THE OPEN UNIVERSITY OF SRI LANKA

B. Sc. Degree Programme/Stand Alone Course — Level 5

Final Examinations 2007/2008

CHU 3238/CHE 5238 — Polymer Chemistry - Paper I

Duration: 2 Hours

10th June 2008   10.00 am – 12.00 noon

- Answer all 50 (fifty) questions
- Choose the most correct answer to each of question and mark your answer with a cross ["X"] on the answer script.
- Use a PEN (not a PENCIL) in answering..
- Any answer with more than **one** "X" marked will be considered as an *incorrect* answer.
- 1/6th of the marks assigned will be deducted for each incorrect answer.
- The use of a *non-programmable* electronic calculator is permitted.
- Logarithm tables, graph papers etc will be provided on request.

Gas constant (R)	=	$8.314 \ J \ K^{-1} mol^{-1}$
Avogadro constant (L)	=	$6.023 \times 10^{23} \ mol^{-1}$
Planck constant (h)	=	$6.63 \times 10^{-34} \ J \ s$
Velocity of light (c)	=	$3.0 \times 10^{8} \ m \ s^{-1}$
Standard atmospheric pressure (π)	=	$10^{5} \ Pa \left(N \ m^{-2} \right)$
$Log_e(X)$	=	$2.303 \ Log_{10}(X)$

1. Which of the following molecule cannot be used as a monomer?
(1) C_6H_5OH (2) CH_3COOH (3) $HOCH_2COOH$ (4) $HOOCCH_2COOH$
(5) H_2NCH_2COOH

2. How many reactive sides are in $CH_3CH=CH_2$?
(1) Four   (2) Three   (3) Two   (4) One   (5) Zero

3. Select the incorrect statement.
(1) Polymers can form viscous solutions.
(2) Polyvinyl alcohol doesn't dissolve in water immediately.
(3) Degree of polymerization is the number of repeating units in a polymer.
(4) Polymers show sharp melting points.
(5) Silk and cotton are natural polymers.

4. Ethylene and polyethylene have
(1) same melting points.   (2) same boiling points.
(3) same solubility.   (4) same physical properties.
(5) different properties from each other.

5. The monomers with $H_2C=CHCN$ can be polymerized by
(1) free radical polymerization only.   (2) anionic polymerization only.
(3) cationic polymerization only.   (4) free radical and anionic polymerization.
(5) cationic and anionic polymerization only.

6. One of the initiators used in cationic polymerization is
(1) Ph_3CK (2) BuLi   (3) BF_3/H_2O (4) KNH_2 (5) NaOH

7. When natural rubber and methyl methacrylate are reacted with peroxide initiator, the polymer formed is
(1) graft   (2) alternate   (3) block   (4) block and alternate   (5) random.

8. Ziegler Natta catalysts of
(a) a cocatalyst.   (b) a catalyst in Group II element.   (c) a catalyst in Group IV-VII elements.
The correct statement/s is/are
(1) a only   (2) b only   (3) c only   (4) a & c only   (5) b & c only

9. Ziegler Natta polymerization can be explained by
(1) monometallic mechanism only.   (2) monometallic and bimetallic mechanism.
(3) bimetallic mechanism only.   (4) free radical polymerization only.
(5) monometallic and free radical polymerization.

10. Autoacceleration takes place in
(1) suspension polymerization. (2) bulk polymerization. (3) emulsion polymerization.
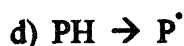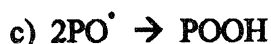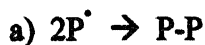(4) solution polymerization.   (5) melt polycondensation.

11. Which statement is not true about emulsion polymerization?
(1) Simple process.   (2) High percentage conversion.
(3) Easy to remove emulsifying agent. (4) Difficult to remove emulsifying agent.
(5) High molarmass polymer can be formed.

12. Low concentration of accelerator and activator relative to sulphur will favour
(1) high degree of cross links structure.
(2) low degree of cross links structure.
(3) a monosulphide cross linked network structure.
(4) a product with high thermal stability.
(5) a product with high stability to oxidation.

Consider following steps of oxidation degradation of polymer P, to answer following questions 13-15.

a) $2P^\bullet \rightarrow P\text{-}P$

b) $2POOH \rightarrow PO^\bullet + POO^\bullet + H_2O$

c) $2PO^\bullet \rightarrow POOH$

d) $PH \rightarrow P^\bullet$

e) $POOH \rightarrow PO^\bullet + OH^\bullet$

13. The initiation step/s is/are
(1) a only   (2) d only   (3) a & c only   (4) b & d only   (5) c & e only

14. The propagation step/s is/are
(1) a only   (2) d only   (3) a & c only   (4) b & d only   (5) b & e only

15. The termination step/s is/are
(1) a only   (2) d only   (3) a & c only   (4) b & d only   (5) c & e only

16. During vulcanization process, the viscosity of rubber
(1) increases.   (2) decreases.   3) doesn't change.   (4) double that of original value.
(5) triple that of original value.

17. Melt polycondensation between adipic acid and octamethylene diammine results in the formation of
(1) Nylon 6,6   (2) Nylon 5,6   (3) Nylon 6,10   (4) Nylon 6,4   (5) Nylon 6,8

18. The basis of grading ribbed smoked sheets is
(1) elasticity.   (2) thickness.   (3) colour.   (4) impurities.   (5) dryness.

19. Thermoset polymers can be
(1) recycled.   (2) soften at elevated temperatures.   (3) soluble in any solvent.
(4) formed by condensation polymerization   (5) flexible.

20. Yellowing of natural rubber latex can be prevented by adding
 (1) ammonia   (2) sulphur   (3) phenol   (4) thiols   (5) water

21. Atactic, isotactic, and syndiotactic polymers can be represented as
 (1) ddddllld, ddddddd, dldldld   (2) llllll, ddddddd, ddddldd
 (3) ddddddd, dldldld, llllll   (4) dldldld, ddddddd, ddddllld
 (5) llllll, dldldld, ddddldd

22. Block copolymer can be represented as
 (1) -A-B-A-B-A-B-   (2) -A-A-A-B-A-A-   (3) -B-A-B-A-B-A-
 (4) -A-A-A-B-B-B-   (5) -A-A-B-A-B-B-

23. Which statement is not true about T_g?
 (1) Below T_g, polymer is in glassy state.
 (2) Above T_g, polymer is in glassy state.
 (3) Glass transition is a reversible physical change.
 (4) Above T_g, polymer shows visco-elastic properties.
 (5) The change from solid to rubbery state is called glass transition temperature.

24. Presence of an aromatic ring in the polymer chain backbone,
 (1) increases T_g.   (2) decreases T_g.   (3) doesn't change T_g.
 (4) doubles the value of T_g.   (5) triple the value of T_g.

25. Above the T_f, the polymer is in the
 (1) rubbery state.   (2) gaseous state.   (3) solid state.
 (4) visco-fluid state.   (5) glassy state.

26. Which is true for unsymmetrical polymers?
 (1) $T_g = \dfrac{1}{2} T_m$ (2) $T_g = \dfrac{2}{3} T_m$ (3) $T_g = \dfrac{3}{2} T_m$ (4) $T_g = T_m$
 (5) $T_g = 5 T_m$

27. The increase in bulkiness of the side chain
 (a) increases T_m (b) decreases T_m (c) doesn't change the value of T_m

The correct statement/s is/are
 (1) a only   (2) b only   (3) c only   (4) a & b only   (5) b & c only

28. If the X side chain of the polymer $-(CH_2-CHX-)_n$ is a bulky polar group, the T_g is
 (1) very low.   (2) is equal to T_m (3) very high   (4) small   (5) not affected.

29. The molar mass of a polystyrene sample with a 200 repeating unit is
 (1) 10,400 g/mol   (2) 1040 g/mol   (3) 20,800 g/mol   (4) 2800 g/mol
 (5) 5200 g/mol

30. If the degree of polymerization of linear polyethylene is 50, what is the average chain length of this polymer of which the C-C distance is 1.54 Å.
(1) 30.8 Å.　　　(2) 15.4 Å.　　　(3) 46.2 Å.　　　(4) 77.0 Å.　　　(5) 154 Å.

31. At ceiling temperature,
(1) $k_p = k_{dp}[M]$　　　(2) $k_p < k_{dp}[M]$　　　(3) $k_p > k_{dp}[M]$　　　(4) $k_p [M] = k_{dp}$
(5) $k_p [M] > k_{dp}[M]$

32. In free radical, cationic and anionic polymerization, the degree of polymerization
(a) increases with increase in temperature.　(b) decrease with decrease in temperature.
(c) increase with decrease in temperature.　(d) doesn't affect by temperature

The correct statement/s is/are
(1) a only　　(2) c only　　(3) d only　　(4) a & c only　(5) b & d only

33.　When the transfer agents are used in the termination step of free radical polymerization, the chain length of polymer is
(a) increased　　　　　　(b) decreased　　　　　　(c) not changed

The correct statement/s is/are
(1) a only　　(2) b only　　(3) c only　　(4) a & c only　(5) b & c only

34. In the free radical polymerization, the rate of the reaction
(a) increases with increase in temperature.　(b) decrease with decrease in temperature.
(c) increase with decrease in temperature.　(d) doesn't affect by temperature

The correct statement/s is/are
(1) a only　　(2) c only　　(3) d only　　(4) a & c only　(5) b & d only

35. The polydispersity values of five polymethylmethacrylate samples are given below.
(1) 3.0　　　　(2) 2.5　　　　(3) 2.0　　　　(4) 1.6　　　　(5) 1.1

Which one has a comparatively narrower molar mass distribution curve?

36.　Which one of the above sample has number average molar mass is very low compared to weight average molar mass?
(1) 3.0　　　　(2) 2.5　　　　(3) 2.0　　　　(4) 1.6　　　　(5) 1.1

37. Light scattering measurements can be used to obtain
(1) number average molar mass.　　　　(2) z-average molar mass.
(3) viscosity average molar mass.　　　　(4) weight average molar mass.
(5) solubility of the polymer.

Questions 38-41 are based on the following statement.
A sample consists of three molecules with molar masses 2000, 3000, and 5000 g/mol.

38. The number average molar mass of above sample is
(1) 333.3   (2) 3000.3   (3) 3333.3   (4) 666.6   (5) 6666.6

39. The weight average molar mass of above sample is
(1) 38   (2) 380   (3) 76   (4) 3800   (5) 760

40. If the number average degree of polymerization is 200, the molar mass of the repeating unit is
(1) 33.3/200   (2) 200/33.3   (3) 200/33.3   (4) 200/666.6   (5) 3333.3/200

41. The polydispersity factor is
(1) 3800/3333.3   (2) 380/333.3   (3) 666.6/3.8   (4) 6666.6/380
(5) 333.3/760

42. Polymer is soluble in a solvent if
(1) $\Delta H_m < (T\Delta S_m)$ (2) $\Delta H_m > (T\Delta S_m)$ (3) $\Delta H_m = (T\Delta S_m)$ (4) $\Delta G_m > 0$
(5) $\Delta G_m \leqslant 0$

43. Osmometry is widely used to determine
(1) the weight average molar mass of polymers.
(2) the number average molar mass of polymers.
(3) the weight average degree of polymerization.
(4) the number average degree of polymerization.
(5) the solubility of polymers.

44. If the –C-C- bond distance of polyethylene is 1.26 Å and the degree of polymerization is 2000, the root mean square distance of the polymer is.
(1) 1.26×2000 Å.   (2) $\sqrt{1.26} \times 2000$ Å.   (3) $1.26/2000$ Å   (4) $2000/1.26$ Å
(5) $1.26 \times \sqrt{2000}$ Å.

45. The flow time of the solvent is 200s and the flow time of a dilute solution made using the same solvent is 5000s, the η_{sp} is
(1) 4800/200   (2) 200/4800   (3) 5000/200   (4) 200/5000   (5) 5000

46. Unit cell dimensions of crystalline polymer can be determined by
(1) Mass   (2) IR   (3) NMR   (4) X Ray   (5) none of the above methods.

47. The densities of five samples of polyethylene are as follows.
(1) 0.827   (2) 0.833   (3) 0.852   (4) 0.860   (5) 0.882 g/dm^{-1}

Which one has a high degree of crystallinity?

48. When styrene monomer is polymerizes by using KNH_2 as the initiator, the termination step is given by the following equation.

$-CH_2CHPh$ + A → B + C

A, B and C are
(1) $-CH_2CH_2Ph$, NH_3 and NH_2^-, respectively.
(2) NH_3, $-CH_2CH_2Ph$, and NH_2^-, respectively.
(3) NH_2, $-CH_2CH_2Ph$, and NH_3, respectively.
(4) NH_3, NH_2^-, and $-CH_2CH_2Ph$, respectively
(5) above reaction is wrong.

49. Kinetic chain length is given by
(1) rate of initiation/ rate of propagation.
(2) rate of initiation/ rate of termination.
(3) rate of propagation/ rate of initiation.
(4) rate of transfer/ rate of propagation.
(5) rate of propagation/ rate of termination.

50. LDPE is a polymer with
(1) high density, high crystallinity and high strength.
(2) high density, low crystallinity and high strength.
(3) high density, high crystallinity and low strength.
(4) low density, low crystallinity and high strength.
(1) low density, low crystallinity and low strength.