

S3

Passage II

Oxyfluorocarbons (OFCs) are oils composed of only carbon (C), fluorine (F), and oxygen (O). They are useful as lubricants in exposed mechanical systems on spacecraft. However, OFCs tend to decompose upon exposure to heated metal surfaces, which usually have a *metal oxide* (MO) outer layer (see Figure 1).

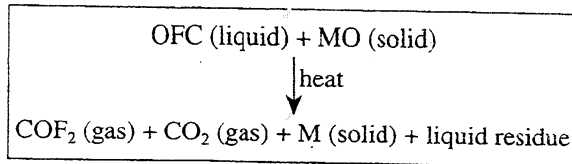


Figure 1

When an oil decomposes, the mechanical systems stop working, crippling the spacecraft.

Chemists studied the decomposition of 2 OFCs (OFC1 and OFC2).

Experiment 1

In a chamber at 100°C and 0.01 atmospheres (atm) pressure, 1.5 g of OFC1 was mixed with 50 mg of powdered iron(III)oxide (Fe_2O_3), an MO. The gases produced by the decomposition of the OFC caused the pressure to increase. The *induction period* (the time for the pressure to rise to 0.20 atm) was measured. Shorter induction periods indicate more rapid decomposition. The procedure was repeated at different temperatures, and for OFC2 (see Table 1).

Table 1		
Temperature (°C)	Induction period (sec)	
	OFC1	OFC2
100	1,800	998
120	903	603
140	442	301
160	218	133
180	111	52
200	55	18
220	29	6

Experiment 2

The induction periods of OFC1 with various powdered Fe compounds were measured as in Experiment 1 at 180°C (see Table 2). Some of these compounds are hypothesized to exist on heated metal surfaces, or to form as minor by-products of the reaction shown in Figure 1.

Table 2		
Compound	Formula	Induction period (sec)
Iron(II)*oxide	FeO	5,784
Iron(III)fluoride	FeF_3	3
Iron(III)chloride	FeCl_3	48
Iron(III)carbonate	$\text{Fe}_2(\text{CO}_3)_3$	996
Iron(III)sulfate	$\text{Fe}_2(\text{SO}_4)_3$	998

*Roman numerals in parentheses indicate the amount of positive charge on the iron atom.

6. If, in Experiment 1, a trial had been done at 150°C, the induction periods (in sec) for OFC1 and OFC2 would most likely have been which of the following?

	OFC1	OFC2
F.	203	311
G.	311	203
H.	301	442
J.	442	301

7. Based on the results of Experiment 2, which compound produced the fastest decomposition of OFC1 at 180°C?
- A. FeO
 B. FeF_3
 C. FeCl_3
 D. $\text{Fe}_2(\text{CO}_3)_3$



8. In which of the following ways was the design of Experiment 1 different from that of Experiment 2? In Experiment 1:
- F. only OFC1 was studied; in Experiment 2, only OFC2 was studied.
 - G. only OFC2 was studied; in Experiment 2, only OFC1 was studied.
 - H. temperature was varied; in Experiment 2, temperature was always the same.
 - J. temperature was always the same; in Experiment 2, temperature was varied.
9. In Experiment 1, during the decomposition of OFC2 at 100°C, as time increased from 0 to 998 sec, the pressure in the chamber:
- A. decreased from 0.20 atm to 0.01 atm.
 - B. decreased from 0.01 atm to 0.20 atm.
 - C. increased from 0.20 atm to 0.01 atm.
 - D. increased from 0.01 atm to 0.20 atm.
10. A chemist claimed that under identical conditions, OFC2 will always break down in the presence of an MO more quickly than will OFC1. Are the results of Experiment 1 consistent with her claim?
- F. No; at each temperature tested, the induction period for OFC1 was less than that for OFC2.
 - G. No; at each temperature tested, the induction period for OFC1 was greater than that for OFC2.
 - H. Yes; at each temperature tested, the induction period for OFC1 was less than that for OFC2.
 - J. Yes; at each temperature tested, the induction period for OFC1 was greater than that for OFC2.
11. Based on the information in the passage, which of the following could be the chemical formula for an OFC?
- A. $\text{CF}_3(\text{CF}_2\text{O})_{25}\text{CF}_3$
 - B. $\text{CF}_3(\text{CH}_2\text{CF}_2\text{O})_{45}\text{CF}_3$
 - C. $\text{CF}_3(\text{CF}_2\text{CO}_2)_{15}\text{CCl}_3$
 - D. $\text{CF}_3(\text{CF}_2\text{OCF}_2)_{35}\text{CH}_3$