Material Science

RAHS C Division Invitational 2017-18

Instructions:

- Answer all questions on this answer sheet.
- Sheets may be double sided, check both sides!
- If you separate the sheets of the test be sure to label each sheet with school/team and ID in case they get mixed up during scoring.
- Tie breakers:

For Scoring only

Test score **(Your Points/ 133** **=_____**

Rank **/24** **=_____**

Multiple Choice (2 pts each)

1. Buna-S is also known as
   a. PTFE
   b. Teflon
   c. Polycrylates
   d. Styrene butadiene rubber (SBR)

2. Neoprene is chemically known as
   a. Styrene butadiene rubber (SBR)
   b. Polyurethane
   c. Polybutandiene
   d. Poly chloroprene

3. Buna-S is a _____ material
   a. Resinous
   b. Rubbery
   c. Fibrous
   d. Plastic

4. Automobile steering wheels are normally made of
   a. Cellulose acetate
   b. PVC
   c. High density polythene
   d. Cellulose nitrate

5. Polymethyl methacrylate (PMMA) is known as
   a. Perspex
   b. Teflon
   c. Bakelite
   d. Nylon-6

6. Mastication of rubber means
   a. Its softening
   b. A treatment to retard its deterioration due to oxidation
   c. Improving its curing rate
   d. Depression of its freezing point

7. Cellulose is the main constituent of moist _____fibers
   a. acrylic
   b. synthetic
   c. Spandex
   d. Natural
   e.

8. Reaction of dimethyl terephthalate (DMT) and ethylene glycol produces
   a. Nylon-6
   b. Polyester
   c. Dacron
   d. PVC

9. In a cross-linked polymer, the monomeric units are linked together to constitute a three-dimensional network. Which of the following is a cross-linked polymer?
   a. Bakelite (phenol formaldehyde)
   b. Polythene
   c. Nylon-6
   d. Polyester

10. Out of all the elastomers, natural rubber has the longest elongate range and flexibility of the order of _____ percent.
   a. 1-1000
   b. 1500-2000
   c. 1000-1500
   d. 2000-2500

11. The monomer of poly vinyl chloride (PVC) is
   a. Ethyl chloride
   b. Chloroform
   c. Ethylene dichloride
   d. Chloroethane

12. Neoprene is a
   a. Synthetic rubber
   b. Monomer
   c. Polyester
   d. None of these

13. These tubes are a good substitute for human blood vessels on heart by-pass operations
   a. PVC
   b. Polythene
   c. Teflon/Dacron
   d. Polystyrene

14. The main use of butadiene is
   a. As an anti-skimming agent in paint
   b. In the manufacture of synthetic rubber
   c. As a plasticizer for unsaturated polyester
   d. None of these

15. Which of the following polymer type is not classified on the basis of its application and properties?
    a. Rubber
    b. Plastic
    c. Fiber
    d. Synthetic
16. Which of the following is a thermosetting polymer?
    a. Polystyrene
    b. Polyolefins
    c. Nylons
    d. Resins
17. Where is polyurethane foam used extensively?
    a. Adhesive
    b. Paint rollers
    c. Printing rollers
    d. Fabric coating
18. What is the use of epoxy resin from a commercial point of view?
    a. As strength adhesives
    b. As cementing agents
    c. Cast objects and laminates
    d. All of the above
19. What is the common or brand name of the polymer polyacrylonitrile?
    a. Mylar
    b. Orlon
    c. Technora
    d. Ultem
20. Most polymers have a specific heat of approximately
    a. 0.004 calories/gram
    b. 0.4 calories/gram
    c. 400 calories/gram
    d. None of the above. The specific heat of polymers is extremely varied

21. Fill in the table using the information below (1 point per box on table)

Code	Description (abbreviation)	Packaging Applications (list two)	Recycled Products (list two)
			
			
			
			
			
			

Descriptions:	Packaging Applications *	Recycled Products*
High Density Polyethylene (HDPE) Low Density Polyethylene (LDPE) Polyethylene Terephthalate (PET, PETE) Polypropylene (PP) Polystyrene (PS) Vinyl (Polyvinyl Chloride or PVC)	Bread and frozen food bags Catsup Bottles Cereal box liners Compact disc jackets Dry Cleaning Egg cartons House siding Medical Tubing Medicine Bottles Milk bottles Ovenable film/food trays Peanut butter jars Plastic Cutlery Plastic soft drink bottles Squeezable bottles (i.e. honey) Wire and cable insulation Yogurt and margarine tubs	Battery cables Bottles Buckets Cables Carpet Egg cartons Fleece clothing Floor tiles Foam packing Furniture Garbage can liners Ice scrapers Loose leaf binders Luggage Pallets Plastic lumber Shampoo bottles Shipping envelopes Thermometers Traffic Cones Trash cans
Note: Some of these may apply to more than one recycle code.		

22. (3 pts) How can chemists control which type of polyethylene (LDPE vs HDPE) is generated?

23. (3 pts) How does the molecular-level structure of polyethylene (LDPE and HDPE) influence their material properties?

24. (3 pts) Define thermoplastics.

25. (3 pts) Define thermosets.

26. (3 pts) Can thermoplastics polymers be transformed to thermosetting polymers? If so, how?

27. (1 pt) Can thermoplastics be recycled? Yes No

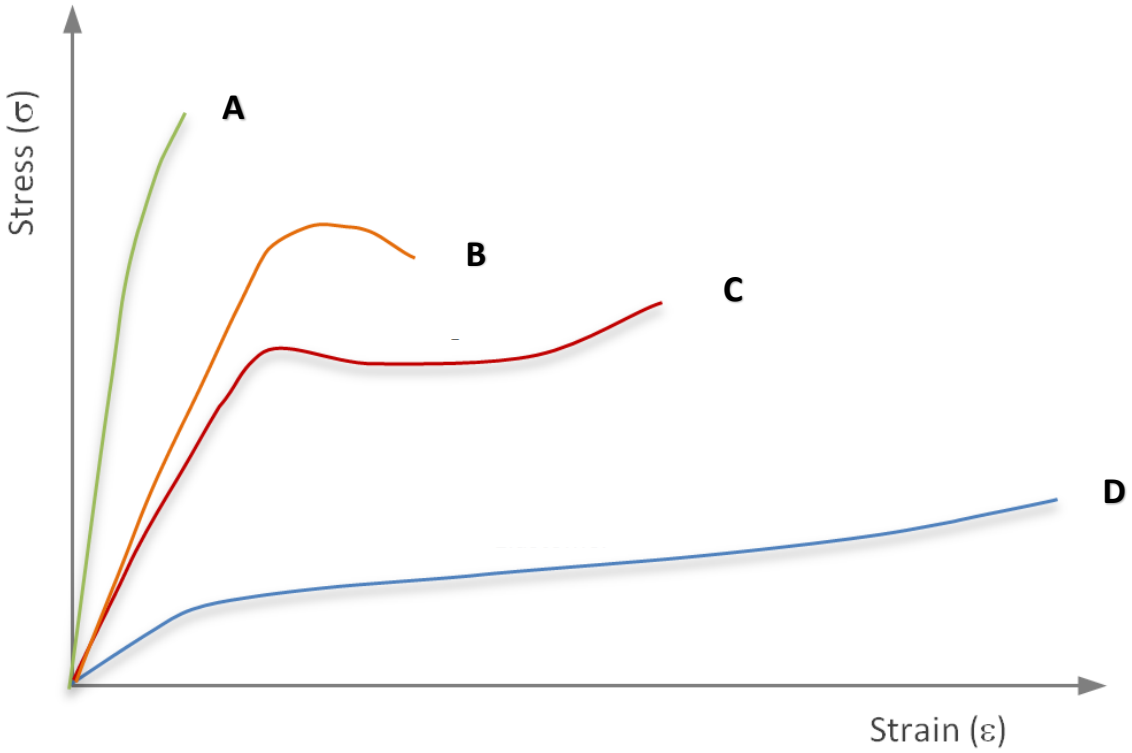
28. (1 pt) Can thermosets be recycled? Yes No

29. (1 pt) Is it easier to recycle thermoplastics or thermosets?

30. Indicate whether the following polymers are thermoset, thermoplastic or neither. (1 pt each)

Item	Thermoset	Thermoplastic	Neither
Cellulose			
Unvulcanized rubber			
A-stage resole			
Cellulose Nitrate			
Molded Bakelite			
Ebonite			
Meat			

Stress-Strain Behavior of Polymers



31. (2 pts) Which polymer is the most brittle?

A B C D

32. (2 pts) Which polymer is most ductile?

A B C D

33. (2 pts) Which polymer is strong and tough?

A B C D

34. (2 pts) Which polymer is hard and tough (with possible strain hardening)?

A B C D

35. (2 pts) Which polymer has the greatest Modulus of Elasticity?

A B C D

For questions 36 and 37 use the following values:

Poly(ethyl acrylate) PEA has a Specific Heat Capacity of at approximately 1.7867 kJ/kg/C for a given temperature.

36. (4 pts) A 5.00 kg block of PEA is heated, increasing its temperature by 2.50 °C. How much energy has been added to the block?

37. (4 pts) A 3.00 kg block of PEA is cooled, reducing its energy by 42.00 kJ. What is the temperature change or the PEA?

38 (4 pts) A block of PEA is heated, increasing its energy by 15.00 kJ. The temperature of the block is raised 7.00°C. What is the mass of the block?

For questions 39 and 40 use the following values:

Shear Modulus: G = 1.25 GPA

Young's Modulus: E = 3.5 GPa

39. (4 pts) What is the strain of a rod that has a diameter of 20 mm^2 if a load of 5,000 kN is applied to the rod?

40. (4 pts) Calculate Poisson's Ratio.

Drawings

41. (5 pts) Draw and label the three isomers of dibromebenzene use ortho, para, meta, nomenclature.

42. (5 pts) Draw the polymer formed from the monomer vinyl chloride, CH_2CHCL:

43. (5 pts) Draw CH_3COOH and CH_3NH_2. Draw the condensation product of the reaction.

44. (5 pts) Polyesters (a condensation polymer) can be formed from two different monomers, a di-acid and a di-alcohol. Draw the two monomers and draw a polymer made of three of each unit.

$HOOCC_6H_4COOH$ benzene ring with two acid groups in para positions	$HOCH_2CH_2OH$ ethane with an –OH group on each carbon