole > ion-ion > H-bonding > London dispersion

2. London dispersion forces hold molecules together in the liquid, solid and solution phases. True False

3. Since aluminum is one of the most common elements in the Earth’s crust, why was pure Aluminum so extremely rare until the late 19th century?

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4. Give a simple definition of Ionic Bond and name a sample:

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5. Give a simple definition of Covalent Bond and name a sample:

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6. Give a simple definition of Amorphous materials and name a sample:

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7. Which class generally has the lowest Young’s modulus: metals, polymers, or ceramics?

8. Name 2 amorphous microstructures materials:

9. Which characteristics of metals makes members of this class such good conductors of electricity?

10. The most prevalent element by mass in a certain material is C. Which class does the material most likely to belong to?

11. Name 2 characteristics of ionic bonds:



12. To what material class do amorphous microstructures belong?

13. What does the machine to the right measure?

Given the following chart, answer the next questions:

**. Titanium High Density Low Density Medium**

**. Ti6Al4V Polyethylene Alumina Bricks Carbon Steel**

**Density** 4.43 g/cm 0.94 g/cm 2.3 g/cm 7.8 g/cm

**Melting Temperature** 1605-1660 \*C 125\*C 2072\*C 1495-1550\*C

**Young's Modulus** 113.8 GPa 700 MPa 375 GPa 210 GPa

**Price per kg** $16.73 $1.14 $131 $0.88

14. Using the above chart, which of the materials would be best to use for Spacecraft reentry tiles?

15. Using the above chart, which of the materials would be best to use for Ferris Wheel Tie-rods?

16. Using the above chart, which of the materials would be best to use for a Tennis Racket frame?

17. Using the above chart, which of the materials would be best to use for Shampoo bottles?

18. Which is less dense, an FCC, BCC, or HCP packed material?

19. Match the (intermolecular force or physical characteristic) to each of the following materials or situations such that all are unique:

a. Chewing Gum -magnetic

b. Brown Sugar -surface tension

c. Oil from a restaurant oil bottle -malleability

d. Comparing Iron to Wood -conductor

e. Comparing Iron to Aluminum -creep

f. Comparing Copper to Wood -stiffness of an elastic material / Young’s modulus

g. Setting rocks on copper pipe -London Disp. Force

h. Putting a drop of oil on water -Soluble

i. when 2 Hydrogen atoms meet one Oxygen atom -Ductility

j. Hanging more & more weights on an electric wire -Intramolecular (ionic) bonding



**Tie breaker questions and/or tasks:**

1. Explain this graph the best you can:

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2. Why would you care about Young’s Modulus in reference to screws in a bed frame?

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3. Give a simple definition &/or drawing of Contact Angle:

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