FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
DEPARTMENT OF MATERIALS AND METALLURGICAL ENGINEERING
RAIN SEMESTER 2019/2020 EXAMINATIONS

COURSE: MME 520 – GLASS MAKING TECHNOLOGY **DATE:** 09/07/2021 **TIME:** 3 HOURS
INSTRUCTION: ANSWER ANY FOUR (4) QUESTIONS.

1. a) Justify Prof. E. D. Zanotto's 2017 definition of glass given in the data sheet.
b) Reproduce Fig. 1 in your answer booklet and label all the necessary points in the diagram. Give a proper explanation of the diagram.
c) Write a note on **ANY** of the following glass compositions:
i. Soda-lime-silica glass.
ii. Borosilicate glass. **[20 mrks]**

2. a) Use well labelled crystallization curves (**ONLY**) to show how a good glass former differs from a poor glass former.
b) [i] Using Johnson-Mehl-Avrami equation $\left[X = 1 - exp\left(-\frac{\pi}{3} I U^3 t^4\right)\right]$, Fig. 2 and Table 1, plot the TTT diagram of a glass melt expected to have an X value of 10^{-6}.
[ii] Determine the critical cooling rate of the glass melt. **[20 mrks]**

3. a) A batch formula for a window glass contains 350kg Na_2CO_3, 150kg $CaCO_3$ and 1200kg SiO_2. Calculate the resulting glass formula.
b) For the window glass in 3a), calculate the glass formula if the batch is supplemented by 100kg of soda feldspar (albite), $Na(AlSi_3)O_8$.
Data: Mol. Wts: Na_2CO_3 = 105.98, Na_2O = 61.98, SiO_2 = 60.10, $CaCO_3$ = 100.10, CaO = 56.08, Al_2O_3 = 102.00, Na = 22.99, Al = 26.98, Si = 28.09 and O = 16.00.
c) How do glass modifiers and intermediates affect the random network structure of a glass former, respectively? **[20 mrks]**

4. a) [i] Is there a trend in Table 2? If yes, what trend?
[ii] Reproduce Table 2 in your answer booklet and complete column 3.
b) With the aid of sketches, explain why oxycarbide and oxynitride glasses are the stiffest glasses. **[Hint:** see Fig. 3]
c) Can the composition of a glass affect its fracture strength? If yes, explain. What factor is majorly responsible for the fracture strength of glass and how? **[20 mrks]**

5. a) With the aid of sketches, explain the thermal strengthening (tempering) of a flat glass.
b) Sketch the fractography of a tempered glass and a non-tempered glass. Aside glass strengthening, mention another importance of glass tempering.
c) Why are glasses likened to transgenders? **[20 mrks]**

6. a) Discuss the effect of viscosity in glass making.
b) Explain the Rotational Viscometer method of measuring viscosity in glass making process. **[20 mrks]**

MME 520 Data Sheet 1

2017 Glass Definition

Glass is a nonequilibrium, non-crystalline condensed state of matter that exhibits a glass transition. The structure of glasses is similar to that their parent supercooled liquids (SCL), and they spontaneously relax toward the SCL state. Their ultimate fate is to solidify, i.e., crystallize.

Table 1

Temp. (K)	I	U	t
1560			
1630			
1720			
1910			

Table 2

Glass compositions	E (GPa)	Reasons for increase/decrease in the value of E
Silicate Glasses SiO_2	73	* 3D formation due to tetrahedral structure * High interconnectivity due to 100% bridging oxygen (BO) formation.
Aluminosilicate glass	77	
Soda-lime silica glass	66	
Borosilicate glass (pyrex)	60	
Other Glass formers TeO_2	50.7	
GeO_2	43.3	
P_2O_5	31.3	
B_2O_3	17	
32.5%Na_2O+67.5%B_2O_3	42	
As_2O_3	11.9	

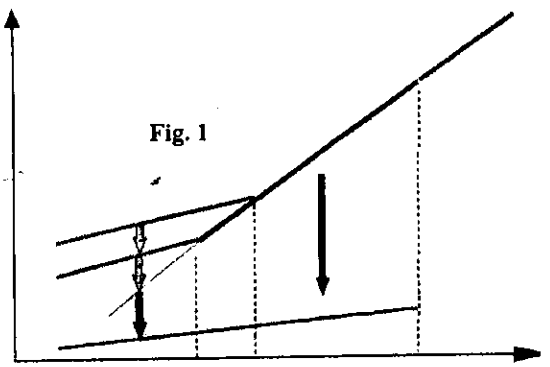

Fig. 1

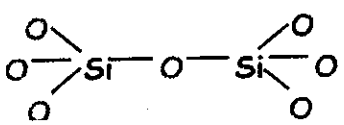

Fig. 3 Pure silica glass

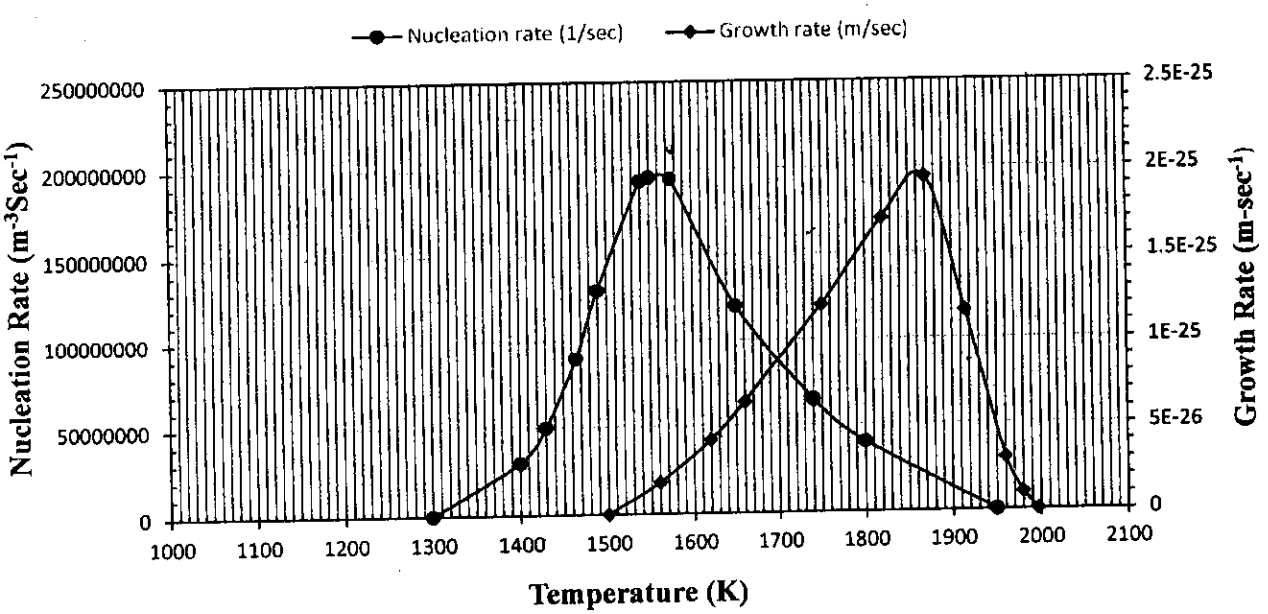

Fig. 2 [NOTE: 5E-26 in the graph means 5×10^{-26}; $T_m = 2000$]