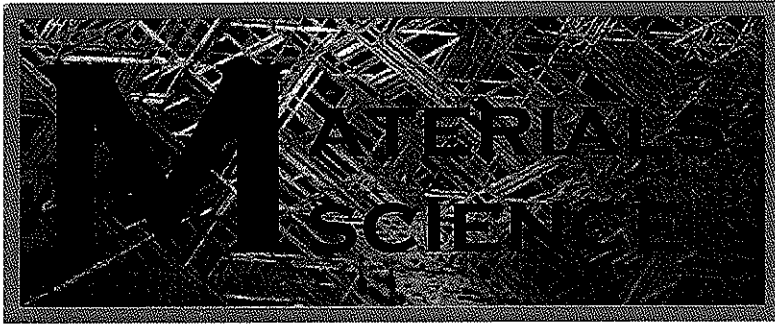


# i s o Illinois Science Olympiad



Please write the letter or number of the correct answer in the spaces provided (solid lines). Unreadable letters will be marked incorrect. Answers are worth 1 point each unless otherwise noted.

Station 1 - please do not move the materials. Refer to the number on each when answering the following questions (1 - 8):

1 = CAST IRON      3 = COPPER  
2 = STAINLESS      4 = PTFE

a 1 1) The crystal structure of which of these allows for triglycerides to infiltrate the surface and form a carbonized layer that prevents materials from sticking?

- a) 1
- b) 2
- c) 3
- d) 4

d 4 2) Which of these takes advantage of the molecular arrangement of carbon and fluorine atoms?

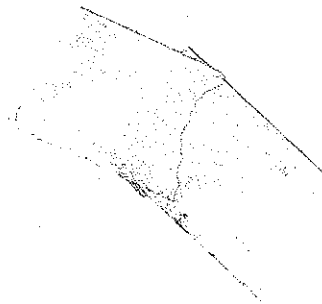
- a) 1
- b) 2
- c) 3
- d) 4

b 2 3) Which of these uses the oxidation of chromium at the surface layer to protect the material below from oxidation?

- a) 1
- b) 2
- c) 3
- d) 4

a 1 4) Which of these would be inappropriate for cooking food high in acids?

- a) 1
- b) 2
- c) 3
- d) 4

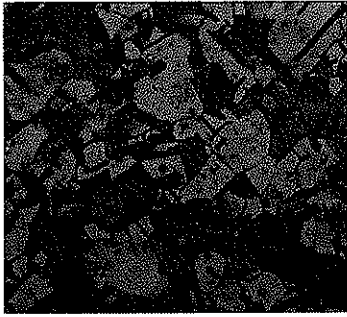


3c

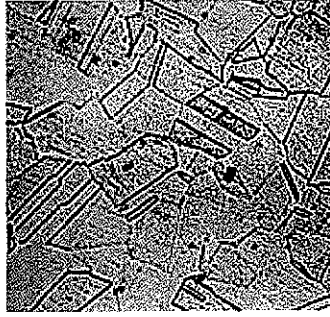
5) Which of these provides ions that stabilize the intermolecular attractions between ovomucoid, globulin and ovomucin?

- a) 1
- b) 2
- c) 3
- d) 4

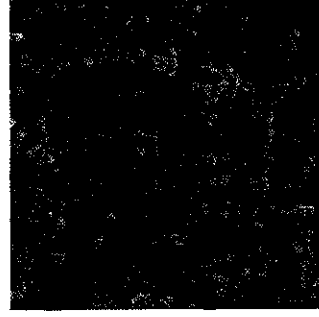
6) Use the following photomicrographs and on the line below each indicate the number of the item you think it shows.



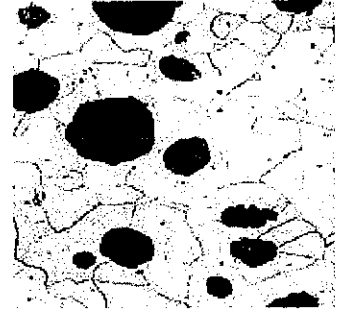
3



2



4



1

b

7) Which molecular packing would correlate with high heat conductivity?

- a) pcc
- b) bcc
- c) fcc
- d) spc

8) Using the lines below, rank the above materials in order of historical appearance.

3

1

2

4

[Oldest  $\longrightarrow$  Newest]

Station 2 - please handle the cylinders with care. Refer to the number of small dots on the top of each when answering the following questions (1 - 3):

1) Calculate the (1) surface area, (2) volume and (3) SA/V ratio for the cylinder with 1 dot. Place your answers on the lines below.

$2945.2 \text{ mm}^2$   
SA

$12271.8 \text{ mm}^3$   
V

0.24  
SA/V

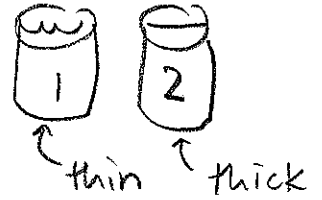
2) Calculate the density of each cylinder and record them on the table below.

DOTS	DENSITY		Material
1	95.67 g	7.80 g/cm <sup>3</sup>	BRASS STEEL
2	100.81 g	8.21 g/cm <sup>3</sup>	BRASS
3	57.74 g	4.71 g/cm <sup>3</sup>	TITANIUM
4	101.98 g	8.31 g/cm <sup>3</sup>	STAINLESS
5	114.85 g	9.34 g/cm <sup>3</sup>	COPPER
6	35.91 g	2.92 g/cm <sup>3</sup>	ALUMINUM

3) Use the table below to determine the material for each cylinder and write the name in the table above.

Aluminum	2.67 g/cm <sup>3</sup>	Chromium	7.15 g/cm <sup>3</sup>
Tin	7.28 g/cm <sup>3</sup>	Brass	8.50 g/cm <sup>3</sup>
Stainless Steel	7.67 g/cm <sup>3</sup>	Titanium	4.50 g/cm <sup>3</sup>
Zinc	7.14 g/cm <sup>3</sup>	Stainless Steel	7.67 g/cm <sup>3</sup>
Scandium	2.98 g/cm <sup>3</sup>	Mercury	13.53 g/cm <sup>3</sup>
Barium	3.59 g/cm <sup>3</sup>	Copper	8.80 g/cm <sup>3</sup>
Selenium	4.80 g/cm <sup>3</sup>	Steel	7.85 g/cm <sup>3</sup>
Galium	5.90 g/cm <sup>3</sup>	Iron	7.87 g/cm <sup>3</sup>
Antimony	6.68 g/cm <sup>3</sup>	Platimun	21.46 g/cm <sup>3</sup>
Neodymium	7.00 g/cm <sup>3</sup>	Silver	10.50 g/cm <sup>3</sup>

Station 3 - please handle these materials with care. Each beaker contains a mixture of polyvinyl alcohol, water and sodium tetraborate. Refer to the number of small dots on the top of each when answering the following questions (1 - 5):



b 1) What is the function of the  $\text{Na}_2\text{B}_4\text{O}_7$ ?

- a) improves miscibility
- b) crosslinks ~~cellulose~~ polyvinyl alcohol
- c) dissolves cellulose
- d) forms hydroxyl groups with water

2 2) Which beaker contains more  $\text{Na}_2\text{B}_4\text{O}_7$ ? Beaker 1 or beaker 2?

d 3) Adding which additional ingredient would result in a more firm mixture?

- a) an acid
- b) starch
- c) additional polyvinyl alcohol
- d) additional sodium tetraborate

a 4) Adding heat to the mixture would \_\_\_\_\_.

- a) increase viscosity
- b) decrease viscosity
- c) triesters and phosphates
- d) sugars and amino acids

d 5) Adding which of the following would make the mixture more 'stretchy'?

- a) an acid
- b) starch
- c) additional polyvinyl alcohol
- d) additional sodium tetraborate

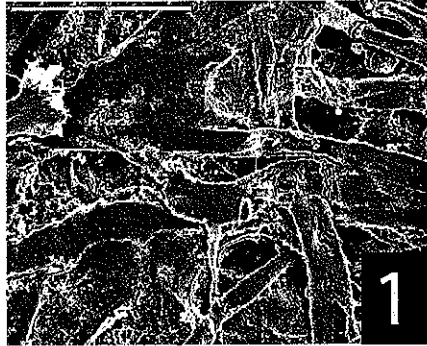
**Station 4 - Using your understanding of materials, their composition, properties and manufacturing explain the following. The object in front of you is half a plastic cup (polystyrene). Why is it that the cup can be torn along the solid line (vertical axis) but not along the dashed line (horizontal axis). (7 pts)**

during extrusion/manufacturing  
the polymers are aligned along  
the axis allowing for easily  
interrupted intermolecular attractions.  
The other axis requires breaking  
more rigid/stronger intermolecular  
attractions. → bands?

**Station 5 - Using the two tubes as levers, explain the compositional nature of the small metal bars. Yes, this is also a test of your ability to manipulate the material world.**

The following photomicrographs are of non-coin currency from different countries. It is often assumed by people that money is full of 'germs'. A recent study examined the influence of money made from different materials; cotton paper (1) and a polymer (2) on the amount of bacteria they accumulate. Place the number, 1 or 2, of the currency you would expect to have the higher bacterial loads.

1) 1



F. Vriesekoop, et al., 2010

d 2) Which pair is correct?

- |                      |                        |
|----------------------|------------------------|
| a) ionic - amorphous | c) ionic - polycrystic |
| b) ionic - mosaic    | d) ionic - crystalline |

b 3) Which of the following is 'pure'  $Al_2O_3$

- |             |             |
|-------------|-------------|
| a) vanadium | c) titanium |
| b) corundum | d) chromium |

a 4) If the crystal structure of a diamond is altered by the incorporation of an element such as boron the resulting crystal interacts with light differently.

- |  |  |
|--|--|
| a) true                                  | c) it depends on the frequency of light                        |
| b) false                                 | d) diamonds always interact with the lights in the same manner |
| e) it depends on the size of the diamond | f) none of the above   |

b 5) Which of the following materials has a low coefficient of friction?

- a) LDPE
- b) PTFE
- c) PUKE
- d) ICBM

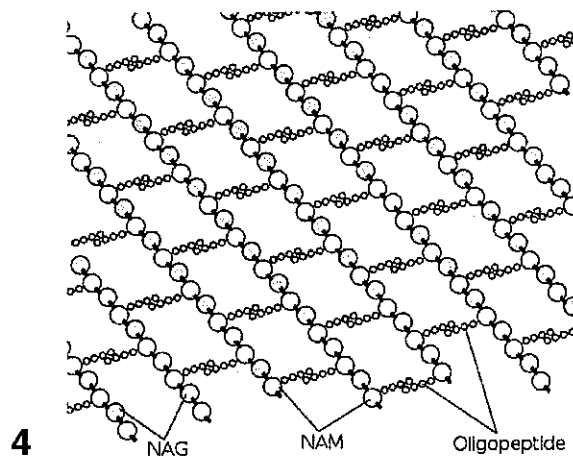
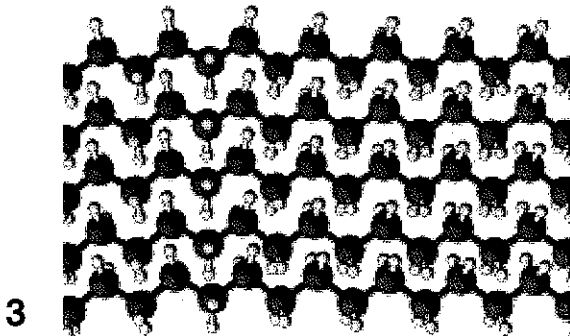
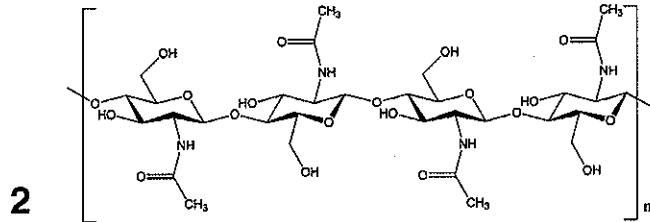
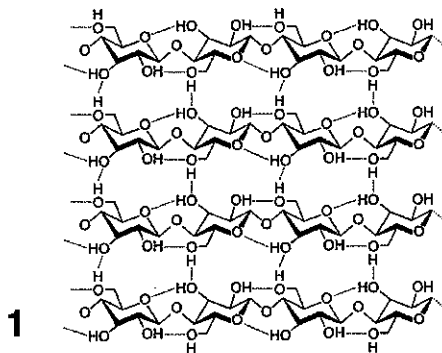
a 6) The science of friction and lubrication is

- a) tribology
- b) resistology
- c) porology
- d) slipology

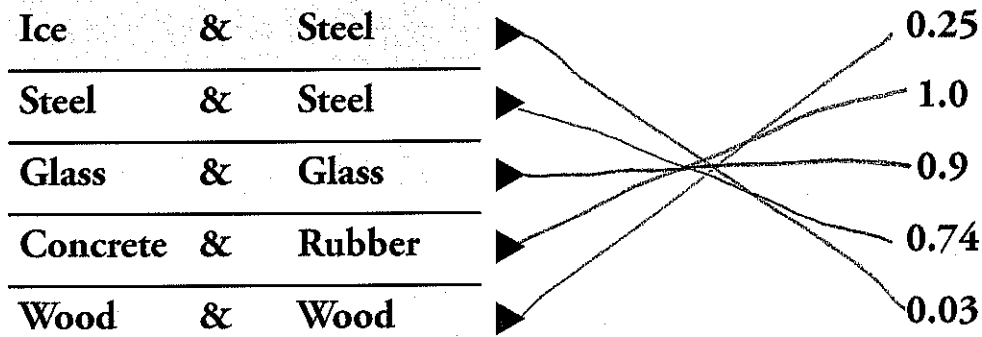
c 7) Vulcanized rubber uses \_\_\_\_\_ to crosslink polyisoprene.

- a) cellulose
- b) heat
- c) sulfur
- d) non of these

any! 8) Which image is the most likely candidate for a successful bioplastic?



\_\_\_\_\_ 9) Draw a line between the following material pairs and their coefficient of static friction.



C 10) PTFE - a low friction material, is composed of \_\_\_\_\_ & \_\_\_\_\_ in a high density.

- a) C & S
- b) F & S
- c) C & F
- d) S & O

d 11) The kinetic contact of materials used in early textile mills often resulted in the combustion of various free-floating fibers in the air. This was due to \_\_\_\_\_.

- a) static friction
- b) rolling friction
- c) rolling resistance
- d) triboelectric effect

A 12) Superhydrophobic <sup>materials</sup> have contact angles > \_\_\_\_\_ and slide angles < \_\_\_\_\_ when a drop of water is placed on them.

- a) 150° & 10°
- b) 120° & 10°
- c) 90° & 25°
- d) 90° & 15°

d 13) Cellulose is often proposed as a new source of 'bioplastics'. This is because cellulose \_\_\_\_\_.

- a) is easily broken down
- b) contains nitrogen
- c) has the potential to form bonds
- d) is a polymer



14) Rank the following according to their elastic modulus. Use 1 for the most deformation and 10 for the least deformation.

- 3 HDPE
- 7 Bronze
- 4 Polystyrene (solid)
- 5 Wood (along grain)
- 8 Titanium
- 2 LDPE
- 9 Tungsten
- 1 Rubber
- 6 Human Bone
- 7 Stinging Nettle Fiber

d 15) This material can be made by exposing it to high temperatures of around 620 °C (well above its transition temperature of 564 °C). The surface is then rapidly cooled while the interior remains free to flow for a short time.

- a) surgical steel
- b) hard candy
- c) lightbulb filaments
- d) glass

b 16) Which of the following is a pseudoplastic?

- a) synovial fluid
- b) whipped cream
- c) water
- d) silly putty

b 17) Which of the following is a dilatant or shear thickening fluid?

- a) whipped cream
- b) cornstarch in water
- c) silly putty
- d) paint

18) Using this image, explain the thermodynamic process that led to the development of the ice crystals on this oak leaf gall. (10 pts)

