University of Biskra
Mathematics Department
First year Master
Module: Mathematical modeling
2026/2027

Worksheet

Exercise 1

Chemically, combustion of ethane (C_2H_6) produces water and carbon dioxide (CO_2). Applying the principle of conservation of mass, determine the quantities of ethane and oxygen required to produce 10 units of CO_2.

Repeat the calculation for the case where ethanol is used.

Exercise 2

Chemically, dilution of phosphorus pentachloride (PCl_5) produces phosphoric acid (H_3PO_4) and hydrochloric acid (HCl). Applying the principle of conservation of mass, determine the quantities of ethane and oxygen required to produce 10 units of HCl.

Exercise 3

The dosing interval is an important concept in medicine. It refers to the time period between successive doses of a medication that a patient must take. This interval plays a crucial role in the effectiveness of drug therapy for at least two reasons:

- Maintaining optimal therapeutic levels in the body.
- Preventing side effects associated with overdose.

The experiment involving blood analysis of a sample of patients showed that the plasma concentration (g) of a specific drug at time t (hours) after the initial intake of this drug is perfectly described by the following function:

$$f(t) = kte^{-t}, \quad \geq 0; \tag{1}$$

where k is a drug-related positive parameter.

- Given that the amount of the drug in the blood must not exceed 2 g to avoid overdose, determine the minimum length of the dosing interval.
- If a patient can be treated with a single dose of this drug—provided that its maximum blood concentration exceeds 1 g—then determine the values of the parameter k that satisfy this condition.

Exercise 4

Suppose an individual wishes to take out a loan from a bank whose strategy mandates a fixed debt repayment amount for each period.

1. Propose a mathematical model to track the evolution of the outstanding principal, calculate interest, and determine the monthly payments.

2. Numerical example: An individual takes out a mortgage loan of 5,000,000 Algerian dinars at an annual interest rate of 3%.

   (a) What monthly payment must they make to repay the debt over 20 years?

   (b) If they make a monthly payment of 50,000 Algerian dinars, when will they have fully repaid the debt to the bank?