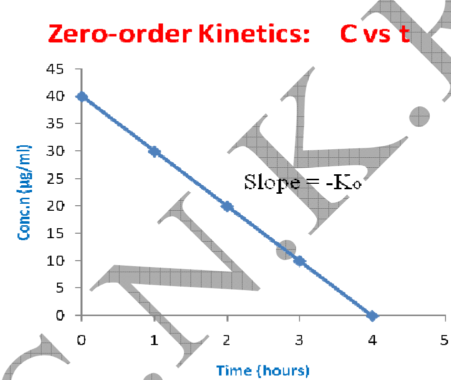
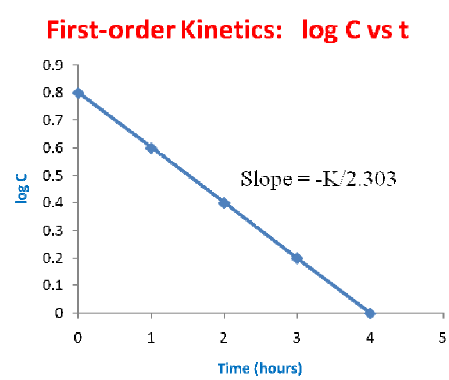
Differences between
Zero-order kinetics and First-order kinetics

S.No	Zero-Order Kinetics	First-Order Kinetics
1.	***Definition:*** the process that takes place at a constant rate independent of drug concentration involved in process	the process that is directly proportional to the drug concentration involved in process
2.	Constant Rate Process	Linear Kinetic Process
3.	Rate of process cannot be increased even the drug concentration was increased also	Rate of process increases linearly with increase in drug concentration
4.	Process doesn't depend on drug concentration i.e., Concentration Independent Process	Depends on drug concentration i.e., Concentration Dependent Process
5.	***General expression:*** $dc/dt = -K_oC^o = -K_o$	$dc/dt = -KC^1 = -KC$
6.	***Rate constant:*** K_o	K
7.	Rate constant ***Units:*** mg/min	min^{-1} or $hour^{-1}$ i.e., per hour
8.	***General Equation:*** $C = C_o - K_ot$ Where, C_o = initial drug conc.n C = drug conc.n at time, t	$C = C_o e^{-Kt}$ (or) $Log\ C = log\ C_o - Kt/2.303$
9.	***Plot:*** Concentration vs time gives straight line whose slope = $-K_o$ 	log C vs time gives straight line whose slope = – K/2.303 
10.	***Half-life:*** $t_{1/2} = 0.5\ C_o/K_o$	$t_{1/2} = 0.693/K$
11.	Half-life depends on initial drug concentration (*reverse to the rate process*)	Half-life is concentration independent and it is a constant value
12.	At some time, the zero-order process comes to an end	The process never comes to an end, since it takes place at certain proportion of the concentration existing at that time
13.	***Examples:*** I.V. Infusion, Controlled/ Sustained drug delivery systems, Carrier based processes after saturation	Absorption, Distribution, Metabolism and Excretion (not linked with carriers or unsaturable state if linked with carriers)

Explanation:

Zero-order process takes place at a constant rate independent of the existing concentration or initial concentration. Let us take an example: A patient was given 100 mg of drug A orally. Assume that the drug absorption follows zero-order kinetics at a rate of 10 mg/min.

- Then can you predict the drug absorption at every minute? Yes, you are right! For every minute, 10 mg of the drug will undergo absorption.
- So after 5 minutes, how much will be absorbed? Yes, 5 x 10 mg = 50 mg will be absorbed.
- Similarly 80 mg will be absorbed after 8 minutes.
- By what time the whole drug will be absorbed? Yes, it will take 10 minutes for complete absorption of drug and the process comes to an end.
- If the administered dose of the same drug is 200 mg, again the same rate, 10 mg/min will be followed and the process comes to an end after 20 mins. Do you agree with me! Good. That's what we should know about Zero-order kinetics.
- If you observe the administration of saline to a patient, it was given at a constant rate and will be completed at some time.

Let us move to First-order kinetics…

First-order process takes place at a constant proportion of the drug concentration available at that time so the process is depending on the initial concentration. Let us consider an example: A patient was given 100 mg of drug B orally and it was assumed to be following first-order kinetics a proportion of 10% per minute, of the existing concentration at that time. Let me clarify the concept clearly!

- What is the dose given: 100mg and what is the proportion it is getting absorbed: 10% per minute.
- So, in first minute 10% of initial drug i.e., 10 mg will be absorbed.
- In the second minute again 10% will be absorbed but here the drug remained for absorption after first minute is 100-10=90 mg only. So 10% of 90 mg will be absorbed in the second minute. Then how much it will be: 9 mg. So, at the end of second minute, 81 mg will be remained for absorption.
- In third minute again 10%, but 10% of 81 mg i.e., 8.1 mg will be absorbed.
- Similarly in 4^{th} minute, 10% of 72.9 mg i.e., 7.29 mg will be absorbed.
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- Yes, the doubt you are getting is correct, after some time, if 1 mg is remained to be absorbed, then also 10% of that 1 mg only will be absorbed. That means the first-order process never comes to an end. Hope you got the point! The same is applicable for others too like Elimination etc.

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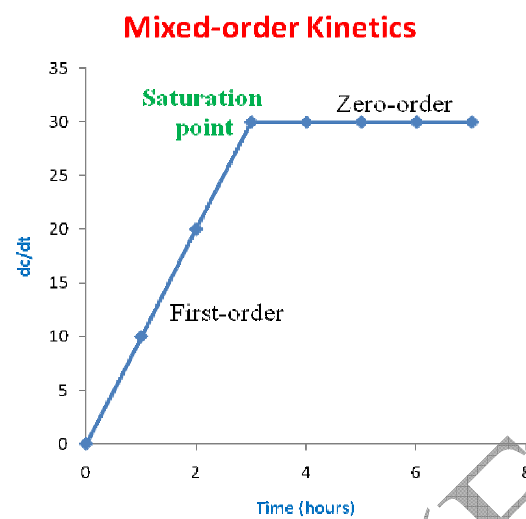
Sometimes, the drug following first-order kinetics may shift to zero-order if the process is carrier dependent and saturation takes place. The scenario represents mixed-order kinetics.



In your project works or research works, you have prepare various formulations and come to a conclusion that some formulation is the best one as per your objectives. At the time you need to report whether the drug release from that formulation is following zero-order or first-order kinetics. [Ofcourse we need to report mechanism also like diffusion or erosion etc, which is out of scope in present explanation]

With the help of plots drawn between C vs time and log C vs time we can determine which order of kinetics the drug release is following. If C vs time plot gives straight line then the drug release is following zero-order and if log C vs time plot gives straight line then the drug release is said to be following first-order kinetics. The same is applicable for any process even you check for absorption of drug in volunteers also, the same principle is applicable.

Some time both plots may be synonymous and difficult to judge the order of kinetics, in that case we have to depend on statistics by checking the best correlation among x-axis and y-axis values. Better correlation determines the order of kinetics.

GOOD LUCK