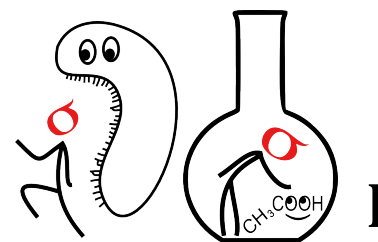


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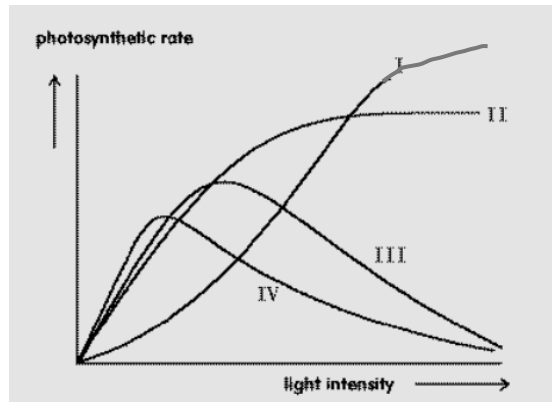
Day 2: Biology & Chemistry



1) Food, by nature, is perishable. Food preservation has been an essential activity throughout history. Drying, pickling, fermenting, curing, sugaring, salting and chilling etc. have all been incorporated into every culture's culinary traditions throughout the world. Name at least two general mechanisms of action and explain how each of these mechanisms prevents or retards food spoilage.

2) In cold northern regions, spring arrives late and the ground remains covered in snow until late May. The temperature of the air rises above freezing for only a few short hours each day. In these conditions, only the top of an anthill heats up. The heat doesn't permeate the deeper layers, where the Queen Ant resides. The Queen Ant cannot lay eggs in the upper layers of the anthill, nor can she lay them in the cold. The larvae also need a warm environment to thrive. Somehow, the depths of the anthill remain warm throughout the cold spring months. Suggest possible mechanisms for this phenomenon.

3) Four types of phytoplankton (I, II, III and IV) were collected from different depths in the ocean. For each of these types, the rate of photosynthesis was measured, as represented in the following figure. Order the types of phytoplankton according to the depth at which they were collected, starting from the deepest one.



4) As a result of a chemical reaction a substance decomposes so that in one hour out of a million of molecules 500 thousands are left and in two hours 250 thousands are left. What would be the mass of the remaining substance if 10 grams of it are left to decompose for 3 hours?

5) Sherlock Holmes and Dr. Watson were invited to investigate a murder of the Duke of Buckingham. The Duke was poisoned. Holmes was able to secure the leftover of the duke's wine - the likely cause of the death. The victim had two enemies: Baron Rothschild and the Bishop of Northumberland. Holmes conducted a series of experiments in his lab at Baker Street and announced to Watson:

"Look, Watson, I was able to find the killer by using solubility table from "Elements of Inorganic Chemistry" by Dr. Lukin!" The Bishop is alone a murderer!"

"That is absolutely remarkable, Holmes! But how?!!!!!"

"It is elementary, my dear Watson! It is well known that Rothschild always uses arsenic compounds and the Bishop has a soft spot for mercury. After doing simple precipitation tests I could tell without any doubt who was the killer."

Can you figure out how could Holmes proved that Bishop committed the crime and that Baron Rothshild is innocent?

For your convenience, the solubility table is reproduced below:

Solubility chart of acids, bases and salts. Metals are shown in columns, and acidic residues in rows.

	H	Li	Na	K	Ca	Mg	Al	Fe (II)	Fe (III)	Zn	Pb	Cu (II)	Hg (II)	Ag
OH	-	s	s	s	M	I	I	I	I	I	I	I	D	D
Cl	s	s	s	s	s	s	s	s	s	s	M	s	s	I
NO ₃	s	s	s	s	s	s	s	s	s	s	s	s	s	s
ClO ₄	s	s	s	s	s	s	s	s	s	s	s	s	s	s
S	s	s	s	s	D	D	D	I	D	I	I	I	I	I
SO ₃	s	s	s	s	I	M	I	I	D	M	I	D	D	M
SO ₄	s	s	s	s	M	s	s	s	s	s	I	s	s	M
PO ₄	s	s	s	s	I	I	I	I	I	I	I	I	I	I
AsO ₄	s	s	s	s	I	I	I	I	I	I	I	I	I	I
SiO ₃	I	s	s	s	I	I	I	I	D	I	I	I	D	D
CO ₃	D	s	s	s	I	D	I	I	D	I	I	I	I	I

s – soluble

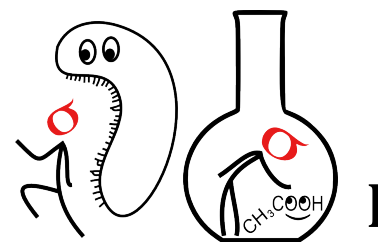
I – insoluble

M – moderately soluble

D - decomposing

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Experimental problem!

(4 points for a complete solution)

A set of solid compounds (white powders) is given to you. Using a minimal amount of test tubes, inflate a balloon using the gas produced in the chemical reaction between some chemical compounds from the set. After balloon is inflated, bring the experimental setup, along with the balloon to the judges. *Do not disconnect the balloon from your setup.* The volume will be measured, and the team having the greatest volume of the balloon wins.