



REPUBLIC OF LEBANON
*Ministry of Education
and Higher Education*



*Center for Educational
Research and Development*

Action Verbs

**Physics, Chemistry
and Life Science**

Definitions and Examples
2012

Prepared by: The committee responsible for unifying some of the action verbs in Physics, Chemistry, and Life Science.

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Intr**o**duction

This document is designed to unify the definition of certain action verbs used in the different scientific disciplines: Physics, Chemistry, and Life Science. It includes a list of certain action verbs which are frequently used in these disciplines, accompanied by supporting examples.

This list does not include all the action verbs that can be used during the formulation of questions. The proposed examples give an idea about the required answers for these verbs.

The Committee

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List of some of the action verbs and their requirements

- 1- **Analyze:** Decompose a whole into its constituent elements to make evident the variations.
- 2- **Calculate:** (Compute) Perform mathematical operations.
- 3- **State:** Express without explaining .
- 4- **Compare:** Indicate the similarities and/or differences between two or more entities.
- 5- **Complete:** Add what is missing.
- 6- **Conclude:** Reach to a decision.
- 7- **Determine:** Reach to a decision or a result through logical reasoning, calculation, ...
- 8- **Describe:** Express, using scientific language, to give the details of an observation, an experiment, a schema, an apparatus, ...
- 9- **Show:** Prove something is evident by logical reasoning, experimenting, calculating,...
- 10- **Deduce:** Draw using logical reasoning new information from given or existing information.
- 11- **Draw out:** Draw from a set of given and without reasoning a relation, a role, a law,...
- 12- **Distinguish:** Recognize or discern one thing from another according to particular traits.
- 13- **Explain:** Clarify, make understandable a phenomenon, a result,...
- 14- **Identify:** Recognize something based on its characteristics or its properties.
- 15- **Interpret:** Analyze and give significance to the result.
- 16- **Indicate:** Designate something without justification.
- 17- **Justify:** Prove something as true and real.
- 18- **Specify:** Indicate and justify.
- 19- **Pick out (Extract):** Select one or more information from a document.
- 20- **Verify:** Confirm using arguments, logical reasoning, ... whether something is true or false.

EXAMPLES ON ACTION VERBS

OFFICIAL EXAMS - GRADE 9

PHYSICS

1- Analyze: Decompose a whole into its constituent elements to make evident the variations.

➤ **Example:** *Analyze* the function of screwdriver tester “Live main indicator” in studying the terminals of an outlet (socket)?

➤ **Answer:** Elements: Neon lamp glows under voltage greater than 80V, metallic head and metallic cap. Variations: Insert the metallic head in one of the female terminals of the outlet and your thumb on the metallic cap (to close the circuit with the earth):
If the lamp lights, the terminal is phase.
If the lamp does not light, the terminal is neutral.

2- Calculate: (Compute) Perform mathematical operations.

➤ **Example:** An Ohmic resistor R of resistance 20Ω , is traversed by a current $I = 0.6 \text{ A}$.

Calculate the voltage U across the resistor.

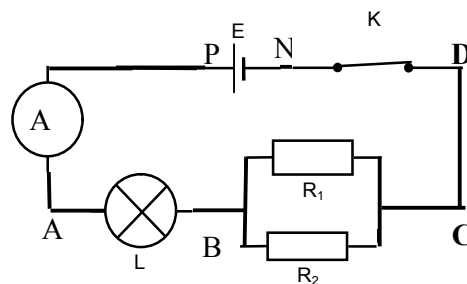
➤ **Answer:** The voltage U is given by: $U = R \times I = 20 \times 0.6 = 12\text{V}$.

3- State: Express without explaining .

➤ **Example:** *State* the various components of the circuit below.

➤ **Answer:** The electrical circuit shown consists of:

- A generator (G) of constant DC voltage;
- An ammeter (A);
- A lamp (L);
- Two Ohmic resistors of resistances R_1 and R_2 ;
- A switch (K);
- Connecting wires.

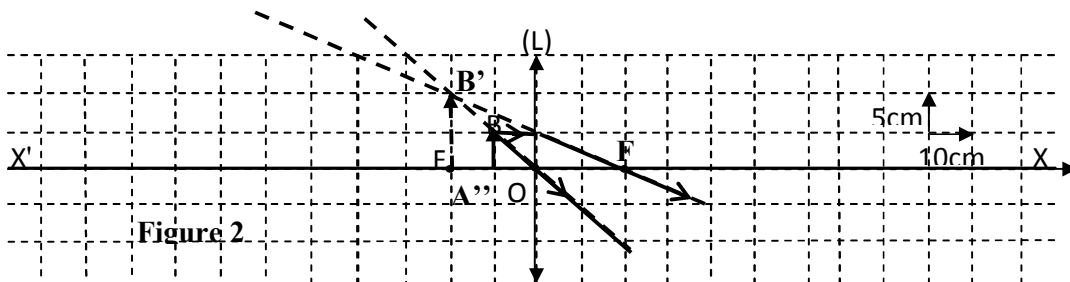
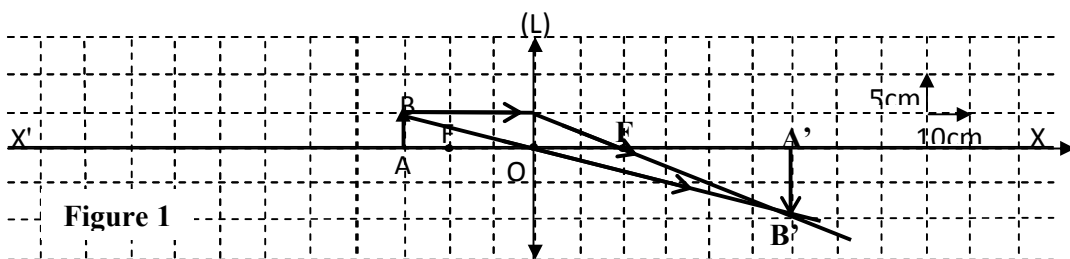


4- **Compare:** Indicate the similarities and/or differences between two or more entities.

➤ **Example :**

- A lens (L) of focal length $f = 20\text{cm}$, gives for an object $AB = 5\text{cm}$, A on the axis, an image:
- $A'B'$ when the object is at distance $d_1 = 30\text{cm}$ from the optical center of (L). (Figure 1)
- $A''B''$ when the object is at distance $d_2 = 10\text{cm}$ from the optical center of (L). (Figure 2)

Referring to Figures 1 and 2, **compare** $A'B'$ and $A''B''$ (Nature, orientation, position, and magnitude).



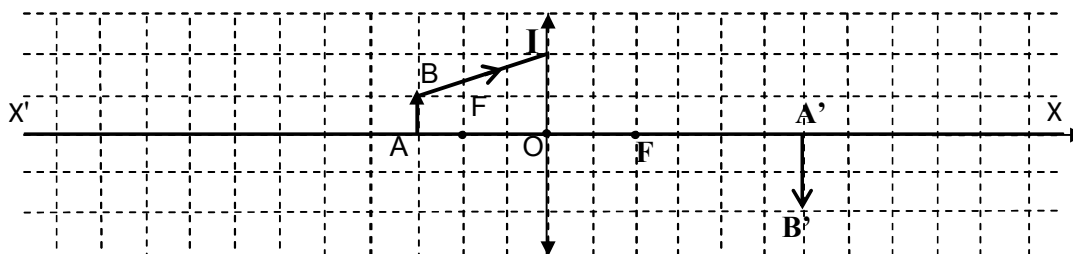
➤ **Answer:**

- $A'B'$ is real while $A''B''$ is virtual image.
- $A'B'$ is inverted relative to AB where $A''B''$ is erect compared to AB .
- $A'B'$ is 60 cm from the optical center O of (L), while $A''B''$ is 20 cm from the optical center O of (L).
- $A'B'$ and $A''B''$ are of same size = 10 cm.

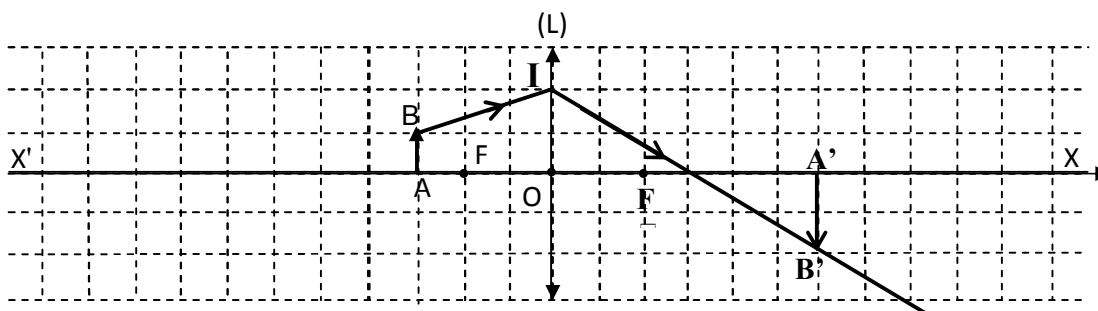
5- **Complete:** Add what is missing.

- **Example:** A converging lens (L) gives for an object AB, perpendicular to its optical axis, A on the axis, a real image A'B'.

Complete the path of the incident ray BI.



➤ **Answer :**



6- **Conclude:** Reach to a decision.

- **Example:** A solid (S) is placed successively in three containers, contains water of density $\rho_1 = 1 \text{ g.cm}^{-3}$, oil of density $\rho_2 = 0.9 \text{ g.cm}^{-3}$ and alcohol of density $\rho_3 = 0.8 \text{ g.cm}^{-3}$ respectively. The table below shows the value of the immersed volume of (S) in the three liquids.

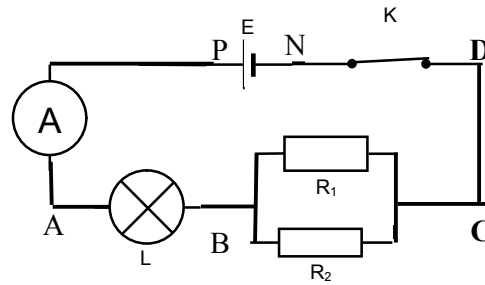
liquid	water	oil	Alcohol
density (g.cm^{-3})	$\rho_1 = 1$	$\rho_2 = 0,9$	$\rho_3 = 0,8$
Immersed Volume (cm^3)	$V_1 = 500$	$V_2 = 555$	$V_3 = 633$

Conclude about the variation of the immersed volume of (S) depending on the density of the liquid.

- **Answer:** From the table above, we recognize that when the density decreases the immersed volume of (S) increases.

7- **Determine:** Reach to a decision or a result through logical reasoning, calculation,...

➤ **Example:** The given circuit consists of a generator (G) of $U_{PN} = 12V$, an ammeter (A) of negligible resistance; a 6V lamp; two ohmic resistors $R_1 = R_2 = 20\Omega$; a switch (K); and connecting wires.



Determine the intensity of the current measured by the ammeter (A).

➤ **Answer :** The law of addition of voltages:

$$U_{PN} = U_{PA} + U_{AB} + U_{BC} + U_{CD} + U_{DN} \quad (1)$$

But $U_{PA} = 0V$ (the resistance of the ammeter is negligible).

$U_{AB} = 6V$ (the lamp lights normally).

$$U_{BC} = R_e \times I = 10 I, \text{ since } R_e = \frac{R_1 \times R_2}{R_1 + R_2} = 10\Omega.$$

$U_{CD} = 0$ (wire).

$U_{DN} = 0$ (closed switch)

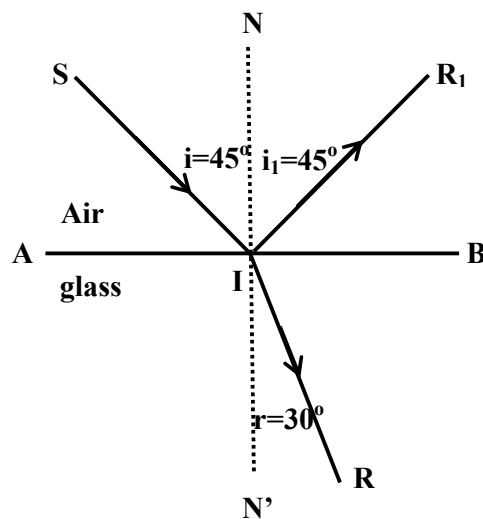
Substitute in equation (1)

$$12 = 0 + 6 + 10I + 0 + 0, \text{ so } I = \frac{12-6}{10} = 0.6A.$$

The ammeter (A) shows 0.6 A.

8- **Describe:** Express, using scientific language, to give the details of an observation, an experiment, a schema, an apparatus, ...

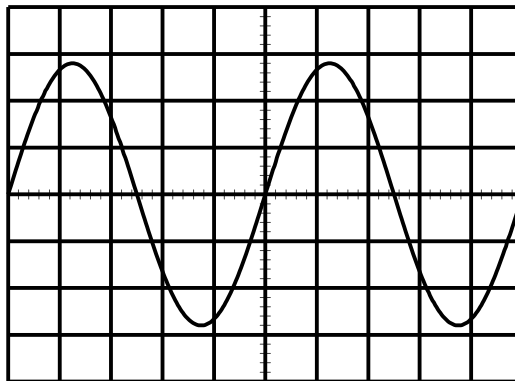
➤ **Example:** Observe the figure below and **describe** the two physical phenomena which appear when the incident ray SI strikes the air-glass surface of separation (AB).



- **Answer:** When the incident light ray meets the surface of separation (AB) of the system air-glass with an angle of incidence $i = 45^\circ$, this ray undergoes:
 - Refraction where the refracted ray IR makes an angle of refraction $r = 30^\circ$.
 - Partial reflection where the reflected ray IR_1 makes an angle of reflection $i_1 = 45^\circ$.

9- Show: Prove something is evident by logical reasoning, experimenting, calculating,...

- **Example :** A 10V Lamp is supplied by a LFG which delivers a sinusoidal voltage u . The figure below shows the screen of an oscilloscope which displays the waveform of u .
The vertical sensitivity of the oscilloscope is: $S_v = 5V/div$.
Take: $\sqrt{2} = 1.4$.



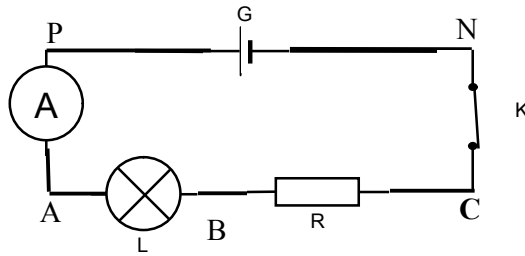
Show that the lamp functions normally.

- **Answer:** A lamp illuminates normally when the effective voltage of LFG is equal to its nominal voltage.
The effective voltage $U_e = U_m / (\sqrt{2})$
But $U_m = (5V/div) \times 2.8div = 14V \Rightarrow U_e = 14/1.4 = 10V$.
The nominal voltage of the lamp is 10V, so (L) lights normally.

10- Deduce: Draw using logical reasoning new information from given or existing information.

- **Example:** The electrical circuit of the figure below, contains in series,
 - A generator (G) providing a constant voltage across its terminals $U_{PN} = 12V$;
 - An ammeter (A) of negligible resistance;
 - A lamp (L) (6V, 3W);
 - An ohmic resistor of resistance R;
 - A switch (K).
 When K is closed, (L) lights normally.

Deduce the value of R.



- **Answer:** The law of addition of voltages gives:
 $U_G = U_R + U_A + U_L + U_K \Leftrightarrow 12 = U_R + 0 + 6 + 0$
 $12 = 0 + 6 + U_R + 0$
 But $U_A = 0$, the resistance of (A) is negligible,
 $U_K = 0$, the switch is closed,
 $U_L = 6\text{v}$, the lamp is operating normally.
 So, $U_R = 12 - 6 = 6\text{V}$.
 The lamp operates normally: $U_L = 6\text{v}$ and $P = 3\text{w}$.
 With $P = U \cdot I$, we obtain: $I = P / U = 3 / 6 = 0.5\text{A}$.
 Use Ohm's law: $U_R = R \cdot I$ and we deduce $R = U_R / I = 12\Omega$.

11- Draw out: Draw from a set of given and without reasoning a relation, a role, a law,

- **Example:** Let (R) a spring of initial length $L_0 = 10\text{cm}$. Its length becomes L when it is subjected to a force T. The table below gives some values of T and the corresponding values of L.

T (N)	2	4	6
L (m)	0.14	0,18	0.22

Comparing the ratio $\frac{T}{L-L_0}$, **draw out** a relation between T, L and L_0 .

- **Answer:**

$$\frac{T}{L-L_0} = \frac{2}{0,14-0,10} = \frac{2}{0,04} = 50\text{N/m.}$$

$$\frac{T}{L-L_0} = \frac{4}{0,18-0,10} = \frac{4}{0,08} = 50\text{N/m.}$$

$$\frac{T}{L-L_0} = \frac{6}{0,22-0,10} = \frac{6}{0,12} = 50\text{N/m.}$$

We found: $\frac{T}{L-L_0} = 50\text{N/m.}$

12- Distinguish: Recognize or discern one thing from another according to particular traits.

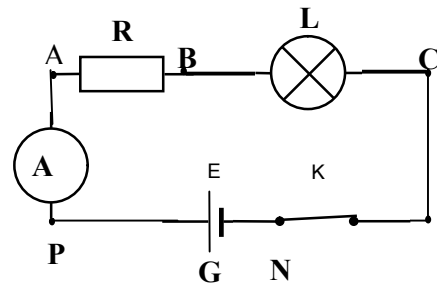
- **Example: *Distinguish*** between a convergent lens and a divergent one.
- **Answer:** The lens is illuminated by a cylindrical beam of light. If the emergent beam:
 - Converges, the lens is convergent.
 - Diverges, the lens is diverging.

13- Explain: Clarify, make understandable a phenomenon, a result, ...

- **Example:** The circuit below has, in series:
 - A generator (G) provides DC voltage $U_{PN} = 12V$;
 - An ammeter (A) of negligible resistance;
 - An ohmic resistor (R) = 10Ω
 - A lamp (L) marked 6V;
 - A switch (K).

If (K) is closed, and the ammeter shows 0.6 A, the lamp (L) glows normally.

Explain why the lamp (L) glows normally.



- **Answer: Voltage across the lamp.**
 Apply the law of addition of voltages: $U_{PN} = U_R + U_L + U_A + U_K$.
 But $U_A = 0V$, the resistance of (A) is negligible,
 $U_K = 0V$, the switch is closed,
 and $U_R = RI$ (from Ohm's law) so:

$$U_{PN} = IR + U_L + 0 + 0$$

$$12 = 10 \times 0.6 + U_L$$
 so $U_L = 12 - 6 = 6V$.
 As the voltage across the lamp is equal to its nominal voltage, the lamp glows normally.

14- Identify: Recognize something based on its characteristics or its properties.

- **Example:** A solid (S) of mass $M = 400g$, floats in equilibrium on the surface of a liquid (L) of density ρ , the immersed volume of (S) is $V_i = 500 \text{ cm}^3$.
 The table below shows the density of some liquids.

liquid	alcohol	oil	water	Salty water
density (g/cm^3)	0.8	0.9	1	1.02

Based on the given table, **identify** (L).

- **Answer:** The solid (S) is subjected to two forces: Its weight \vec{W} and up-thrust \vec{F} .

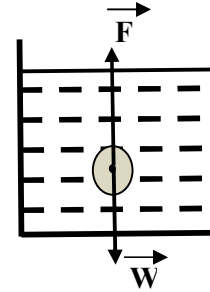
At equilibrium: $\vec{W} + \vec{F} = \vec{0}$, but in magnitude $W = F \Rightarrow$

$$Mg = \rho V_i g \Rightarrow M = \rho V_i, \text{ so } \rho = M / V_i = 400/500 = 0.8\text{g/cm}^3.$$

Referring to the above table the liquid (L) is alcohol since its density is equal to 0.8g/cm^3 .

15- Interpret: To analyze and give meaning to the result.

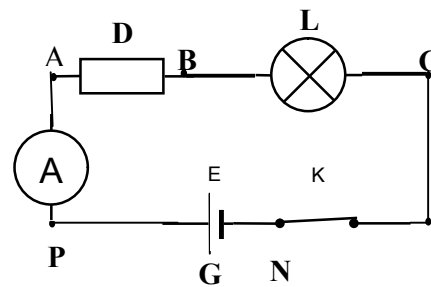
- **Example:** Consider a beaker containing a certain amount of water of density $\rho = 1\text{g/cm}^3$. A solid (S) of mass $m = 600\text{g}$ and volume 800cm^3 is pushed to become immersed completely in the container. When (S) is released, it rises to the surface of the water.
Interpret.



- **Answer:** Inside the water, the solid (S) is subject to two forces: Its weight W and up-thrust force F .
The magnitude of the weight W is: $W = M \times g = 0.6 \times 10 = 6\text{N}$.
The magnitude of the buoyant force F is:
 $F = \rho V_i \times g = 1000 \times 0.0008 \times 10 = 8\text{N}$.
($V_i = V_s = 0.0008\text{m}^3$ because the solid is completely immersed in water).
Since $F > W$, it appears clearly that the solid will rise to the surface of the water, but since F decreases as V_i decreases so F becomes equal to W , and the solid floats on the liquid surface.

16- Indicate: Designate something without justification.

- **Example:** *Indicate*, in the adjacent circuit, the direction of electric current I .
- **Answer:** The direction of I is from the positive pole P of the dry cell (G) through the circuit to the negative pole N .

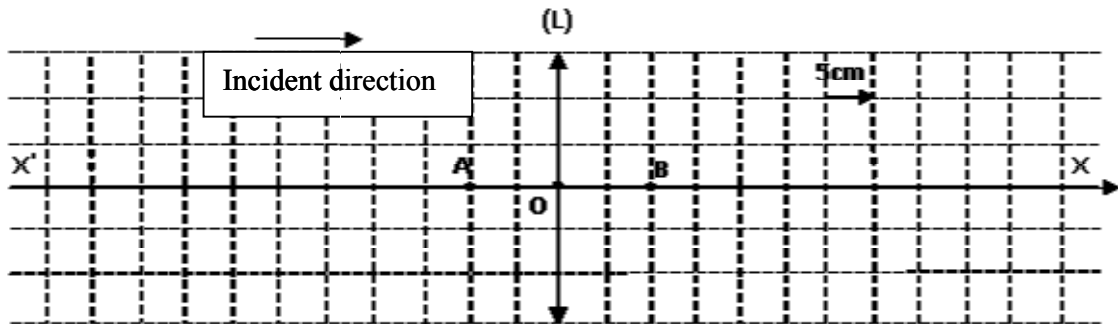


17- Justify: Prove something as true and real.

- **Example:** *Justify* that the resistance of lamp is not ohmic resistor
- **Answer:** The (I-V) characteristics graph of a lamp is not a straight line passing through the origin. So the resistance of the lamp is not ohmic resistance.

18- **Specify:** Indicate and justify.

- **Example:** The figure below shows a converging lens (L) of focal length $f = 10\text{cm}$. Its principle axis $x'x$, passes through the optical center O and two points A and B. **Specify** the position of the object focus of (L).



- **Answer:** “A” is the position of the focus object for the convergent lens (L). The object focus point is by the side of the incident light and at the distance $f = 10\text{cm}$ from optical center O. Since the distance $OA = 2\text{div} \times 5\text{cm/div} = 10\text{cm}$, A is the position of the object focus of (L).

19- **Pick out (Extract):** Select one or more information from a document

- **Example:** Figure 1 shows the waveform of a sinusoidal voltage u. Referring to Figure 1, **Pick out** the characteristics of u.

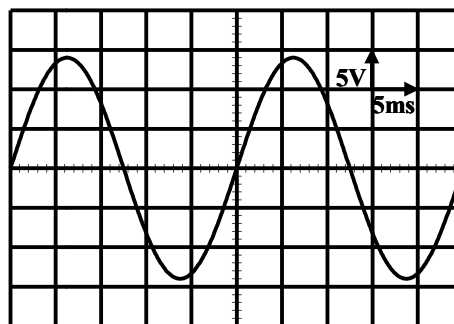


Figure 1

- **Answer:**
 From Figure 1, the characteristics of u are:
 The maximum voltage $U_m = S_v \times y = 5\text{V/div} \times 2.8\text{div} = 14\text{V}$.
 The effective voltage: $U_e = U_m / (\sqrt{2}) = 14 / 1.414 = 10\text{V}$.
 The period $T = S_h \times x = 5\text{ms/div} \times 5\text{div} = 25\text{ms}$.
 The frequency $f = 1 / T = 1 / 0.025 = 40\text{Hz}$.

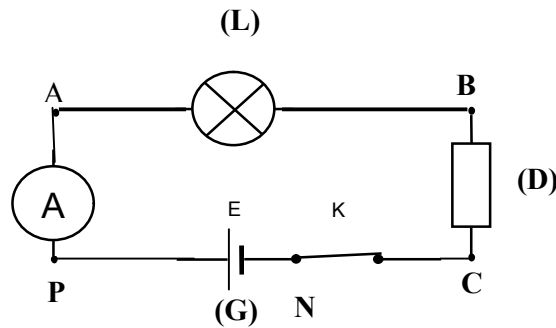
20- **Verify:** Confirm using arguments, logical reasoning, ... whether something is true or false.

➤ **Example:** The circuit below includes:

- A DC generator (G) $U_{PN} = 12V$;
- An ammeter (A) of negligible resistance;
- A lamp (L) with a nominal voltage 6V;
- An ohmic resistor (R) = 10Ω ;
- A switch (K).

The switch (K) is closed. The ammeter indicates 0.3 A.

Verify that the lamp may burn out.



➤ **Answer:** By applying the law of addition of voltages

$$U_{PN} = U_{PA} + U_{AB} + U_{BC} + U_{CN}$$

But $U_{PA} = 0V$ (ammeter of negligible resistance),

$$U_{BC} = IxR = 10 \times 0.3 = 3V \text{ (ohm's law),}$$

$U_{CN} = 0V$ (switch closed), we find: $12 = 0 + 3 + 0 + U_{AB}$

$$U_{AB} = 9V.$$

So, the voltage across the lamp exceeds its rated voltage, so the lamp will burn out.

EXAMPLES ON ACTION VERBS

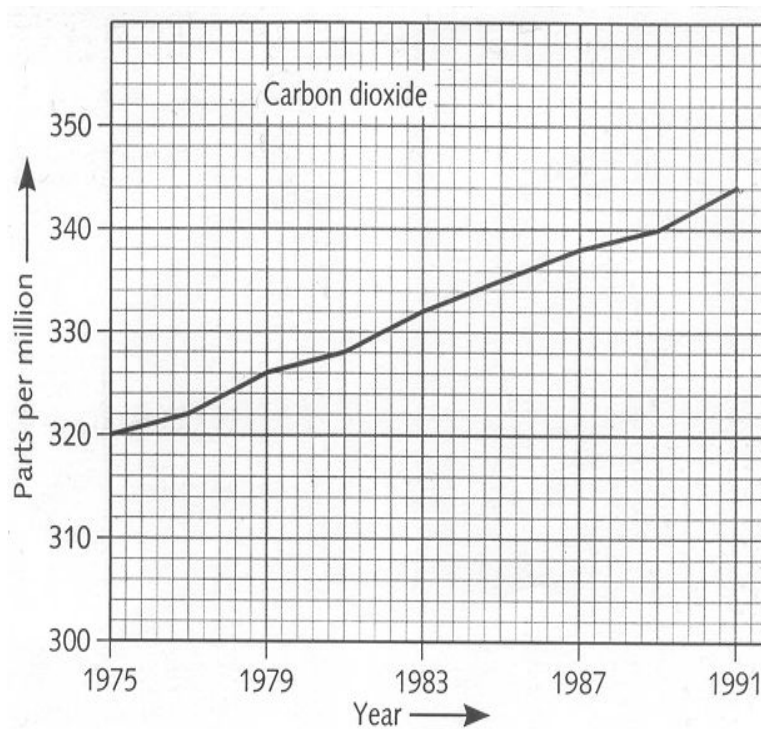
OFFICIAL EXAMS - GRADE 9

CHEMISTRY

1- Analyze: Decompose a whole into its constituent elements to make evident the variations.

➤ **Example:** The “greenhouse” effect is associated to the increasing amount of carbon dioxide in the air.

The curve given below shows the changes in the amount of carbon dioxide in ppm (parts per million) through the years 1975-1991.

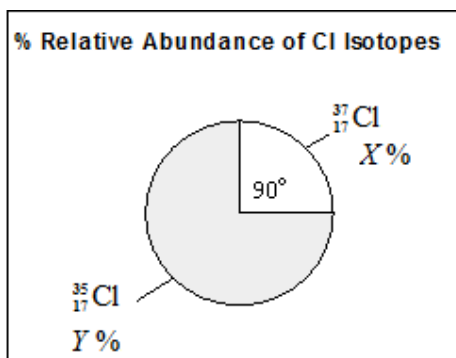


Analyze this curve.

➤ **Answer:** The amount of carbon dioxide is 320 ppm in 1975. The curve is an increasing curve, the amount of carbon dioxide increases 2 ppm in two years and becomes 322 ppm in the year 1977, but after two other years it increases by 4 ppm and becomes 326 ppm in the year 1979. This pattern is repeated in the intervals of four years, from 1979 to 1983, from 1983 to 1987 and from 1987 to 1991; it becomes 344 ppm in the year 1991.

2- Calculate: (Compute) Perform mathematical operations.

- **Example:** Chlorine exists in nature as an isotopic mixture. The **figure** given below shows the representation of the isotopes of chlorine and the percentage relative abundance of each isotope expressed as $X\%$ and $Y\%$.

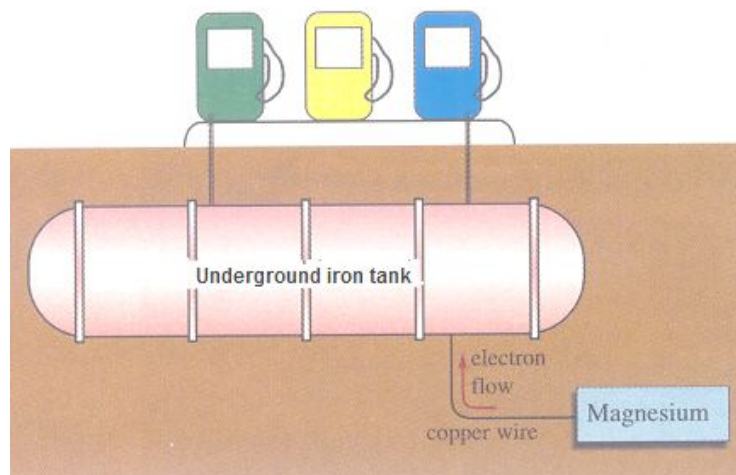


Calculate, based on the **figure**, the % relative abundance of the isotope ${}^{37}_{17}\text{Cl}$.

- **Answer :** The % relative abundance of ${}^{37}_{17}\text{Cl}$ is:
- $$\%{}^{37}_{17}\text{Cl} = X\% = \frac{90}{360} \times 100 = 25\% .$$

3- State: Express without explaining.

- **Example:** Corrosion of underground metallic pipes and tanks can be greatly prevented by connecting the pipes or the tanks to a more active metal such as zinc or magnesium.

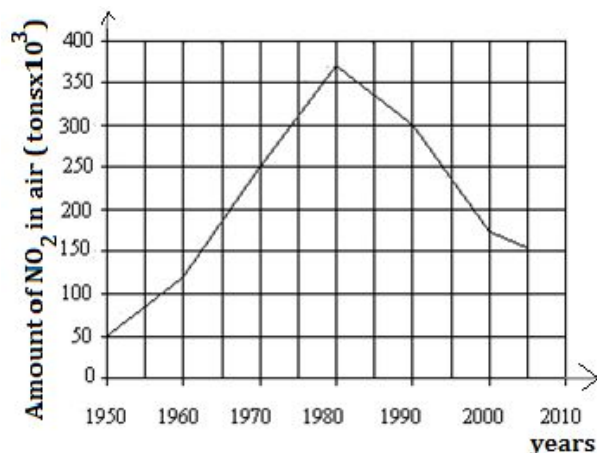


State how underground iron storage tank can be prevented from rusting.

- **Answer :** Underground iron storage tank can be prevented from rusting by connecting it to an active metal such as zinc.

4- **Compare:** Indicate the similarities and/or differences between two or more entities.

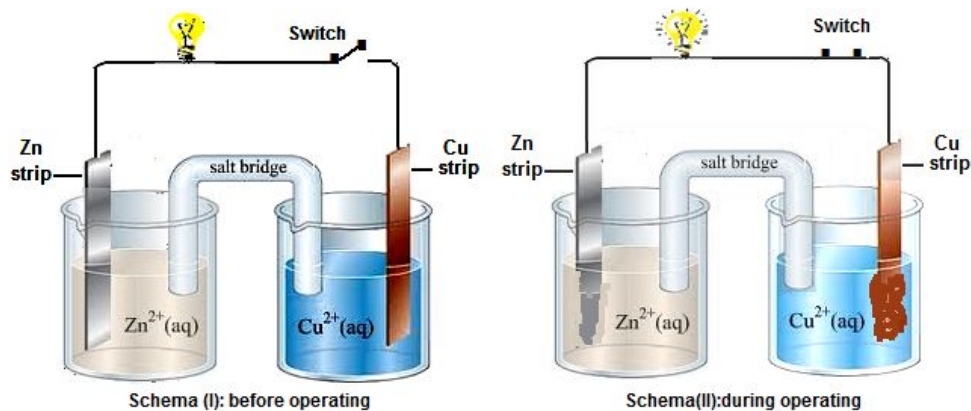
- **Example 1:** The graph given below shows the change of the amount of NO_2 gas in 10^3 tons released into the air between the years 1950 and 2005.



Compare the amount of NO_2 gas released into the air in 1970 to that released in 2005.

- **Answer:** The amount of NO_2 gas released into the air in 1970 is 250×10^3 tons.
The amount of NO_2 gas released into the air in 2005 is 150×10^3 tons.
The amount of NO_2 gas released into the air in 1970 > than the amount of NO_2 gas released into the air in 2005.

- **Example 2:** Below is given the schemas (I) and (II) of a zinc-copper galvanic cell.



Compare the two given schemas.

- **Answer :** Schema (I) and Schema (II) consist of zinc half-cell and copper half cell associated to each other by a salt bridge. The external part of each galvanic cell consists of a lamp and a switch in series.

In schema (I), the switch is open, the lamp is not lighting.

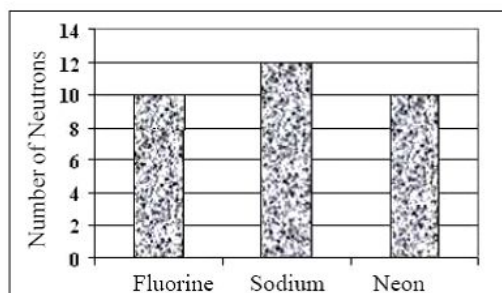
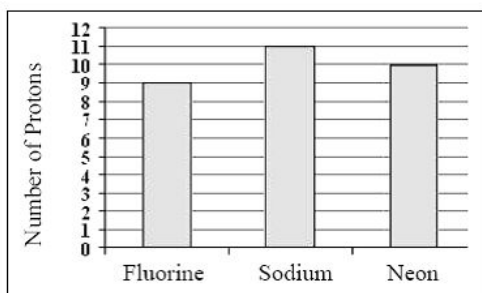
In schema (II), the switch is closed, the lamp is lighting.

In Schema (II), the immersed part of the zinc strip is thinner than that in schema (I) and the immersed part of the copper strip is thicker than that in schema (I).

In schema (I), the intensity of the color of the solution containing Cu^{2+} ions is more than that of schema (II).

5- Complete: Add what is missing.

- **Example:** The bar graphs given below show the components of the nucleus of each of the atoms: fluorine, sodium and neon.



Complete the table given below:

<i>Atoms</i>	<i>Atomic number</i>	<i>Mass number</i>	<i>Number of electrons</i>
Fluorine (F)			
Sodium (Na)			

- **Answer :**

<i>Atoms</i>	<i>Atomic number</i>	<i>Mass number</i>	<i>Number of electrons</i>
Fluorine (F)	9	19	9
Sodium (Na)	11	23	11

6- Conclude: Reach to a decision.

- **Example:** The normal boiling point temperatures and the IUPAC names of several straight-chain alkanes are given in the table below:

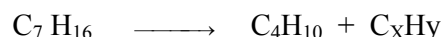
<i>Alkanes</i>	<i>ethane</i>	<i>propane</i>	<i>butane</i>	<i>pentane</i>	<i>hexane</i>	<i>octane</i>
<i>Normal boiling point Temperature (°C)</i>	-89	- 42	0	36	69	126

Indicate, referring to the table, the variation of the normal boiling point temperatures of these alkanes according to the number of carbon atoms in their molecules. **Conclude.**

- **Answer :** The normal boiling point temperature of these alkanes increases from -89°C for ethane to 126°C for octane. It can be concluded that the normal boiling point temperatures of straight-chain alkanes increases as the number of carbon atoms in their molecules increases.

7- Determine: Reach to a decision or a result ..., through logical reasoning, calculation,...

- **Example:** At the refinery, the cracking of heptane gives an alkane (**A**) of molecular formula C₄H₁₀ and a hydrocarbon (**B**) of molecular formula C_XH_Y according to the equation:



Determine the molecular formula of (**B**).

- **Answer :** According to the law of conservation of mass (atoms), in a chemical reaction the number of atoms of each element is conserved.
For C atoms: $7 = 4 + X \Rightarrow X = 3$
and for H atoms: $16 = 10 + Y \Rightarrow Y = 6$
Therefore, the molecular formula of hydrocarbon (**B**) is C₃H₆.

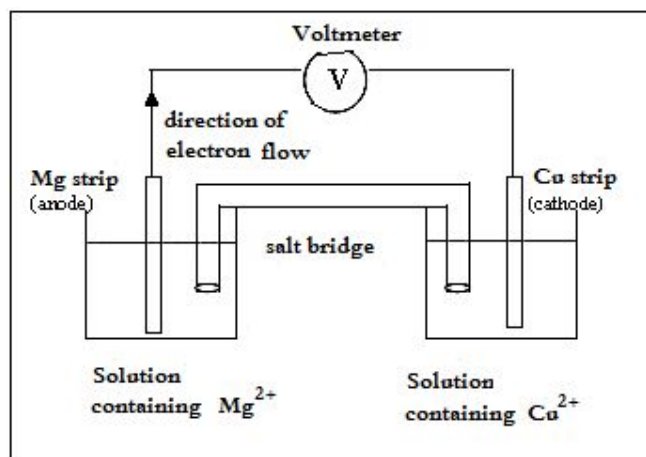
8- Describe: Express, using scientific language, to give the details of an observation, an experiment, a schema, an apparatus,...

- **Example:**

Available Materials:

- Magnesium strip and copper strip
- Solution containing magnesium (Mg²⁺) ions
- Solution containing copper (II) (Cu²⁺) ions
- Two beakers
- U-shape salt bridge
- Connecting wires
- Voltmeter

Describe the construction of the galvanic cell schematized below.

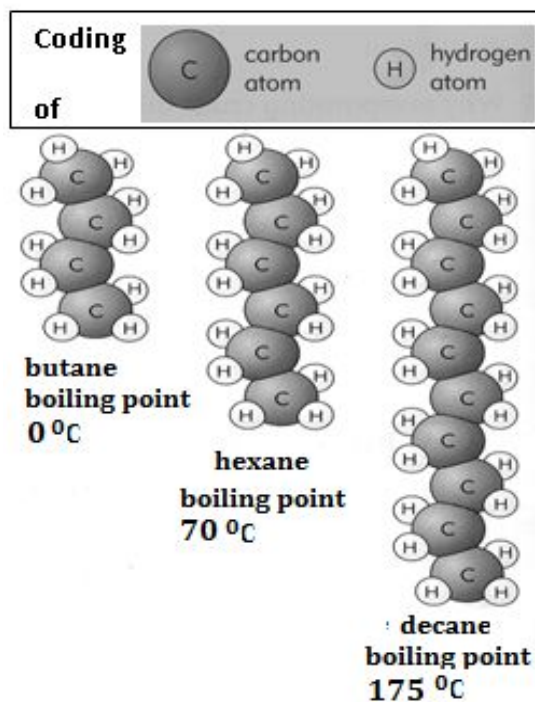


➤ **Answer:**

- 1- Into a beaker, pour a small amount of the solution containing Mg^{2+} ions and dip the Mg strip in it.
- 2- Into another beaker, pour a small amount of the solution containing Cu^{2+} ions and dip the Cu strip in it.
- 3- Associate the two solutions by a salt bridge.
- 4- Connect the voltmeter to the Mg strip and to the Cu strip using connecting wires.

9- **Show:** Prove something is evident by logical reasoning, experimenting, calculating,...

- **Example 1:** The normal boiling point temperature of a straight-chain alkane depends on the number of carbon atoms in its molecule.



Show, referring to the text and the schema, that the normal boiling point temperature of pentane (C₅H₁₂) is between 0°C and 70 °C.

- **Answer :** A pentane molecule consists of 5 C atoms in straight chain; its carbon chain is longer than that of butane molecule and shorter than that of hexane molecule.
The normal boiling point temperature of pentane is between 0°C and 70 °C.
- **Example 2:** The nucleus of sodium atom has a relative charge +11.
(Relative charge of a proton = +1)

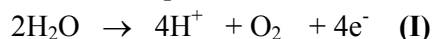
Show that the atomic number of sodium is 11.

- **Answer :** Relative charge of the nucleus, $Q_n = (+1)Z$, where Z is the number of protons in the nucleus.
 $+11 = (+1) Z \Rightarrow Z=11,$
- Atomic number = Z = number of protons in the nucleus
 \Rightarrow Atomic number of sodium is 11.

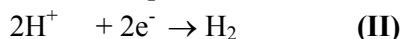
10- Deduce: Draw using logical reasoning new information from given or existing information.

- **Example:** In the laboratory, oxygen gas can be obtained by applying electrolysis on water to which a small amount of sulphuric acid is added. The electrodes used are inert.

The half-reaction that takes place at the anode is:

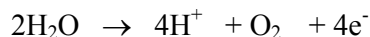


The half-reaction that takes place at the cathode is:



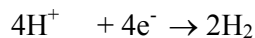
Deduce the equation of the overall reaction of this electrolysis.

- **Answer :** Number of electrons released at the anode should be equal to the number of electrons captured at the cathode.
The half-reaction that takes place at the anode is:



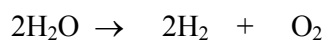
Multiplying half-reaction **(II)** by 2.

The half-reaction at the cathode is:



Adding the two half- reactions

The equation of the overall reaction is:



11- Draw out: Draw from a set of given, and without reasoning a relation, a role, a law,....

➤ **Example:** The table given below shows the IUPAC names of three alkanes and their normal boiling point temperatures.

Alkanes	pentane	2-methylbutane	2,2- dimethylpropane
Normal boiling point Temperature (°C)	36	28	10

Draw out a relation between the variation of the normal boiling point temperature and the number of branching in the molecules of the mentioned isomers.

➤ **Answer:** The normal boiling point temperature of the isomers decreases as the number of branching increases in the molecules of the isomers.

12- Distinguish: Recognize or discern one thing from another according to particular traits.

➤ **Example:** Addition of hydrogen molecule to an alkene produces an alkane.

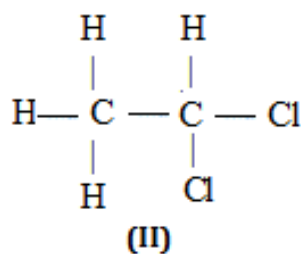
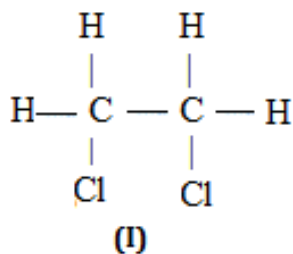
Distinguish the structure of the molecule of an alkene from that of an alkane.

➤ **Answer :** In the structure of the molecule of an alkene there exists only one double covalent bond between two consecutive carbon atoms. In the structure of the molecule of an alkane all the carbon-carbon bonds are single covalent bonds.

13- Explain: Clarify, make understandable a phenomenon, a result, ...

➤ **Example:** One molecule of ethene reacts with one molecule of chlorine; a compound **(D)** is formed.

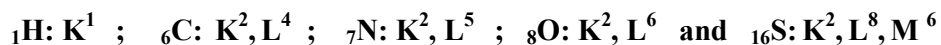
Explain which of the following two structural formulas **(I)** or **(II)** can be associated to compound **(D)**.



- **Answer :** Ethene is an alkene of formula C_2H_4 . It undergoes addition reaction with chlorine. One of the bonds of the double covalent bond of the molecule C_2H_4 breaks and the bond in a chlorine molecule breaks; one chlorine atom is added to each carbon atom. => Structural formula **(I)** can be associated to compound **(D)**.

14- Identify: Recognize something based on its characteristics or its properties.

- **Example:** **Given:** Electron configuration of:

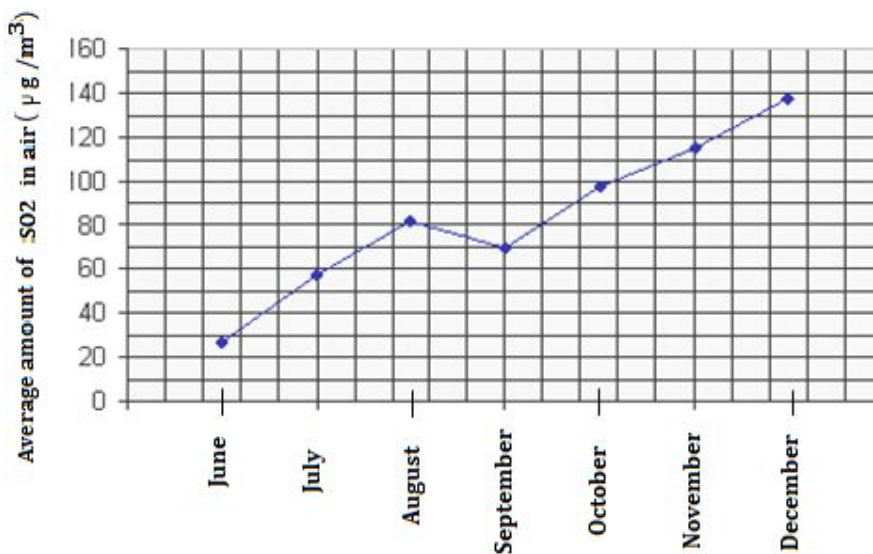


Identify among the given atoms (H, C, N, O, and S) those that belong to the same period (row) and those that belong to the same column (group).

- **Answer :** The elements that belong to the same period (row) are C, N, and O, because they have the same number of occupied energy levels.
The elements that belong to the same group (column) are O and S, because they have the same number of electrons on their valence energy level.

15- Interpret: Analyze and give significance to the result.

- **Example:** The graph given below shows the average amount of sulfur dioxide SO_2 gas emitted into the air from the combustion of fuel containing sulfur as impurity. SO_2 gas contributes to the formation of acid rain. The maximum tolerable level of SO_2 in air is $75 \mu g/m^3$.

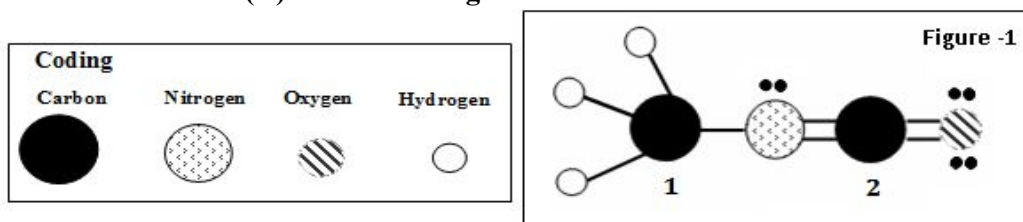


Interpret the contribution of the average amount of sulfur dioxide SO₂ gas emitted into the air during the months shown on the graph to the formation of acid rain.

- **Answer :** The average amount of SO₂ in air is: In June 19 (μ g/m³), in July 60 (μ g/m³) and in September 70 (μ g/m³). The contribution of SO₂ to acid rain formation is slight, because the average amount of SO₂ in air did not pass the maximal tolerable level of SO₂ 75 (μ g/m³).
- The average amount of SO₂ in air is: In August 80 (μ g/m³), in October 100 (μ g/m³), in November 115 (μ g/m³) and in December 140 (μ g/m³). During these months, the emission of sulfur dioxide passed the maximal tolerable level 75 (μ g/m³). The contribution to the formation of acid rain is strong.

16- Indicate: Designate something without justification.

- **Example:** The Lewis dot structure of the molecule of an organic compound (A) is shown in **Figure -1**.

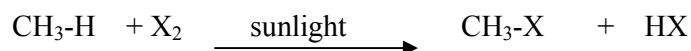


Indicate the type of bond between the nitrogen atom and each of the carbon atoms (C1 and C2) in the molecule of compound (A).

- **Answer :** The Nitrogen - Carbon (C1-N) bond is a single covalent bond. (N - C)
The Nitrogen - Carbon (C2=N) bond is a double covalent bond. (N = C)

17- Justify: Prove something as true and real.

- **Example:** Halomethanes are compounds used as refrigerants, solvents, anesthetics... They are obtained from the reaction of methane with halogens according to the equation:



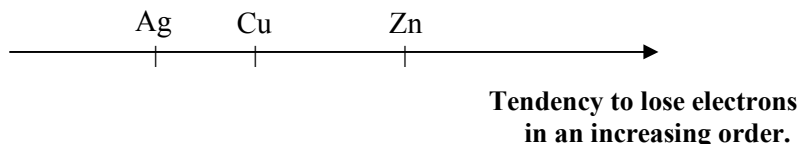
Where, X₂ is the formula of a halogen molecule such as Cl₂ or Br₂.

Justify that the reaction represented by the above given equation is a substitution reaction.

- **Answer:** It is a substitution reaction because one hydrogen atom of methane is replaced by one halogen atom.

18- Specify: Indicate and justify.

- **Example:** The tendency to lose electrons of three metals: Silver, copper and zinc are arranged in an increasing order on a horizontal axis.



In a galvanic cell, the greater is the difference in the tendency to lose electrons of the metals serving as electrodes, the greater is the voltage of the galvanic cell.

Two galvanic cells (G_1) and (G_2) have respectively the following written cell representations:

- a) $\text{Zn} | \text{Zn}^{2+} \text{ — salt bridge — } \text{Cu}^{2+} | \text{Cu}$
- b) $\text{Zn} | \text{Zn}^{2+} \text{ — salt bridge — } \text{Ag}^+ | \text{Ag}$

Specify among the given written cell representations, the written cell representation of the galvanic cell which has the greater voltage.

- **Answer :** The written cell representation which has the greater voltage is: $\text{Zn} | \text{Zn}^{2+} \text{ — salt bridge — } \text{Ag}^+ | \text{Ag}$; because the difference in the tendency to lose electrons between Zn and Ag is greater than the difference in the tendency to lose electrons between Zn and Cu.

19- Pick out (Extract): Select one or more information from a document.

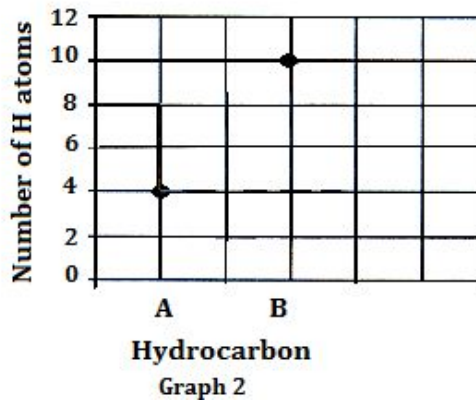
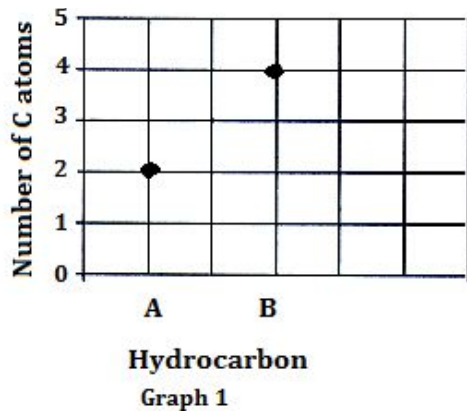
- **Example:** Fresh fruits and vegetables have various colors, tastes and odors. They are very important to our health. Parsley contains vitamin C, carotene, potassium, calcium... . Red cabbage contains vitamin C more than orange. Red cabbage is rich in compounds that contain sulfur.

Pick out the names of three chemical elements mentioned in the passage.

- **Answer :** The names of three chemical elements are potassium, calcium and sulfur.

20- **Verify:** Confirm using arguments, logical reasoning, ... whether something is true or false.

➤ **Example:** The graphs (1) and (2) show the number of carbon and hydrogen atoms in the molecules of (A) and (B).



Verify, referring to the graphs (1) and (2), whether the molecular formula of (A) is C_2H_4 and that of (B) is C_4H_8 .

➤ **Answer:** For (A):
From graph (1) Number of C atoms = 2 ;
From graph (2) Number of H atoms = 4
Molecular formula of (A) is: C_2H_4 .

For (B):
From graph (1) Number of C atoms = 4 ;
From graph (2) Number of H atoms = 10
Molecular formula of (B) is not C_4H_8 .

EXAMPLES ON ACTION VERBS

OFFICIAL EXAMS - GRADE 9

LIFE SCIENCE

1- Analyze: Decompose a whole into its constituent elements to make evident the variations.

➤ **Example 1 :** At the level of pulmonary alveoli, hemoglobin (Hb) in red blood cells fixes oxygen gas (O₂) forming an unstable product: oxyhemoglobin (HbO₂). In the presence of carbon monoxide (CO), a harmful gas contained in tobacco smoke, hemoglobin fixes (CO) forming a stable product (HbCO).

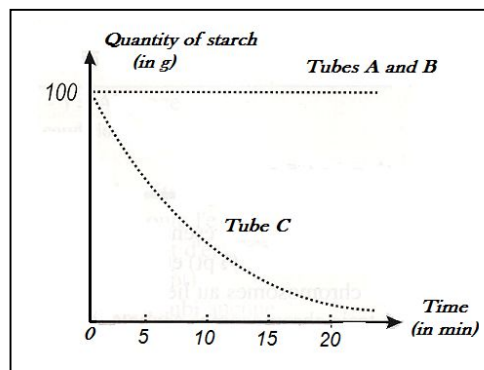
Many studies showed the effect of (CO) on the transport of O₂ gas by hemoglobin. The results of these studies are shown in the following table.

Quantity of CO in the alveoli (in %)	0.5	1	1.5	2	2.5
Quantity of HbO₂ In the blood (in %)	90	80	70	60	50

Analyze the obtained results.

➤ **Answer:** The quantity of HbO₂ in blood is 90% when the quantity of CO in the alveoli is 0.5%. This quantity of HbO₂ decreases to 50% with the increase in the quantity of CO to 2.5%.

➤ **Example 2:** We put in three tubes A, B, and C the same quantity (100g) of starch. Trypsin is added to tube A, lipase to tube B, and amylase to tube C. These three tubes are placed in a water bath at 37°C for 20 minutes. The media in these tubes are convenient: Tubes A and B have a medium of pH= 8, and tube C has a medium of pH= 7. The results are presented in the adjacent document.



Analyze the obtained results.

- **Answer:** In tube A which contains trypsin and tube B which contains lipase, throughout the experiment, the quantity of starch remains constant and equal to 100g, but in tube C which contains amylase, the quantity of starch decreases from 100g to 0g after 20 min.

2- Calculate: (Compute) Perform mathematical operations.

- **Example1:** An ear of corn contains: 225 black grains and 75 yellow grains.

Calculate the proportions of the obtained grains.

- **Answer:** Calculation of proportions.
Total number of grains = $225 + 75 = 300$
Proportions of black grains: $225 / 300 = 3 / 4$
Proportions of yellow grains: $75 / 300 = 1 / 4$

Or

We divide by the smallest number.
Black grains: $225/75 = 3$
Yellow grains: $75/75 = 1$
Total: $3 + 1 = 4$
Proportions of Black grains: $\frac{3}{4}$
Proportions of Yellow grains: $\frac{1}{4}$

- **Example 2:** An ear of corn contains: 225 black grains and 75 yellow grains.

Calculate the percentages of the obtained grains.

- **Answer:** Calculation of percentages.
Total number of grains = $225 + 75 = 300$
Percentages of black grains: $\frac{225 \times 100}{300} = 75\%$
Percentages of yellow grains: $\frac{75 \times 100}{300} = 25\%$

3- State: Express without explaining .

- **Example 1: State** the characteristics of the respiratory exchange surface.

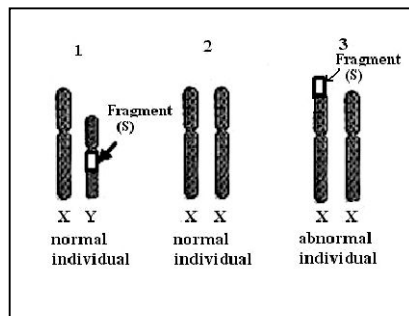
- **Answer:** The characteristics of respiratory exchange surface are:
- Thin wall
- Large surface area of exchange
- Surface rich in blood vessels.

- **Example 2: State** 2 factors which are capable of stopping the transformation of a given kind of food during digestion.

- **Answer:** Temperature, medium pH, duration, enzyme (State only 2 factors).

4- Compare: Indicate the similarities and/or differences between two or more entities.

➤ **Example 1:** The chromosomes are carriers of the genetic information. Any change in the number or form of a chromosome can lead to a modification in the expression of the genetic program. A fragment "S" located only on chromosome Y, carries the genetic information responsible for the appearance of masculine characteristics. The above document presents the sex chromosomes of three individuals.



Compare the sex chromosomes of individual 3 to those of individual 2.

➤ **Answer:** Individual 3 has an X chromosome of the same length as the X chromosome in individual 2; whereas, the other X chromosome in individual 3 is longer, carrying an additional fragment S, than that in individual 2.

➤ **Example 2:** Respiratory gases move between the alveolar air and blood, from a medium of higher pressure to a medium of lower pressure. The table below represents the pressures of oxygen gas and carbon dioxide in alveolar air and blood.

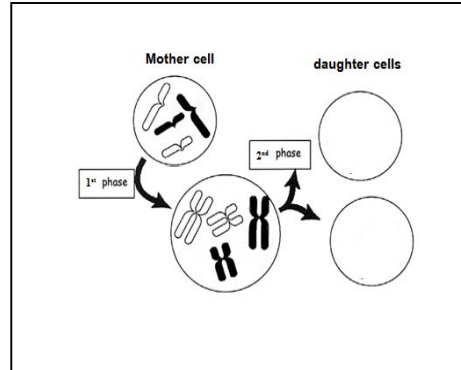
	Pressure of O ₂ gas (in mm Hg)	Pressure of CO ₂ gas (in mm Hg)
Alveolar air	105	40
Blood	45	45

Compare the pressures of O₂ gas and CO₂ gas in alveolar air with those in blood.

➤ **Answer:** The pressure of O₂ gas in alveolar air, 105mm of Hg, is greater than that in blood, 45mm Hg; while, the pressure of CO₂ gas in alveolar air, 40mm Hg, is smaller than that in blood, 45mm Hg.

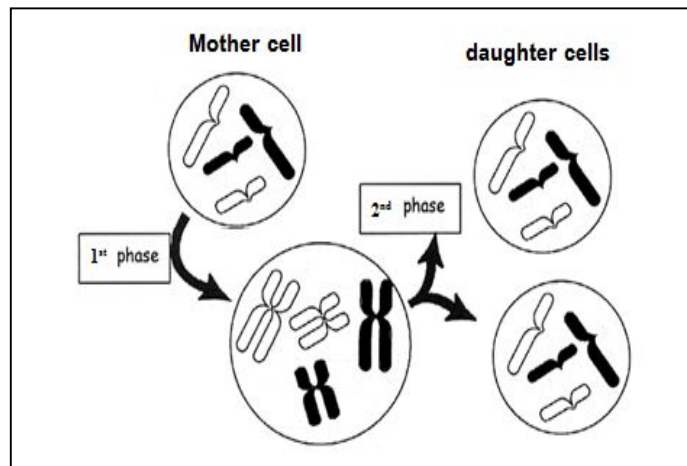
5- **Complete:** Add what is missing.

➤ **Example :** The adjacent document represents two phases of the cell cycle of a cell having 4 chromosomes.



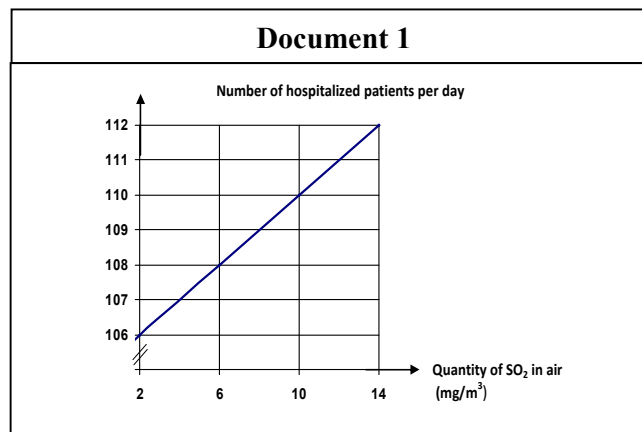
Complete the diagram by drawing the chromosomes obtained in each of the daughter cells.

➤ **Answer:**



6- **Conclude:** Reach a decision.

➤ **Example 1:** In a region polluted by sulfur dioxide gas (SO_2), we notice that the number of hospitalized patients due to respiratory difficulties varies with the quantity of SO_2 in air (document 1).



1- Analyze the graph in document 1.

2- What do you **conclude**?

➤ **Answers :**

- 1- The number of hospitalized patients due to respiratory difficulties is 106 patients/day when the quantity of SO₂ gas in air is 2mg/m³. This number increases progressively with the increase in the quantity of SO₂ gas till it reaches 112 patients/day when the quantity of SO₂ gas is 14mg/m³.
- 2- SO₂ gas favors the occurrence of respiratory difficulties.

➤ **Example 2 :** The document below presents the variations of the volumes of oxygen gas and carbon dioxide gas in the blood at the level of the lungs

	Blood (100 mL)	
	Entering the lungs	Leaving the lungs
Oxygen gas (in mL)	15	20
Carbon dioxide gas (in mL)	53	48

- 1- Compare the volumes of oxygen gas and carbon dioxide gas in blood entering and blood leaving the lungs.
- 2- What do you *conclude*?

➤ **Answers:**

- 1- The volume of oxygen gas in blood entering the lungs, 15mL/100mL, is smaller than that in blood leaving the lungs, 20 mL/100mL. The volume of carbon dioxide in blood entering the lungs, 53mL/100mL, is greater than that in the blood leaving the lungs, 48mL/100mL.
- 2- In the lungs the blood is enriched with oxygen and impoverished in carbon dioxide.

7- **Determine:** Reach a decision or a result, through logical reasoning, calculation...

➤ **Example 1:** Thalassaemia or Mediterranean anemia is a recessive disease that affects children since birth and leads to death if not treated. Some people who are heterozygous (carry the recessive allele) show no symptoms of the disease, but they can be identified by blood tests.

Determine the percentages of the phenotypes and the genotypes of the descendants obtained from a normal heterozygous couple.

➤ **Answer:** Let "T" be the symbol of the dominant allele determining the normal phenotype.
Let "t" be the symbol of the recessive allele determining the disease.
Since the normal parents are heterozygous (Tt), each one of them should carry the recessive allele (t) determining the disease

which is masked phenotypically. The phenotypic and genotypic percentages should be the same in F₂ generation as in the case of monohybrid dominance. So, the descendants of this couple should have the following percentages of the theoretical phenotypes and genotypes:

<u>Phenotypes :</u>	<u>Genotypes:</u>
75% normal children	25% TT
	50% Tt
25% diseased children	25% tt

Or Factorial Analysis

Let "T" be the symbol of the dominant allele determining normal phenotype.

Let "t" be the symbol of the recessive allele determining the disease.

Parental phenotypes:	♂ Normal	x	♀ Normal
parental genotypes :	Tt		Tt
γP :	50%T 50% t		50%T 50% t

Table of cross (punnet square) :

♂ ♀	50%T	50%t
50%T	25%TT	25%Tt
50%t	25%Tt	25%tt

<u>Genotypes</u>	<u>Phenotypes</u>
25% TT	75% normal children or [T]
50% Tt	
25% tt	25% diseased children or [t]

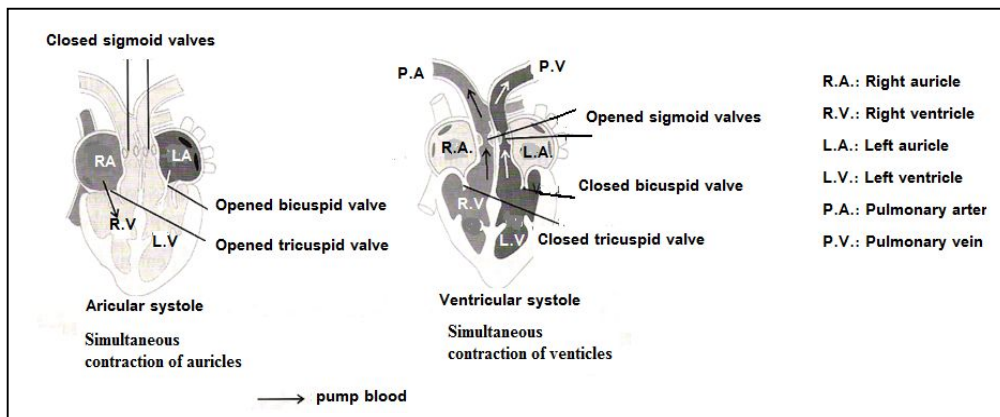
- **Example 2:** The ABO blood group system is controlled by a gene located on chromosome pair no9. This gene exists in three versions or alleles: A, B and O. The alleles A and B are codominant relative to each other and dominant over allele O. Allele O is recessive and is not expressed phenotypically except in the case of homozygous. A couple had three children: Ziad is of blood group O, Zeina is of blood group AB and Nada is of blood group B.

Determine the alleles present in each of the parents, as well as the blood type of each.

- **Answer:** This couple had a child (Ziad) of blood type O who is homozygous recessive and this blood type is only expressed when the allele "O" exists in two copies. So, this child has taken an allele O from his father and an allele O from his mother. This means that each parent has allele O.
- Similarly, the couple had another child (Zeina) of blood type AB. This child took allele A from one parent and allele B from the other parent. This means, one of the parents has alleles A and O and is of blood group A, and the other parent has alleles B and O and is of blood group B.

8- Describe: Express using scientific language, to give the details of an observation, of an experiment, a schema, an apparatus...

- **Example 1:** Write a short text *describing* the heart activity during the two phases presented in the following document.

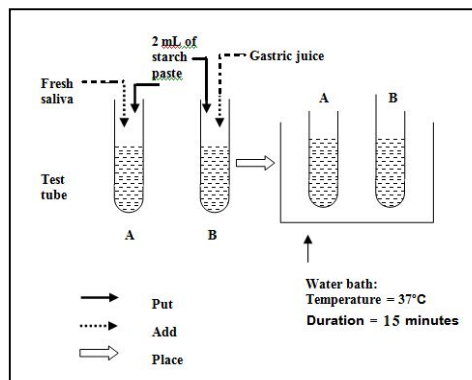


- **Answer:** **Aricular systole:** The simultaneous contraction of both auricles pumps blood from the right auricle to the right ventricle through the opened tricuspid valve and from the left auricle into the left ventricle through the opened bicuspid valve. During this phase, the sigmoid valves are closed.

Ventricular systole: The simultaneous contractions of both ventricles pumps blood from the right ventricle into the pulmonary artery and from the left ventricle into the aorta through the opened sigmoid valves. During this phase, the bicuspid and tricuspid valves are closed.

- **Example 2:** The adjacent document summarizes the experimental conditions of in vitro digestion of starch paste.

Describe this document.



- **Answer:** 2 ml of starch paste is put into each of the two tubes A and B. Fresh saliva is added to tube A and gastric juice to tube B. The two tubes are placed in a water bath at a temperature of 37°C for 15 minutes.

9- **Show:** Prove “something” is evident by logical reasoning, experimenting, calculating...

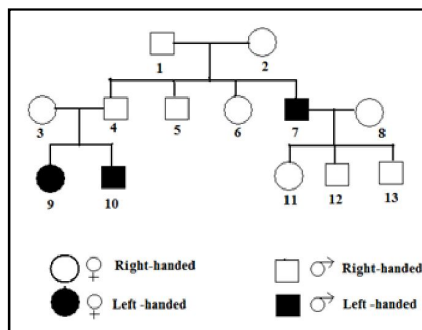
- **Example 1:** The table below summarizes the experimental setup of a series of experiments done in the laboratory. Each of the tubes contains a medium of pH=8 and is placed at a favorable temperature of 37°C for a sufficient duration of time: 60 minutes for proteins and 20 minutes for starch paste.

Tubes	Tube A	Tube B	Tube C	Tube D
Contents				
Beginning of the experiment	Proteins Water Trypsin	Starch paste Water Amylase	Proteins Water Amylase	Starch paste Water Trypsin
End of the experiment	Amino acids Water Trypsin	Maltose Water Amylase	Proteins Water Amylase	Starch paste Water Trypsin

Show that the enzyme remains intact during the chemical transformation of foods.

- **Answer:** At the end of the experiment, we observe that food transformation took place in tubes A and B since proteins and starch in both tubes disappeared and were replaced by amino acids and maltose respectively. However, the enzymes, trypsin in tube A and amylase in tube B, are still present at the end of the experiment. So, we can say that the enzyme remains intact at the end of experiment.

- **Example 2:** In the human species the trait right-handed and left-handed show autosomal mode of transmission. The gene responsible for this hereditary trait is represented by 2 alleles. The allele responsible for right-handed (R) is dominant over the allele responsible for left-handed (L). The above pedigree represents the genealogical tree of a family which some of its members are left-handed.



Show that if female 9 marries a homozygous right-handed male, then all her offsprings will be right-handed.

- **Answer:** Female 9 is left-handed: This trait is recessive and is only expressed in people who are homozygous for this trait. This means that her genotype is ll and she gives her children only one type of alleles (l) which is recessive.

If this female marries a right-handed male who is homozygous of genotype RR, this male gives his children only one type of alleles (R) which is dominant. So, all the children will have the genotype Rl where the recessive allele (l) taken from the mother will be masked by the dominant allele (R) taken from the father, so their phenotype will be right-handed.

10- Deduce: Draw, using logical reasoning, new information from given or existing information.

- **Example 1:** In a series of five test tubes, we introduce in each 2g of coagulated and fragmented ovalbumin (a protein), pepsin, and hydrochloric acid. These tubes are placed at different temperatures. After one hour, the quantity of ovalbumin is measured in each tube. The results are presented in the table below.

Tube	Content	Temperature (°C)	Quantity of ovalbumin (g)
A	2g of ovalbumin + pepsin+ HCl	0	2
B	2g of ovalbumin + pepsin + HCl	20	1,7
C	2g of ovalbumin + pepsin + HCl	37	0
D	2g of ovalbumin + pepsin + HCl	45	1,7
E	2g of ovalbumin + pepsin+ HCl	60	2

Deduce the temperature which is favorable for the activity of pepsin.

- **Answer:** The results at the end of the experiment show that a total transformation of ovalbumin occurred only in tube C where the temperature is 37°C. Therefore, the most favorable temperature for the activity of pepsin is 37°C
- **Example 2:** The following table presents the variation of the volume of oxygen gas and carbon dioxide in air and in blood at the level of the lungs.

	Air (100mL)		blood (100mL)	
	Inspired	Expired	Entering the lungs	Leaving the lungs
Oxygen gas (in mL)	21	16	15	20
Carbon dioxide gas (in mL)	0.03	5	53	48

- 1- Calculate the variations in the volume of oxygen gas and the volume of carbon dioxide gas in the air and in the blood.
- 2- **Deduce** the gas exchange taking place at the level of the lungs?

➤ **Answers:**

- 1- The variation in the volume of O₂ gas between the inhaled air and exhaled air is: $21 - 16 = 5$ mL.
The variation in the volume of CO₂ gas between the inhaled air and exhaled air is: $5 - 0.03 \approx 5$ mL.
The variation in the volume of O₂ gas between blood entering and blood leaving the lungs is: $20 - 15 = 5$ mL.
The variation in the volume of CO₂ gas between blood entering and blood leaving the lungs is: $53 - 48 = 5$ mL.
- 2- The volume of O₂ gas (5ml) remaining in the lungs is equal to that gained by the blood leaving the lungs(5ml). The volume of CO₂ gas eliminated from the blood entering the lungs (5ml) is approximately equal to that gained by the exhaled air ≈ 5 mL.

We deduce that O₂ gas brought by the inhaled air passes from the lungs to the blood, and CO₂ gas brought by the blood to the lungs exit the lungs with the exhaled air.

11- Draw out: Draw from a set of given and without reasoning a relation, a role, a law....

➤ **Example1:**

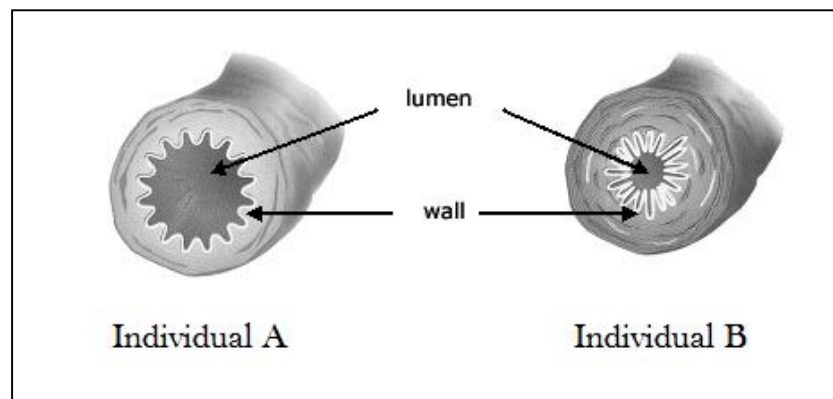
Certain individuals cannot tolerate gluten, a wheat flour protein, in their diet. This intolerance appears generally in 6 to 18 months-old babies, and is expressed by diarrhea, weight loss, hypo-nutrition (undernourishment), fatigue.... A sample taken from the intestinal mucosa reveals atrophy (a decrease in volume and malfunctioning) of the intestinal villi. Digestive troubles disappear with a strict diet that includes the suppression of gluten; i.e. the suppression of the flour of wheat, barley, oats...etc. Medical analysis shows that the intestine recovers its normal features within a few months, but any reintroduction of gluten would lead (or leads) to a new atrophy of the villi.

Draw out from the text the disrupted biological phenomenon due to intolerance to gluten.

➤ **Answer:** The disrupted biological phenomenon due to intolerance to gluten is intestinal absorption.

➤ **Example 2:** In a region polluted by sulfur dioxide gas (SO₂), we notice that the number of hospitalized patients due to respiratory difficulties varies with the content of SO₂ in air.

The document below shows the aspect of the bronchi of a healthy individual A and of another individual B who live in this region polluted by SO₂.



Draw out the effect of sulfur dioxide on the bronchi that leads to these respiratory difficulties.

➤ **Answer:** Sulfur dioxide narrows the bronchi and renders the circulation of air at this level difficult thus leading to respiratory difficulties.

12- Distinguish: Recognize or discern one “thing” from another according to particular traits.

➤ **Example:** *Distinguish* an artery from a vein.

➤ **Answer:** The wall of the artery is thick while that of the vein is thin. The opening of the artery is widely opened while that of the vein is flaccid.

13- Explain: Clarify, make understandable a phenomenon, a result...

➤ **Example 1:** In the framework of studying the action of pepsin on ovalbumin (protein), two tubes A and B are placed at a temperature of 37 ° C for 1 hour. The two tubes A and B contain:
Tube A: water + ovalbumin + pepsin; pH = 7
Tube B: water + ovalbumin + pepsin; pH=2
The results , at the end of the experiment, show a positive result with the coagulation test in tube A and negative result with the same test in tube B.

Explain the obtained results.

➤ **Answer:** The positive result with coagulation test indicates the presence of proteins while the negative result indicates its absence. The transformation of ovalbumin took place in tube B where ovalbumin disappears , but not in tube A where ovalbumin is still present and not transformed. In both tubes, the enzyme is pepsin which is specific for proteins, but it is only active in acidic medium. For that, the transformation of protein took place in tube B where the pH is equal to 2(acidic medium) but not in tube A where the enzyme is inactive at pH = 7 (neutral medium).

➤ **Example 2:** The cigarette fumes contain several toxic substances: Nicotine, tar, carbon monoxide gas (CO). This gas can fix easily on a hemoglobin molecule leading to the formation of a stable compound HbCO.

Explain how a high concentration of CO gas in blood causes intoxication.

➤ **Answer:** CO gas forms a stable compound with hemoglobin. Also, Hemoglobin transports O₂ and CO₂ gases. The formation of HbCO compound hinders the transportation of Oxygen gas indispensable for the cells and hinders the transportation of CO₂ gas to the lungs to be eliminated out by the exhaled air. CO₂ remains in blood and causes intoxication.

14- Identify: Recognize “something” based on its characteristics or its properties.

➤ **Example:** The following tests are realized on two foods:

- Banana + iodine water $\xrightarrow{\text{cold}}$ blue color.
- Grapes juice + Fehling solution $\xrightarrow[\text{till boiling}]{\text{heat}}$ red brick precipitate.

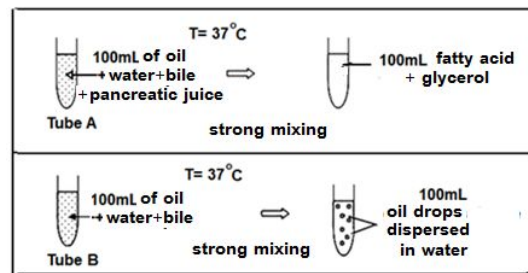
Identify the carbohydrates present in each of these foods.

➤ **Answer:** Starch gives a blue color with iodine solution, and this means that banana contains starch.

Reducing sugar gives a brick-red precipitate with Fehling’s solution when it’s heated, and this means that grape juice contains reducing sugar.

15- Interpret: Analyze and give significance to the result.

➤ **Example 1:** In the framework of studying the role of pancreatic juice on digestion, we realized the experiment presented in the adjacent document.



Interpret the obtained results.

➤ **Answer:** The results at the end of the experiments indicate a complete transformation of oil into fatty acids and glycerol in tube A in the presence of bile and pancreatic juice. However, oil remains intact, dispersed as drops of oil in water, in tube B in the presence of bile and absence of pancreatic juice. Therefore, pancreatic juice is responsible for transformation of oil into fatty acids and glycerol.

➤ **Example 2:** To realize an in vitro digestion of lactose, milk sugar, we put 5ml of milk and 0.5 ml of NaOH (to render the medium basic) in each of the two tubes A and B. We add lactase in tube B only. We place the two tubes at a temperature of 37 °C and for a convenient duration of time. Moreover, we measure the quantity of sugars present in each of the two tubes at the beginning and at the end of the experiment. The measured results are presented in the following document.

Tube	Beginning of the experiment	End of the experiment
A		
B		

Interpret obtained results.

- **Answer:** At the beginning of the experiment, the quantity of lactose is 100% in both tubes A and B. At the end of experiment, this quantity of lactose remains the same (100%) in tube A which does not contain lactase, but it disappears and there is appearance of 50% of galactose and 50% of glucose in tube B which contains lactase. This means that the lactase has permitted the transformation of lactose into galactose and glucose.

Or

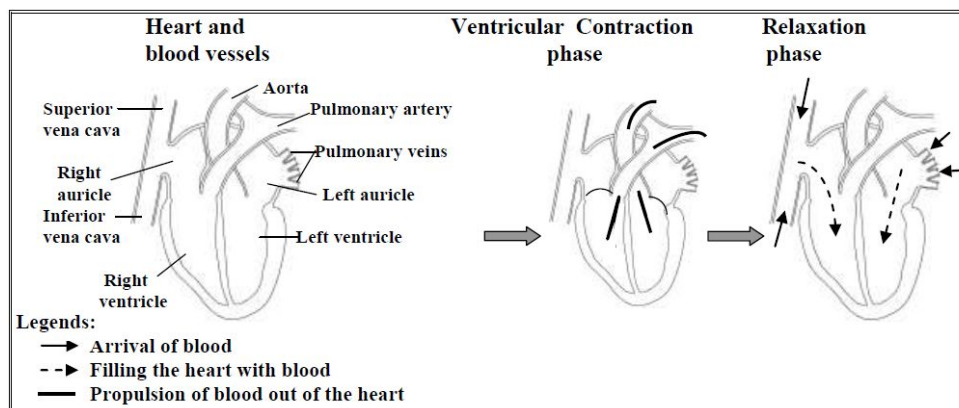
In tube A which does not contain lactase, the quantity of lactose stays the same(100%) from the beginning till the end of the experiment. However, in tube B which contains lactase, the quantity of lactose (100%) present at the beginning of the experiment, disappears at the end of the experiment and there is appearance of 50% galactose and 50% glucose.

This means that the lactase has permitted the transformation of lactose into galactose and glucose.

16- Indicate: Designate “something” without justification.

- **Example 1:** *Indicate* the true expressions.
- 1- During ventricular systole, blood is pumped from the ventricles into the veins.
 - 2- Auricular systole is the simultaneous contraction of both auricles.
 - 3- During diastole, auricles and ventricles contract.
 - 4- During auricular systole, the bicuspid and tricuspid valves are closed.
 - 5- The valves prevent the back flow of blood.

- **Answers:** 2 – Correct
5 - Correct
- **Example 2:** The heart contracts and relaxes in a rhythmic way. It ensures the circulation of blood. The document below shows the organization of the heart, the principle blood vessels and the two phases of cardiac activity.



Indicate, by referring to the above document:

- a- The blood vessels that ensure the arrival of blood to the heart and those that ensure its exit out of the heart.
- b- What happens during the ventricular contraction phase and the relaxation phase of the heart.

- **Answers:**
 - a-The blood vessels that ensure the arrival of blood to the heart are the superior and inferior vena cava and the pulmonary veins.
The blood vessels that ensure the exit of blood out of the heart are the aorta and the pulmonary arteries.
 - b-During the ventricular contraction phase, blood is propelled out from the ventricles to the arteries.
During the relaxation phase, blood arrives the auricles through the veins and fills the heart.

17- Justify: Prove “something” as true and real.

- **Example 1:** Sickle cell anemia, a hereditary disease characterized by the synthesis of abnormal hemoglobin, is due to a gene located on the chromosome pair No. 11. For a person to be diseased, it necessitates the presence of the abnormal allele on each of the two chromosomes of pair 11. If one chromosome carries the abnormal allele and the other carries the normal allele, the person will be normal and not affected by the disease.

Justify how a normal couple can give birth to a diseased child.

- **Answer:** The allele for the disease is recessive. Normal couples who are heterozygous carry the allele responsible for sickle cell anemia disease but is masked. When each of the parents gives the recessive allele responsible for the disease to the child, this child will be homozygous and sick.

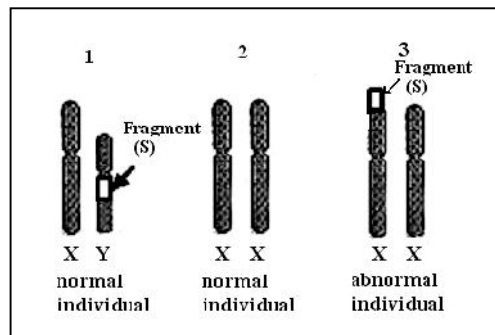
- **Example 2:** Hemoglobin is called "functional protein".

Justify this statement.

- **Answer:** Hemoglobin is known as a functional protein because it is used for the transport of respiratory gases: CO₂ and O₂.

18- Specify: Indicate exactly and justify.

- **Example 1:** The chromosomes are carriers of the genetic information. Any change in the number or form of a chromosome can lead to a modification in the expression of the genetic program. A



fragment (S), located only on chromosome Y, carries the genetic information responsible for the appearance of masculine characteristics. The opposite document shows the sex chromosomes of three individuals.

Specify the sex of individuals 1 and 2.

- **Answer:** Individual 1 is a male and individual 2 is a female. Individual 1 is a male because he has two different sex chromosomes X and Y. Individual 2 is a female because she has two identical sex chromosomes X.

- **Example 2:** The blood groups of ABO system are controlled by a gene located on chromosome pair n^o9. This gene has three alleles A, B and O. The alleles A and B are codominant with respect to each other and dominant over the allele O. Allele O is recessive and is expressed phenotypically when it is present in two copies (homozygous).

A man of blood group A married a woman of blood group B. This couple had a daughter of blood group B.

Specify the alleles which determine the blood group of this girl.

- **Answer:** This girl has allele B and allele O. Being of blood group B, she received an allele B from her mother who is of blood group B, and an allele O, recessive with respect to allele A, from her father, of blood group A. Otherwise, she will not be of blood group B.

19- - Pick out (Extract): Select one or more pieces of information from a document.

- **Example:** Wheat starch is a complex molecule constituted of many molecules of glucose. During digestion, starch reacts with water and is degraded into very small-sized molecules. This chemical reaction is called hydrolysis. The enzymes, contained in saliva and pancreatic juice, activate the hydrolytic reaction and favor the molecular simplification of starch. These enzymes remain intact at the end of this reaction.

1- Pick out from the text:

- a- The constituent molecules of the wheat starch molecule.
- b- The definition of hydrolysis.
- c- The phrase which indicates the role of enzymes.

➤ **Answers:**

- a- The constituent molecules of the wheat starch are the glucose molecules.
- b- A Hydrolytic reaction is when starch reacts with water and is degraded into molecules of very small size.
- c- The enzymes activate the hydrolytic reaction and favor the molecular simplification of starch.

20- Verify: Confirm using arguments, logical reasoning, whether something is true or wrong.

- **Example 1:** To verify the hypothesis "tobacco favors lung cancer", studies were conducted in a medical center and the results are presented in the document below.

	Non smokers	Smokers			
Quantity of tobacco consumed (in g/person/day)	0	1-4	5-14	15-24	>25
Percentage of patients with lung cancer	31	36	48	53	73

Verify, based on the obtained results, if the hypothesis is valid.

- **Answer:** The percentage of patients with lung cancer is 31 in non-smokers and it increases to 36% in smokers who consume 1 to 4 g of tobacco per person per day. This percentage continues to increase with the increase in the quantity of consumed tobacco to become 73% when tobacco consumption exceeds 25 g/ person / day. Therefore, tobacco increases the risk of lung cancer occurrence, so the formulated hypothesis is valid.
- **Example 2:** Sickle cell anemia, a hereditary disease characterized by the synthesis of an abnormal hemoglobin, is due to a gene located on the chromosome pair No. 11. For a person to be diseased, it necessitates the presence of the abnormal allele on each of the two chromosomes pair 11. If one chromosome carries the abnormal allele and the other carries the normal allele, the person will be not affected by the disease.

Verify, by making the necessary factorial analysis, that a normal couple can have a sick child.

- **Answer:** Let N be the symbol of the dominant allele determining the non-affected person (normal).
Let s be the symbol of the recessive allele determining the disease.
In cases where both normal parents are heterozygous, each of the parents can give the abnormal allele to the child that will be homozygous and affected.

Parental phenotype: ♂ x ♀
 [N] [N]
Parental Genotype: Nd Nd
γ P : ½ N ½ d ½ N ½ d

	♂	½ N	½ d
♀	↙	½ N	½ d
½ N		¼ NN	¼ Nd
½ d		¼ Nd	¼ dd

Results: ¾ normal [N]
¼ sickle cell anemia [d]
According to the table of cross, a child with genotype dd is sick.
So, the unaffected parents can have a sick child.

EXAMPLES ON ACTION VERBS
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THIRD YEAR OF SECONDARY CYCLE

PHYSICS

1- Analyze: Decompose a whole into its constituent elements to make evident the variations.

➤ **Example:** *Analyze* the function of loud speaker.

➤ **Answer:** Elements of loudspeaker are: coil- magnet creates magnetic field – membrane that fixed to the coil. When a variable current traverses the coil, the elastic membrane is set in vibration due to the electromagnetic force acts on it.

2- Calculate: (Compute) Perform mathematical operations.

➤ **Example:** *Calculate* the value of the capacitance C of a capacitor in RC series circuit of constant voltage, knowing the values of the time constant τ , and the resistance R .

➤ **Answer:** The time constant $\tau = RC$ for the RC group, knowing τ and R , calculate $C = \tau/R$

3- State: Express without explaining .

➤ **Example:** *State* the main components of a transformer.

➤ **Answer:** The main components are: coil and soft iron core.

4- Compare: Indicate the similarities and/or differences between two or more entities.

➤ **Example 1:** *Compare* the functioning of a loud speaker and the microphone.

➤ **Answer:** A loud speaker converts an electrical signal into a mechanical sound signal. A microphone converts sound signal to electrical signal.

➤ **Example 2:** *Compare* the Pseudo period T to the proper period T_0 of an elastic oscillator.

➤ **Answer:** The pseudo-period T is slightly greater than the proper period T_0 .

5- **Complete:** Add what is missing.

- **Example:** A car is moving along x- axis. At time t its position is given by its coordinate x and velocity v. The table below gives values of x and v at successive instants. **Complete** this table:

t(s)	0	$t_1 = \tau = 60$	$t_2 = 2\tau$	$t_3 = 3\tau$	$t_4 = 4\tau$	$t_5 = 5\tau$	$t_6 = 6\tau$
Position	A_0	A_1	A_2	A_3	A_4	A_5	A_6
x (mm)	0	7.2	28.9	64.9	115	181	259
v (m/s)	0	0.24		0.72		1.20	

- **Answer:** $V_2 = \frac{x_3 - x_1}{2\tau} \Rightarrow V_2 = \frac{57.7 \times 10^{-3}}{0.12} = 0.48 \text{ m/s}$
 $V_4 = \frac{116.1 \times 10^{-3}}{0.12} = 0.97 \text{ m/s}.$

6- **Conclude:** Reach to a decision.

- **Example:** Without transformer, transmission of electric energy occurs with a loss of energy by Joule's effect, but with a step up transformer the loss of energy is reduced $E' \ll E$; **conclude** about the role of the transformer in the transport of electric power over long distances.
- **Answer:** The transformer greatly reduces the loss by Joule's effect through the transmission lines.

7- **Determine:** Reach to a decision or a result through logical reasoning, calculation,...

- **Example:** A horizontal elastic pendulum consists of mass m and spring of stiffness constant k, has a differential equation $x'' + \frac{k}{m}x = 0$, where x is the abscissa of the center of inertia of the solid relative to the origin O of the x-axis. At equilibrium center G of m is at O. **Determine** the expression of the natural period T_0 of the pendulum in terms of m and k

- **Answer:** The differential equation $x'' + \frac{k}{m}x = 0$, is of the form $x'' + \omega_0^2 x = 0$, the proper angular frequency is $\omega_0^2 = \frac{k}{m}$, but $T_0 = \frac{2\pi}{\omega_0}$, we obtain

$$T_0 = 2\pi \sqrt{\frac{m}{k}}$$

8- Describe: Express, using scientific language, to give the details of an observation, an experiment, a schema, an apparatus, ...

➤ **Example: Describe** the appearance of fringes observed on the screen in Young's double-slit experiment.

➤ **Answer:** On the screen, the fringes are rectilinear, parallel to the slits, they are equidistant and alternately bright and dark.

9- Show: Prove something is evident by logical reasoning, experimenting, calculating,...

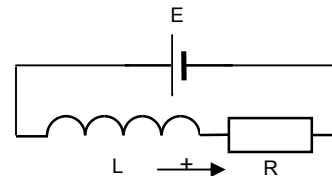
➤ **Example 1: Show** that the skydiver, falling vertically will reach a limiting speed.

➤ **Answer:** Forces acting on the parachute are: weight \vec{W} , and air resistance \vec{R}
Apply Newton's second law:

$$\vec{W} + \vec{R} = m\vec{a}.$$

At the beginning of the fall, the magnitude of the weight W is greater than the magnitude of air resistance R . Over time, the speed increases, this leads to increase the magnitude of R , where W remains constant. At a certain point R becomes equal to W , and the motion will be a uniform rectilinear motion and the parachute reaches a limiting speed.

➤ **Example 2: Show** that in steady state, the current in RL series circuit fed by a constant voltage E is $I = E/R$.



➤ **Answer:** Using the law of addition of voltages: $E = Ri + L \frac{di}{dt}$.

At steady state, $i = \text{constant}$, and $\frac{di}{dt} = 0$

so $E = IR$, and $I = E/R$.

10- Deduce: Draw using logical reasoning new information from given or existing information.

➤ **Example 1:** What condition must the angular abscissa θ satisfy so that motion of a pendulum is simple harmonic? **Deduce** the expression of the proper period of the oscillations knowing that the differential equation governing the motion of the pendulum is:

$$\theta'' + \frac{Mga}{I} \sin \theta = 0.$$

➤ **Answer:** If $\theta < 10^0$, $\sin \theta = \theta$ (in radians), the differential equation is then:

$$\theta'' + \frac{Mga}{I}\theta = 0 \Rightarrow \text{sinusoidal motion of angular frequency}$$

$$\omega_0 = \sqrt{\frac{Mga}{I}} \text{ and proper period } T_0 = \frac{2\pi}{\omega_0} = 2\pi\sqrt{\frac{I}{Mga}}$$

➤ **Example 2:** Calculate the mass defect [mass before (m_b) - the mass after (m_a)] in a nuclear reaction. **Deduce** that this nuclear reaction releases energy.

➤ **Answer:** Calculating the mass before reaction and the mass after reaction, we find that the mass before reaction is greater than the mass after reaction, so there is a reduction in mass during this nuclear reaction, and this loss of mass is converted into released energy.

11- Draw out: Draw from a set of given and without reasoning a relation, a role, a law,....

➤ **Example: Draw out** from the table of the planets of the solar system, how the period of revolution of a planet varies with its distance from the Sun.

➤ **Answer:** As the distance from the Sun increases, the period of revolution of a planet increases.

12- Distinguish: Recognize or discern one thing from another according to particular traits.

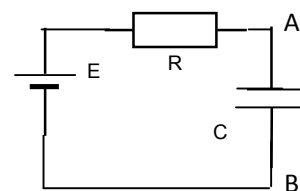
➤ **Example: Distinguish** between the emission spectrum and the absorption spectrum of an atom.

➤ **Answer:** The emission spectrum of an atom is made up of colored lines on a black background; the absorption spectrum is composed of black lines on a colored background.

13- Explain: Clarify, make understandable a phenomenon, a result, ...

➤ **Example: Explain** the charging phenomenon of a capacitor under a constant dc voltage

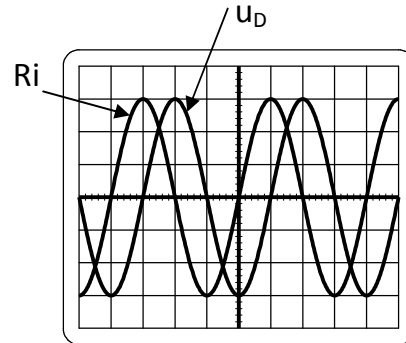
➤ **Answer:** The positive pole of the generator attracts the free electrons of the armature A of the capacitor and electrons move from the negative pole of the generator to the armature B of the capacitor, so voltage U_{AB} appears.



This process continues until the voltage $u_C = U_{AB} = E$ (e.m.f. generator), and the current becomes zero.

14- Identify: Recognize something based on its characteristics or its properties.

- **Example:** Using the waveform of adjacent Figure, *identify* the electric dipole (D), placed in a series circuit of resistor R and a L.F.G delivering a sinusoidal alternating voltage.



- **Answer:** The voltage across the dipole u_D lags the current i , so (D) is a capacitor.

15- Interpret: Analyze and give significance to the result.

- **Example: Interpret** the functioning of loud speaker.
- **Answer:** When a variable current (I) traverses the coil placed in a magnetic field of magnitude B, the coil is subjected to a variable electromagnetic force (Laplace) F proportional to (I). The elastic membrane that is fixed to the coil is set into vibration.

16- Indicate: Designate something without justification.

- **Example: Indicate** the direction of the displacement of the central bright fringe in Young's double slits if parallel plate is placed in front of one of them.
- **Answer:** The central bright fringe moves on the same side of the parallel plate.

17- **Justify:** Prove something as true and real.

- **Example: *Justify*** that the transformer does not work under DC voltage.
- **Answer:** If a DC voltage is applied across the primary turns of a transformer, the current in the primary is constant, so the flux ϕ_2 is constant, and the induced electromotive force e_2 across the secondary is
$$e_2 = \frac{d\phi_2}{dt} = 0 \text{ v, and so the transformer will not function.}$$

18- **Specify:** Indicate and justify.

- **Example: *Specify*** the mode of the electric oscillations that take place in a circuit formed of a charged capacitor of capacitance C, and a coil L of negligible resistance (LC circuit).
- **Answer:** The oscillations are free un-damped since no external intervention (free) and $R = 0$ (un-damped).

19- **Pick out (Extract):** Select (extract) one or more information from a document.

- **Example: *Pick out*,** from the text, the sentence which indicates the transformation of radiant energy into thermal energy.

“...The radiant energy, apparently rarely used, is however one of the most important forms. Sun rays, heating up Earth, make life, and especially the growth of plants possible...Nowadays, we use the solar cells to produce electric energy...”
- **Answer:** The rays that come from the Sun heats the Earth.

20- **Verify:** Confirm using arguments, logical reasoning, ... whether something is true or false.

- **Example: *Verify*** that $i = \frac{E}{R} e^{-\frac{t}{RC}}$ is the solution of the differential equation

$$i + RC \frac{di}{dt} = 0.$$

- **Answer:** Derive i with respect to time $\frac{di}{dt} = \frac{-1}{RC} \times \frac{E}{R} e^{-\frac{t}{RC}}$

Replace in the differential equation:

$$\frac{E}{R} e^{-\frac{t}{RC}} + RC \left(\frac{-1}{RC} \times \frac{E}{R} e^{-\frac{t}{RC}} \right) = 0, \text{ so verified.}$$

EXAMPLES ON ACTION VERBS
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CHEMISTRY

1- Analyze: Decompose a whole into its constituent elements to make evident the variations.

➤ **Example:** Titration of a strong acid against a strong base is carried out using a pH meter. The curve below represents the variation : $\text{pH} = f(V)$.

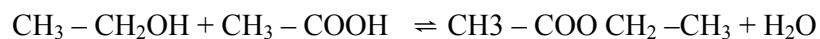


Analyze this curve.

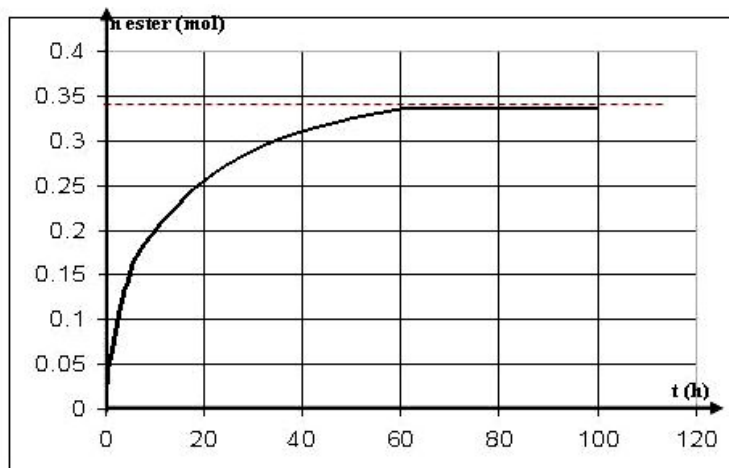
➤ **Answer:** For :
 $0 < V < 14$ mL, pH varies slightly.
 $14 < V < 18$ mL, pH varies sharply (sudden jump of pH value).
 $V > 18$ mL, pH varies slightly.

2- Calculate: (Compute) Perform mathematical operations.

➤ **Example:** A mixture of 0.5 mol of ethanoic acid and 0.5 mol of ethanol is heated, in the presence of concentrated sulfuric acid. A reaction takes place according to the equation:



The study of the variation of the number of moles of ester formed versus time gives the following result:



Calculate the yield of this reaction.

➤ **Answer:** Yield of this reaction is:

$$R = \frac{n(\text{ester})_{\text{obtained at equilibrium}}}{n(\text{ester})_{\text{theoretical (initial)}}} = \frac{0.33}{0.50} = 0.66.$$

3- State: Express without explaining.

➤ **Example:** A mixture of salicylic acid and an excess methanol is subjected to reflux heating in the presence of few drops of concentrated sulfuric acid.

State the two kinetic factors involved in this experimental activity.

➤ **Answer:** The two kinetic factors involved in this activity are:
The temperature and the catalyst represented by concentrated sulfuric acid.

4- Compare: Indicate the similarities and/or differences between two or more entities.

➤ **Example:** Greasy substances such as tallow, olive oil, peanut oil,... are triesters of fatty acids (saturated or unsaturated) and glycerol.

Compare the structure of a saturated fatty acid to that of a mono-unsaturated fatty acid.

➤ **Answer:** In the molecule of saturated fatty acid all the carbon-carbon bonds are single covalent bonds, whereas, in the molecule of a mono unsaturated fatty acid there is only one double covalent

bond between two consecutive carbon atoms in addition to the single covalent bonds of the carbon-carbon atoms.

These two fatty acids have the same functional group -COOH.

5- Complete: Add what is missing.

- **Example:** The volume V of nitrogen gas released is measured at different instants of time, in the decomposition reaction of $C_6H_5 - N_2Cl$ according to the equation:



The results are given in the following table:

t (min)	0	3	6	9	12	14	18	22
V (mL)	0	10.5	19	27	33	36	41	45
$[C_6H_5 - Cl]_t \times 10^{-4} \text{ (mol.L}^{-1}\text{)}$								

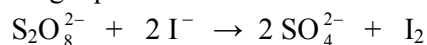
Complete the preceding table such that: $[C_6H_5 - Cl]_t = 4 \cdot 10^{-5} \times V$; where V (expressed in mL) is the volume of nitrogen gas released at instant t.

- **Answer:** Multiplying by 0.4, we get:

t (min)	0	3	6	9	12	14	18	22
$[C_6H_5 - Cl]_t \times 10^{-4} \text{ mol.L}^{-1}$	0	4.2	7.6	10.8	13.2	14.4	16.4	18.0

6- Conclude: Reach to a decision.

- **Example:** Iodide ions react with peroxydisulfate ions according to the following equation:



A reaction system consists of a volume V_1 of solution potassium iodide ($K^+ + I^-$) and a volume $V_2 = 100 \text{ mL}$ of sodium peroxydisulfate solution ($2Na^+ + S_2O_8^{2-}$), is kept at constant temperature (T). Samples of this reaction system are titrated in order to determine the concentration of the iodine formed. The experiment is repeated, at the same temperature (T), but in the presence of few drops of iron II sulfate solution at the beginning of the reaction.

The results of the two experiments are:

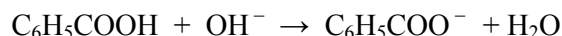
	Experiment in the absence of Fe^{2+}	Experiment in the presence of Fe^{2+}
Half-life time of reaction: $t_{1/2}$	24 min	11 min

Conclude the role of Fe^{2+} ions.

- **Answer:** The half-life $t_{1/2}$ (in the presence of Fe^{2+}) < $t_{1/2}$ (in the absence of Fe^{2+}), it can be concluded that the presence of Fe^{2+} ions increases, at a given temperature, the rate of the reaction.
 $\Rightarrow \text{Fe}^{2+}$ is a catalyst of this reaction.

7- Determine: Reach to a decision or a result ..., through logical reasoning, calculation,...

- **Example:** A volume $V_a = 20.0$ mL of solution (S) is titrated with sodium hydroxide solution ($\text{Na}^+ + \text{OH}^-$) of concentration $C_b = 3.0 \times 10^{-2} \text{ mol.L}^{-1}$, in the presence of a convenient indicator. The volume added to reach the equivalence point is $V_{bE} = 13.6$ mL.
 The equation of the titration reaction is:



Determine the concentration C_a of solution (S).

- **Answer:** At the equivalence point, $n(\text{C}_6\text{H}_5\text{COOH})$ in $V_a = n(\text{OH}^-)$ in V_{bE} . $\Rightarrow C_a \times V_a = C_b \times V_{bE}$.
 Therefore; $C_a = \frac{3.0 \times 10^{-2} \times 13.6}{20} = 2.0 \times 10^{-2} \text{ mol.L}^{-1}$.

8- Describe: Express, using scientific language, to give the details of an observation, an experiment, a schema, an apparatus,...

- **Example:** It is required to prepare a volume of 500 mL of ammonium chloride ($\text{NH}_4^+ + \text{Cl}^-$) solution (B) of concentration $C_2 = 0.10 \text{ mol.L}^{-1}$.

Given:

- Flask containing pure crystals of ammonium chloride NH_4Cl ; $M(\text{NH}_4\text{Cl}) = 53.5 \text{ g.mol}^{-1}$.

Describe, briefly, the procedure for the preparation of solution (B) choosing the materials needed from the given list of available materials.

List of Available Materials

- Precision balance, watch glass, spatula, funnel, magnetic stirrer
- Beakers: 100, 200 and 500 mL
- Graduated cylinders: 100, 200 and 500 mL
- Volumetric flasks: 100, 200 and 500 mL
- Volumetric pipets: 10 and 20 mL

- **Answer:** In order to prepare 500 mL of solution (B), the mass needed is:
 $m = 0.1 \times 500 \times 10^{-3} \times 53.5 = 2.675 \text{ g}$. Using precision balance, spatula and watch glass, weigh 2.675 g of $\text{NH}_4\text{Cl}_{(s)}$. Using funnel, introduce the weighed solid into a 500 mL volumetric flask containing a little of distilled water, shake to dissolve the solid; add more distilled water to fill the volumetric flask till the line mark. Stopper the volumetric flask; invert it several times to homogenize the solution.

9- Show: Prove something is evident by logical reasoning, experimenting, calculating,...

- **Example:** $\text{C}_6\text{H}_5 - \text{N}_2\text{Cl}$ is an explosive, not containing oxygen, it is stored at a temperature less than 5°C . The decomposition of $\text{C}_6\text{H}_5 - \text{N}_2\text{Cl}$ in an aqueous medium at a temperature of 25°C is slow. This decomposition takes place according to the following equation:



Given:

- Molar volume of gas at the experimental conditions:
 $V_m = 25 \text{ L}\cdot\text{mol}^{-1}$.
- $\text{C}_6\text{H}_5 - \text{N}_2\text{Cl}$ is decomposed in a solution of volume 1 L.

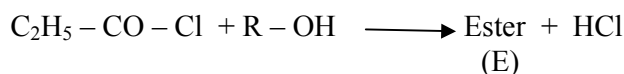
Show, at each instant t , that the concentration of $\text{C}_6\text{H}_5 - \text{Cl}$, expressed in $\text{mol}\cdot\text{L}^{-1}$ is given by the following expression: $[\text{C}_6\text{H}_5 - \text{Cl}]_t = 4 \times 10^{-5} \times V$; where V is the volume, in mL, of nitrogen gas formed at instant t .

- **Answer:** At each instant t : $n(\text{C}_6\text{H}_5\text{Cl})_{\text{formed}} = n(\text{N}_2)_{\text{formed}}$.
 Dividing by the volume of solution (1 L), we get:

$$[\text{C}_6\text{H}_5\text{Cl}]_t = \frac{V(\text{N}_2)}{V_m \times V_{\text{solution}}} = \frac{V \times 10^{-3}}{V_m \times 1} = \frac{V \times 10^{-3}}{25} = 4 \times 10^{-5} \times V$$

10- Deduce: Draw using logical reasoning new information from given or existing information.

- **Example:** 0.05 mol of propanoyl chloride is reacted with an excess of a saturated non cyclic mono alcohol (D) designated as (R-OH) in the presence of a suitable catalyst. At the end of the reaction, an ester (E) is obtained, having the odor of a fruit and of mass equal to 5.8g, according to the following equation:



1- Determine the molar mass of ester (E).

2- Deduce the molecular formula of alcohol (D).

➤ **Answer :**

1- According to the law of conservation of mass:

$$M(\text{C}_2\text{H}_5\text{COCl}) + M(\text{D}) = M(\text{ester}) + M(\text{HCl})$$

$$M(\text{D}) = (116 + 36.5) - 92.5 = 60 \text{ g.mol}^{-1}.$$

2- Alcohol (D) has a molecular formula $\text{C}_x\text{H}_{2x+1}\text{OH}$;

$$\text{or } M(\text{C}_x\text{H}_{2x+1}\text{OH}) = 14x + 18 = 60 \text{ and } x = 3.$$

Therefore, the molecular formula alcohol (D) is $\text{C}_3\text{H}_7\text{OH}$.

11- Draw out: Draw from a set of given and without reasoning a relation, a role, a law,

➤ **Example:** Carbon monoxide, CO, is largely used in industry to synthesize different basic organic compounds. The reaction of propene, with a mixture of carbon monoxide and hydrogen gas in the presence of a convenient catalyst, leads to a mixture of two isomeric aldehydes having 4 carbon atoms and consequently to 1-butanol. Similarly, 1-pentanol can be obtained from carbon monoxide, hydrogen gas and 1-butene by reacting.

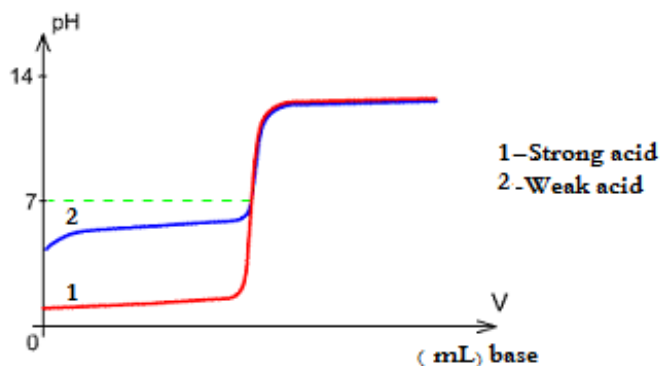
Draw out, from what has preceded, the importance of carbon monoxide in organic industry.

➤ **Answer:** In organic industry, carbon monoxide participates in the synthesis of organic compounds having longer carbon chains than the starting compounds.

12- Distinguish: Recognize or discern one thing from another according to particular traits.

➤ **Example:** Using pH meter, titration is carried out for the following two cases:
- Strong acid-strong base
- Weak acid-strong base

The results obtained are given by the graph given below.



Distinguish, based on the obtained results, a strong acid from a weak acid.

- **Answer:** Case of strong acid-strong base: The curve admits one inflection point of pH =7
Case of weak acid-strong base: The curve admits two inflection points.

13- Explain: Clarify, make understandable a phenomenon, a result, ...

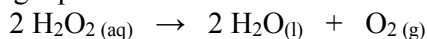
- **Example:** A tablet of effervescent aspirin contains acetylsalicylic acid and an excess of sodium hydrogen carbonate (NaHCO₃). These two ingredients are inert in anhydrous medium and are reactive in an aqueous solution giving A⁻ ions. These ions (A⁻) produce (HA) in acidic medium in the form of very tiny dispersed crystals.

Explain how the formulation of effervescent aspirin facilitates the absorption of aspirin by the stomach.

- **Answer:** The formulation of effervescent aspirin has the advantage of dispersing the active site in the ionic form (A⁻) in an aqueous solution. In the stomach, this ion reacts with gastric juice (H₃O⁺) to produce HA (salicylic acid) in the form of very tiny crystals that are dispersed all over the mucous wall of the stomach where they are rapidly absorbed.

14- Identify: Recognize something based on its characteristics or its properties.

- **Example:** A volume of hydrogen peroxide solution is placed in a 100 mL volumetric flask. The volumetric flask is placed on a precision balance.
At time t=0, a volume of 2 mL of iron (III) nitrate solution is poured into the volumetric flask.
After a short time, the release of large amount of oxygen gas is observed from the decomposition reaction according to the following equation:



As time elapses the balance indicates a decrease in mass. During this decomposition, the variation in mass Δm is recorded which, practically represents the mass of oxygen gas released at each instant of time t.

Given :

- Oxygen gas practically is insoluble in water.

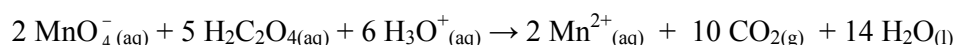
$$- n(\text{H}_2\text{O}_2)_{\text{left at } t} = 4.46 \times 10^{-2} - \frac{\Delta m}{16}$$

Identify the chemical species present in the obtained solution at the instant where Δm is equal to 713 mg.

- **Answer:** For $\Delta m = 713$ mg, we get $n(\text{H}_2\text{O}_2)_{\text{left at } t \approx 0}$
 $\Rightarrow \text{H}_2\text{O}_2$ has reacted completely and the chemical species present in the obtained solution are : H_2O which is the solvent and is one of the products in the reaction, Fe^{3+} which is a catalyst and NO_3^- which is an indifferent (spectator) ion.

15- Interpret: Analyze and give significance to the result.

- **Example:** Permanganate ions (MnO_4^-) react with oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$) in acidic medium according to the following equation:



Where, (MnO_4^-) is the only colored species in the reaction-medium.

In order to study the effect of some kinetic factors on the rate of the above reaction, the three following mixtures are prepared. (Potassium permanganate solution is added to each mixture at $t = 0$).

	Mixture (A)	Mixture (B)	Mixture (C)
$\text{H}_2\text{C}_2\text{O}_4 : C_1 = 2.0 \times 10^{-2} \text{ mol.L}^{-1}$	$V_1 = 20 \text{ mL}$	$V_1 = 20 \text{ mL}$	$V_1 = 20 \text{ mL}$
H_2SO_4 concentrated	$V_2 = 10 \text{ mL}$	$V_2 = 10 \text{ mL}$	$V_2 = 10 \text{ mL}$
Distilled water	0	60 mL	0
Temperature θ °C	20 °C	20 °C	40 °C
$\text{KMnO}_4 : C_3 = 1.0 \times 10^{-2} \text{ mol.L}^{-1}$	$V_3 = 10 \text{ mL}$	$V_3 = 10 \text{ mL}$	$V_3 = 10 \text{ mL}$
Δt	$\Delta t_{(A)} = 140 \text{ s}$	$\Delta t_{(B)} = 190 \text{ s}$	$\Delta t_{(C)} = 22 \text{ s}$

Δt is the time needed to obtain decolorization of the mixture.

Interpret the decolorization of the solution in each mixture at the end of the reaction.

- **Answer:** In each of the three mixtures, the only colored species is the MnO_4^- ion. At the end of the reaction, there is complete disappearance of this species and the appearance (formation) of the colorless Mn^{2+} species; this interprets the decolorization of the solution in each mixture.

16- Indicate: Designate something without justification.

- **Example:** The carboxylate ion ($\text{R} - \text{COO}^-$) of a soap is formed of two parts, the hydrocarbon chain ($\text{R} -$) and the carboxylate group ($-\text{COO}^-$).

Indicate, in the carboxylate ion, the part that corresponds to the hydrophilic group and the part that corresponds to the hydrophobic group.

- **Answer:** The hydrocarbon part (R –) is hydrophobic group and the part (– COO[–]) is hydrophilic group.

17- Justify: Prove something as true and real.

- **Example:** A solution of (H₃O⁺ + Cl[–]) is gradually added into a beaker containing sodium ethoxide solution and few drops of bromothymol blue until equivalence point is reached. The pH of the solution at the equivalence point is equal to 7.

Justify this result based on the chemical species present in this solution.

- **Answer :** At the equivalence point, the major species present in the solution are: Na⁺, Cl[–], C₂H₅OH and water. The species: Na⁺, Cl[–] and C₂H₅OH (conjugate acid of strong base) are indifferent with respect to water. The pH will be equal to that of pure water at 25°C; pH = 7.

18- Specify: Indicate and justify.

- **Example:** A solution of (H₃O⁺ + Cl[–]) is gradually added into a beaker containing sodium ethoxide solution and few drops of bromothymol blue, until equivalence point is attained.

Given :

Bromothymolblue : Yellow 6.0 Green 7.6 Blue.

Specify the color change observed at the equivalence point.

- **Answer :** At equivalence point, adding a single drop will cause the color of the solution to change from blue to green.

19- Pick out (Extract): Select one or more information from a document.

- **Example:** A healthy food helps to improve general health and the wellbeing. A healthy diet can help with better feeling, ensures more energy, and helps to remain active, in good form and to fight the stress...

Pick out from the text four advantages of healthy diet.

- **Answer:** The four advantages are:
Helps with better feeling, ensures more energy, helps to remain active and in good form and to fight the stress....

20- Verify: Confirm using arguments, logical reasoning,... whether something is true or false.

➤ **Example:** Sodium hydrogencarbonate (NaHCO_3) commercially known as sodium bicarbonate is much used in everyday life.

Conjugate acid-base pair	$\text{HCO}_3^- / \text{CO}_3^{2-}$	$(\text{CO}_2, \text{H}_2\text{O}) / \text{HCO}_3^-$	$\text{H}_2\text{O} / \text{OH}^-$	$\text{H}_3\text{O}^+ / \text{H}_2\text{O}$
pK_a	10.3	6.4	14	0

A volume of sodium hydrogencarbonate solution $V_b = 20 \text{ mL}$ is introduced into a beaker. A hydrochloric acid solution of concentration $C_a = 0.10 \text{ mol.L}^{-1}$ is added gradually into the beaker and the pH change is measured using a calibrated pH meter.

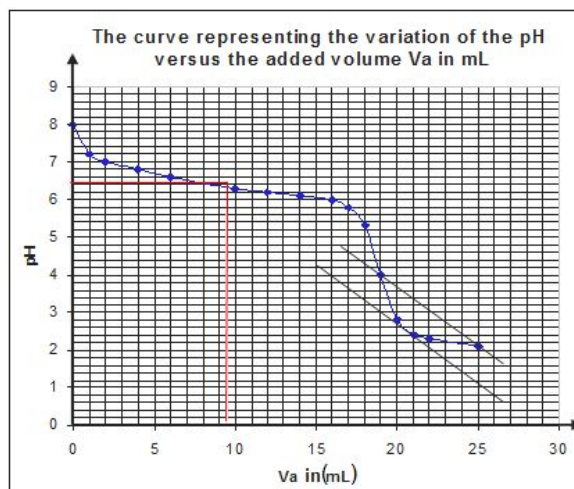
The results are recorded in the table below:

$V_a(\text{mL})$	0	1	2	4	6	10	12	14	16	17	18	19	20	21	22	25
pH	8.0	7.2	7.0	6.8	6.6	6.3	6.2	6.1	6.0	5.8	5.3	4.0	2.8	2.4	2.3	2.1

- 1- Plot, on a graph paper, the curve $\text{pH} = f(V_a)$.
Take as scale; on X-axis: 1 cm for 2 mL; Y-axis: 1 cm for 1 pH unit.
- 2- *Verify*, graphically, the value of pK_a of the conjugate acid- base pair $(\text{CO}_2, \text{H}_2\text{O}) / \text{HCO}_3^-$.

➤ **Answer:**

1-



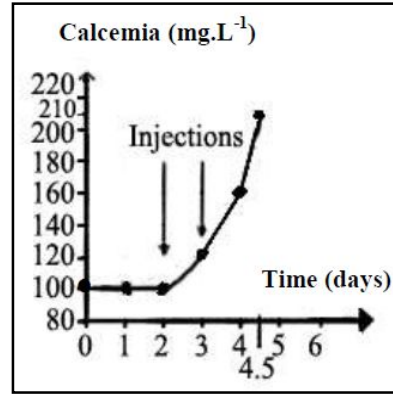
- 2- At half-equivalence point: $\text{pH} = \text{pK}_a + \log \frac{[\text{base}]}{[\text{acide}]}$ with $[\text{base}] = [\text{acid}]$.
 $\Rightarrow \text{pH} = \text{pK}_a$; for $V_a = 9.5 \text{ mL}$, $\Rightarrow \text{pK}_a = 6.4$.

EXAMPLES ON ACTION VERBS
OFFICIAL EXAMS
THIRD YEAR OF SECONDARY CYCLE

LIFE SCIENCE

1- Analyze: Decompose a whole into its constituent elements to make evident the variations.

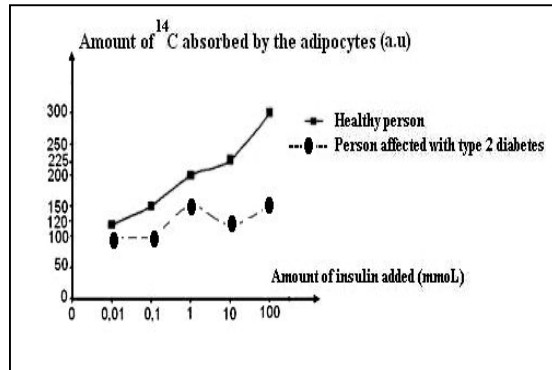
- **Example 1: Experiment** The parathyroid glands that are situated at the base of the neck are four in number. Their structure shows no excretory ducts, but they are richly irrigated by blood vessels. The parathyroid glands do not secrete calcium. In order to determine the role of these glands, we inject a substance isolated from parathyroid extracts into a normal animal and we measure the evolution of calcemia. The obtained results are presented in the adjacent document.



Analyze the obtained results.

- **Answer :** From day 0 till day 2 before the injection of parathyroider extracts, calcemia rate remains constant at 100 mg.L⁻¹. Then it increases from 100mg/L to 210 mg/L between D 2 and D 4.5 after two successive injections of parathyroid extracts at D2 and D3.

- **Example 2 :** Adipose cells (adipocytes) are extracted from a healthy person and from another person affected with type 2 diabetes. These cells are cultured in a medium containing ¹⁴C-labelled glucose. Insulin is added to this medium and the amount of ¹⁴C contained in the adipocytes is measured. The results are shown in the adjacent document.



Analyze the obtained results.

- **Answer:** The quantity of ^{14}C absorbed by the adipocytes of a healthy person increases from 120 a.u to 300 a.u. as the quantity of insulin added increases from 0.01 mmol to 100 mmol. Also, for the same quantity of added insulin, the quantity of ^{14}C absorbed by the adipocytes of a person affected with type 2 diabetes increases, but slightly, and fluctuates between 100 and 150a.u.

2- Calculate: (Compute) Perform mathematical operations.

- **Example 1 :** Geneticists crossed a mouse having curly hair and malformed eyes with a mouse having smooth-hair and normal eyes. All the mice of the first generation (F1) have curly hair and normal eyes. The results of (F2) generation resulting from crossing of F1 female mice with F1 male mice are the following:
 - 42 mice having smooth-hair and normal eye.
 - 127 mice having curly hair and normal eyes.
 - 41 mice having curly hair and malformed eyes.
 - 14 mice having smooth hair and malformed eyes.

Calculate the phenotypic proportions of the F2 generation.

- **Answer:** Calculation of proportions of F2:
 $42/14 = 3$; $127 / 14 = 9,07 \approx 9$; $41/14 = 2,92 \approx 3$; $14 / 14 = 1$
 Total = $3 + 9 + 3 + 1 = 16$

 $3/16$ mice having smooth-hair and normal eye.
 $9/16$ mice having curly hair and normal eyes.
 $3/16$ mice having curly hair and malformed eyes.
 $1/16$ mice *having* smooth hair and malformed eyes.

- **Example 2:** *Calculate* the BMI (body mass Index) of an individual whose mass is 80 kg and whose length is 160cm knowing that $\text{BMI} = M/T^2$ (mass in kg, length in m).

- **Answer:** $\text{BMI} = M/T^2 = 80 / (1.6)^2 = 31.25 \text{ kg/m}^2$.

3- State: Express without explaining .

- **Example 1:** *State* the steps of the transmission of nerve message at the level of synapse.

- **Answer:**
 - Arrival of the A.P. to the terminal buds of the presynaptic neuron.
 - Entrance of Ca^{2+} into the terminal buds of presynaptic neuron.
 - Exocytosis of synaptic vesicles.
 - Liberation of the neurotransmitter to the synaptic cleft.

- Fixation of the neurotransmitters on specific receptors on postsynaptic membrane
- Opening of the postsynaptic channels.
- Generation of postsynaptic potential.
- Degradation of the neurotransmitters by specific enzymes or/and recapturing of neurotransmitters through the presynaptic membrane.

➤ **Example 2:** *State (List)* three biological effects resulting from cortisol discharge during stress.

- **Answer:** Three of five effects:
- Increases the amount of glucose in the blood.
 - Slows down water excretion by the kidneys.
 - Contributes to body's resistance against aggression.
 - Has an anti-inflammatory effect.
 - Reduces the glucose consumption by cells except the brain cells.

4- Compare: Indicate the similarities and/or differences between two or more entities .

➤ **Example 1:** In the framework of studying the role of insulin, the researchers measured the absorption of glucose and the amount of stored glycogen in a muscle placed in a medium with or without insulin. The results are shown in the following document.

Quantity of absorbed glucose by muscle (in mg/g of muscle) every 10 minutes		Quantity of glycogen contained in the muscle (in mg/g of muscle) after 10 minutes	
Medium without insuline	Medium with insulin	Medium without insuline	Medium with insulin
1.43	1.88	2.45	2.85

Compare the obtained results.

- **Answer:** Every 10 min, the quantity of glucose absorbed by the muscle in a medium containing insulin(1.88mg/g of muscle) is greater than that absorbrd by the muscle in a medium deprived of insulin (1.43mg/g of muscle). Similarly, after 10 min, the quantity of glycogen contained in the muscle present in the medium with insulin(2.85mg/g of muscle) is greater than that contained in the muscle in the medium without insulin (2.45 mg/g of muscle).
- **Example 2 :** Document 1 reveals the foods consumed by a person in one day, document 2 reveals the distribution of the energy supply by these

foods, and document 3 reveals the distribution of energy supply recommended by dietitians.

<ul style="list-style-type: none"> ▪ Breakfast: tea, cake, cereals, orange juice. ▪ Lunch: half an avocado, pasta, lamb meat, fresh pineapple, water. ▪ 4 O'clock snack: two biscuits, apple, water. ▪ Dinner: fish, carrots, potatoes, yoghurt, orange, bread, water. 	<p>Breakfast: 20%</p> <p>Lunch: 40%</p> <p>4 O'clock snack:10%</p> <p>Dinner: 30%</p>	<p>Breakfast: 25%</p> <p>Lunch: 30%</p> <p>4 O'clock snack:15%</p> <p>Dinner: 30%</p>
<i>Document 1</i>	<i>Document 2</i>	<i>Document 3</i>

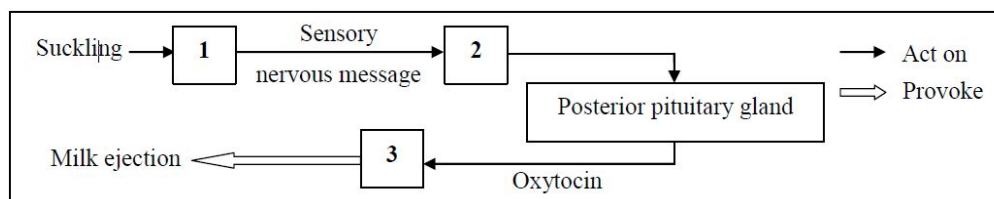
Compare the distribution of energy supply of the foods consumed by this person to that recommended by dietitians.

- **Answer:** In this person, the energy supply from breakfast (20%) is less than that recommended by a dietitians (25%), and the energy supply from 4 O'clock snack (10%) is less than that recommended by a dietician (15%). However, the energy supply from lunch (40%) is more than that recommended by dietitians (30%), and the energy supply from dinner (30%) is the same as that recommended by the dietitians (30%).

5- Complete: Add what is missing.

- **Example 1:** Oxytocin is a hormone produced by the posterior pituitary gland which activity is controlled by the hypothalamus. This hormone stimulates milk ejection by the mammary glands. For this reason, the oxytocin concentration in the blood of a lactating female (sheep or goat) increases during breast feeding (sucking milk).

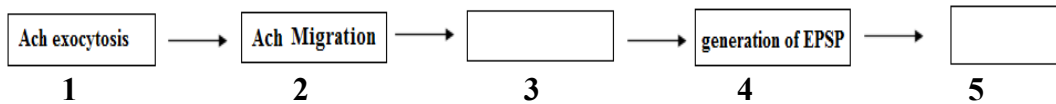
Complete the functional diagram below illustrating the mechanism of milk ejection by naming the structures that correspond to the numbered boxes 1, 2 and 3.



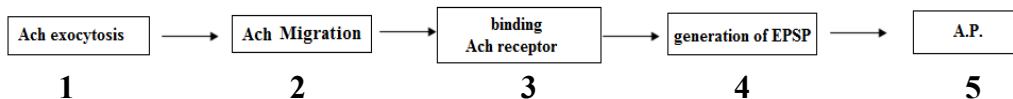
- **Answer:**
- 1 : sensory receptor
 - 2 : hypothalamus
 - 3 : mammary glands

- **Example 2:** The document below represents a functional diagram showing the mechanism of transmission of a nerve message at the level of an excitatory synapse.

Complete the functional diagram by writing the convenient expression in each of the empty boxes, 3 and 5.



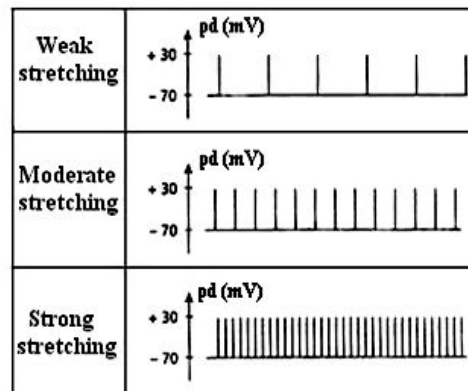
- **Answer:**



6- Conclude: Reach to a decision.

- **Example 1:** Myotatic reflex is a muscle response triggered by a stimulus which receptor is the neuromuscular spindle.

Tapping the Achillean tendon provokes the stretching of the foot's extensor muscle into variable lengths. Simultaneously, and during the same duration, we record the nerve message transmitted all along a nerve fiber issued from the neuromuscular spindle of this muscle. The results are shown in document 1.



Document 1


- 1- a) Interpret the obtained recordings.
 b) What can you *conclude*?

- **Answers:**

- 1-a) Following a weak stretching of the neuromuscular spindle, six action potentials (AP) of the same amplitude of 100mV are recorded. This number increases to 34 AP, in the same duration, when the stretching increases (strong stretching), while the amplitude of the AP remains constant. Therefore, the response of the nerve fiber increases only in frequency when the intensity of the stimulus increases.
- b) At the level of a nerve fiber, the nerve message is coded by modulation of frequency of AP and not by amplitude.

- **Example 2:** We inject, with a micropipette a certain quantity of the neurotransmitter acetylcholine, at the level of the two categories of neurons, A and B, that are in different states of activity. We measure, at the same time, the frequency of action potentials transmitted at the level of these neurons. The results are presented in the table below.

Time (in seconds)	10	15	20	30	50
Frequency of AP					
Neurons A	3	10	14	14	3
Neurons B	40	30	20	20	40



Injection of acetylcholine

- 1- a) Analyze the obtained results.
 b) What can you *conclude* concerning the action of acetylcholine?

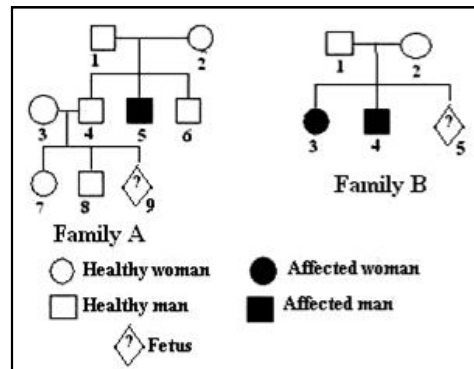
➤ Answers:

- 1- a) 10 seconds before the injection of acetylcholine, the frequency of AP recorded at the level of neurons A is 3, and at the level of neurons B is 40.
 After the injection of acetylcholine at the 15th second, the frequency of AP increases to 10 AP in neurons A while decreases to 30 AP in neurons B. As injection of acetylcholine continuous till the 30th second, the frequency of AP continues increasing to 14 A.P. at the level of neurons A while continues decreasing to 20 A.P. at the level of neurons B, as the time proceeds to the 20th second, then it stays constant in both neurons A and B till the 30th second. After the arrest of acetylcholine injection at the 50th second, the frequency of AP returned back to their initial state before each injection in both neurons A and B: 3 AP at the level of neurons A and 40 AP at the level of neurons B.
- b) Acetylcholine has an excitatory action on neurons A, and an inhibitory action on neurons B.

OR Acetylcholine has a double effect on neurons : Excitatory and inhibitory.

7- **Determine:** Reach a decision or a result through logical reasoning, calculation...

- **Example 1:** Phenylketonuria is a disease caused by a deficit in a hepatic enzyme – PAH – responsible for the transformation of an amino acid, phenylalanine, into another one called tyrosine. In Europe, the



risk of being heterozygous is 1/50.

Document 1

Document 1 shows the pedigrees of two families A and B which some members are affected with this disease. Couples (3, 4) of family A and (1, 2) of family B ask for a prenatal diagnosis.

- 1- **Determine**, by rigorous analysis of the pedigree of family B, whether the allele responsible for the disease is dominant or recessive and the location of the gene responsible for the disease.
- 2- **Determine** the genetic risk for each fetus to be affected with this disease.

➤ **Answers:**

- 1- The pedigree of family B reveals that normal parents have a daughter and a boy both affected. This means that the allele responsible for the disease is present in the parents but masked, which means it is recessive.

The gene is not located on gonosomes because if the gene was Y-linked on the segment not homologous with X, the females could not be affected, but this is not the case. If the gene for the disease was X-linked on the segment not homologous with Y, then, the diseased daughter in family B would have both alleles for the disease carried on 2X chromosomes, and this means that she would have inherited one of these X chromosome from her father, then her father should be diseased, but this is not the case. If the gene was linked on the homologous segment of X and Y, then the father of the diseased children in family B would have been affected in order to give X and Y chromosomes, both carrying the affected allele, to his daughter and son respectively, but this is not the case.

Therefore, the allele responsible for this disease is located on an autosome.

- 2- The risk for the fetus in family A to be diseased: Mother (3) is healthy with no family history of phenylketonuria. Then, the probability to be heterozygous is 1/50 and in this case, half of her gametes will be carrying the mutant allele. Father

(4) is healthy but has an affected brother, then the probability to be healthy and heterozygous is $2/3$ and to be healthy homozygous is $1/3$.

If the father is healthy homozygous, the risk to obtain a diseased fetus is nil since the father can only transmit the normal allele to his descendants.

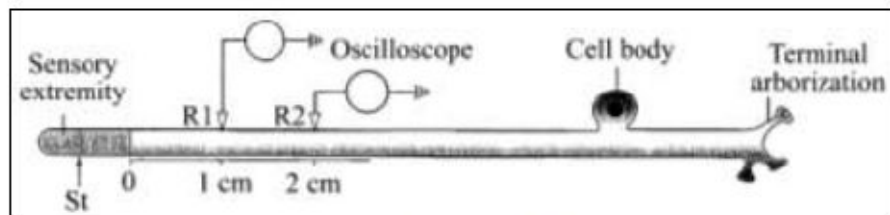
However, if the father is healthy and heterozygous, half of his gametes will be carrying the mutant allele.

Then the risk to obtain a fetus which is diseased will be: $2/3 \times 1/2 \times 1/2 \times 1/50 = 1/300$.

The risk of the fetus in family B to be diseased: The parents of the fetus are necessarily heterozygous, then half of their gametes will be carrying the allele of the disease.

Then the risk of having a fetus which is diseased will be: $1/2 \times 1/2 = 1/4$.

- **Example 2:** An experimenter connected two microelectrodes, R1 and R2 to the sensory neuron of an insect which is placed in physiological liquid (doc 1).



Document 1

The sensory ending of this neuron is subjected to mechanical stimuli of increasing intensities ($I_1 < I_2 < I_3 < I_4$). The obtained results are represented in document 2.

	I_1	I_2	I_3	I_4
R_1				
R_2				

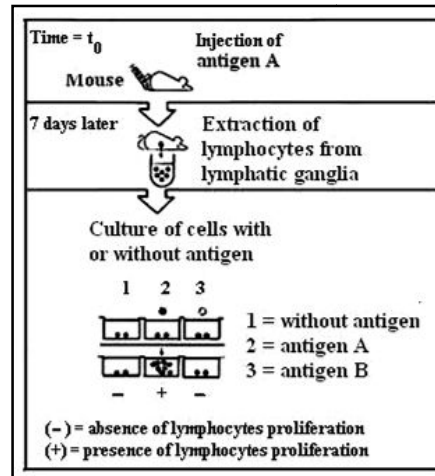
Document 2

Determine, by referring to document 2, the form of coding of nerve message at the level of nerve fiber.

- **Answer:** The number of APs recorded by R1 and R2 increases from 3AP to 6AP during 4ms, while their amplitude stays constant, as the intensity of effective stimulation increases from I_2 to I_4 . This means that at the level of a nerve fiber, the nerve message is coded in terms of modulation of frequency of AP and not amplitude.

8- Describe: Express using scientific language, to give the details of an observation, an experiment, a schema, an apparatus...

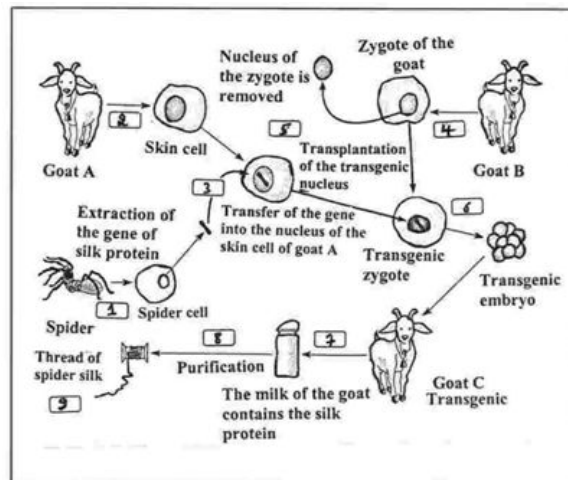
- **Example 1:** In order to study one of the characteristics of the immune response, the experiment shown in the adjacent document was carried out.



Write a short text *describing* the experiment carried out as well as the obtained results.

- **Answer:** Antigen A is injected into a mouse at t_0 . 7 days later, cells of the lymphatic ganglia are extracted and put in 3 culture media: Without antigens in medium (1), with antigen A in medium (2), and with antigen B in medium (3). We observe the presence of lymphocytes proliferation in medium (2) and absence of lymphocytes proliferation in media (1) and (3).

- **Example 2:** Spider silk is a protein which is more resistant than steel and lighter than carbon fiber. Being flexible and recyclable, this protein became of human interest for various applications: stitching



threads for surgery, bone prostheses, anti-bullet vests..... One inconvenience is that raising of spiders is difficult, and the production of this silk is rare.

Studies showed that the mammary glands are similar to the glands which secrete silk in a spider. From these studies, the idea of transferring the gene coding for spider silk to a mammal, such as the goat, came out. The above document shows the technique of gene transfer achieved.

Describe this technique.

- **Answer:** We remove a cell from the spider and extract the gene of the silk protein. We transfer this gene into the nucleus of a skin cell taken from goat A. We take a zygote from goat B and we remove its nucleus. Then we transplant the nucleus of the cell taken from goat A into the anucleated zygote of goat B. We obtain a transgenic zygote that gives an embryo, which becomes a transgenic goat C. The milk produced by this goat contains the silk protein that, after purification, gives the spider silk thread.

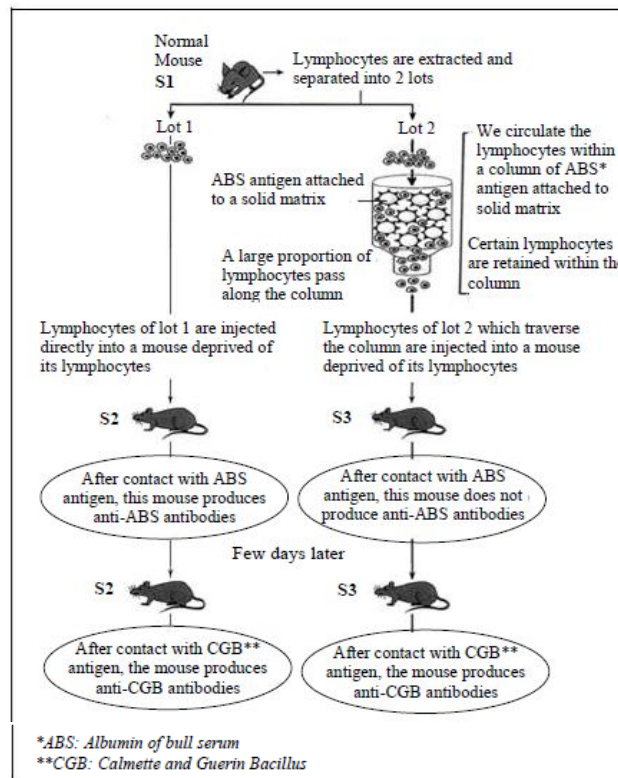
9- Show/ show that: Prove “something” is evident by logical reasoning, experimenting, calculating...

- **Example 1:** In the midst of the twentieth Century, two hypotheses were proposed to explain the high **diversity of antibodies**.

First hypothesis: Any lymphocyte encountering any antigen is capable of producing antibodies specific to this antigen.

Second hypothesis: Only some lymphocytes which correspond to an antigen are capable of producing antibodies specific to this antigen.

To know which of the two hypotheses is valid, an experiment was performed on mice of the same strain. The steps and results of this experiment are represented in the document below.



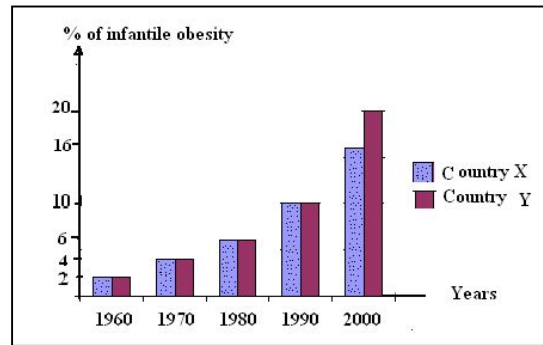
Show which of the two hypothesis is validated.

➤ **Answer:** Lymphocytes (Lot1) which are extracted from the normal mouse S1 and injected in mouse S2 deprived of its lymphocytes, were able to produce anti-BSA antibodies after their contact with ABS antigen and anti-CGB antibodies after their contact with CGB antigen.

However, Lymphocytes (lot2) ,originating from the same mouse S1 and traversing a column having ABS antigen attached to a solid matrix then injected to mouse S3 deprived of its lymphocytes, upon encountering the same type of antigens, were not able to produce anti-ABS antibodies, but were able to produce anti-CGB antibodies.

We can say that mouse (3) did not receive lymphocytes specific to ABS antigen since these lymphocytes bind to ABS antigen attached to the solid matrix of the column, but it received other lymphocytes, some of which are specific to CGB antigen and which were able to pass through this column. Then, for each antigen, there are specific lymphocytes which produce specific antibodies against it and not any lymphocyte encountering any antigen is capable of producing antibodies specific to it. So, the second hypothesis is valid.

➤ **Example 2:** The increase of childhood obesity in some countries is alarming. 20 to 50% of obese or overweight children before puberty will remain obese in adolescence. Of these obese adolescents, 50 to 70% will remain in adulthood. The neighboring document shows the variations of the percentage of obesity among children who are 5 to 11 years old in two different countries X and Y.

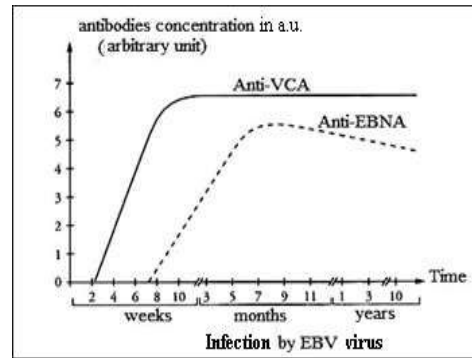


Show that childhood obesity is truly alarming

➤ **Answer:** From 1960 till 2000, the percentage of childhood obesity increased from 2% to 16% in country X and from 2% to 20% in country Y . Because the childhood obesity increases in both countries , and as 20 to 50% of these children will remain obese in adolescence and 50 to 70% of these adolescents will remain obese in adulthood, then we can say that childhood obesity is truly alarming.

10- Deduce: Draw using logical reasoning new information from given or existing information.

- **Example 1:** To better understand one of the immune responses triggered against the EBV virus, we follow up the evolution of anti-VCA and anti-EBNA antibodies directed respectively against two peptides, VCA and EBNA, that are found on the surface of this virus. The results are shown in the adjacent document.

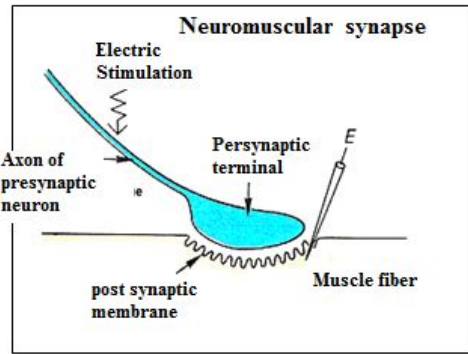


Deduce, based on this document, that the immune response revealed by the results is specific for the antigen epitope (antigenic determinant).

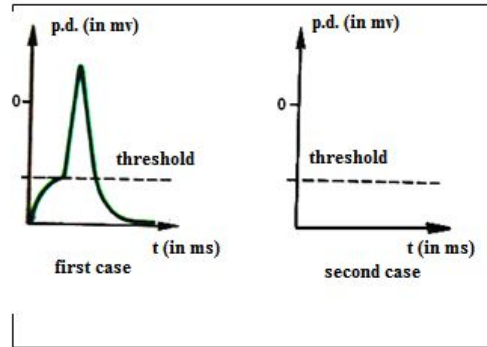
- **Answer:** Since after the infection with EBV virus the organism produces two different types of antibodies, anti-VCA and anti-EBNA antibodies against the two peptides on the surface of the same virus, we deduce that the immune response is specific for epitopes on the antigen.
- **Example 2:** In the framework of studying the transmission of nerve message at the level of the synapse, we realize the experimental setup presented in document 1. We stimulate the presynaptic axon and register the recordings by electrode E_0 , placed at the level of the postsynaptic membrane. Document 2 shows the results obtained in two different cases:

1st case: Effective stimulation of the presynaptic neuron.

2nd case: Effective stimulation of the presynaptic neuron preceded by an injection of a chemical substance, curare, in the synaptic cleft. This substance has a high affinity to the receptors of acetylcholine, a neurotransmitter which interferes in the neuromuscular synapse.



Document 1



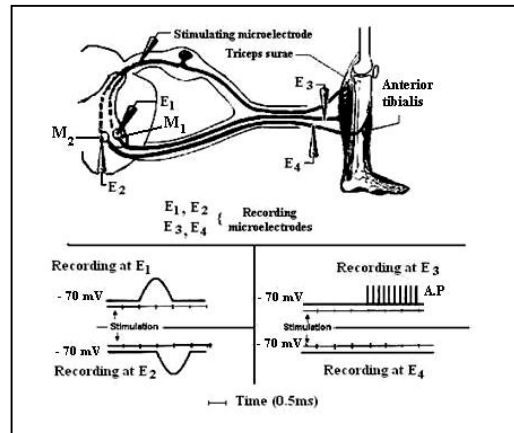
Document 2

Deduce the role of curare.

- **Answer:** After curare injection, no EPSP is recorded after effectively stimulating the presynaptic neuron. We deduce that curare blocks the action of acetylcholine.

11- Draw out: Draw from a set of given and without reasoning a relation, a role, a law...

- **Example 1:** In order to understand the functioning of the neurons' circuits implied in maintaining posture during dancing, and to know how muscles interfere in maintaining the body's equilibrium the following experiment is performed.



A nerve fiber issued from a neuromuscular spindle of an extensor muscle, the triceps surae, is stimulated. This stimulation leads to modifications of the electric status of two motor neurons, M_1 and M_2 , located at the level of the gray substance of the spinal cord. One of these motor neurons innervates the extensor muscle while the other innervates the flexor muscle, anterior tibialis. The above document reveals the experimental set up and the results of the recordings.

Draw out, based on the document, the effect of the activity of the motor neurons on the concerned muscles.

- **Answer:** M_1 sent an excitatory nerve message to the triceps surae, so it contracted; M_2 did not send any message to the anterior tibialis, so it remained relaxed.

- **Example 2:**

"Scurvy is one of the old known diseases. It was the main cause of death among sailors. This disease starts with fatigue then it is manifested by edema in arms and legs, followed by bleeding of the nose and gum. The teeth become unstable and fall down. Persons having this disease are incapable of standing, and die from exhaustion or from complications of respiratory infections. In 1593, the sailors of an English ship that was sailing to India did not get the disease because their captain made them drink daily a few drops of fresh citrus juice: orange and lemon. In May 20th, 1747, James Lind, an English physician, prescribed six different treatments to 12 sailors, having the disease, divided into groups of two. After six days, only the sailors who ate fresh oranges and lemons were healed. Analysis showed that citrus fruits are rich in ascorbic acid.

" Doctor C.BINET, *Vitamines et vitaminotherapie*

Draw out from the text the cause of this disease.

- **Answer:** Scurvy is due to the absence of ascorbic acid found in fresh citrus fruits.

12- Distinguish: Recognize or discern one "thing" from another according to particular traits.

- **Example 1:** *Distinguish* Anaphase I from Anaphase II


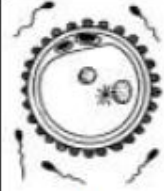
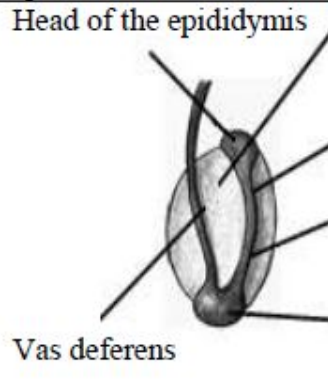
- **Answer:** During Anaphase I homologous chromosomes ,each two chromatids, separate and migrate to opposite poles of the cell, while during anaphase II sister chromatids separate to opposite poles of the cell.

13- Explain: Clarify, make comprehensive a phenomenon, a result...

- **Example 1 :** Female rabbits were mated with sterile males in order to induce ovulation, and then they were inseminated with sperm cells taken from different levels of the genital tract of adult fertile male rabbits.

One day following the insemination, the aspect of the cells that were taken from the oviducts was observed under the microscope. Document 1 presents the percentages of the two main aspects (schema X and Y) observed according to the site where the sperm cells were removed.

Explain briefly the structural modifications that take place during the passage of the cell from aspect X to aspect Y.

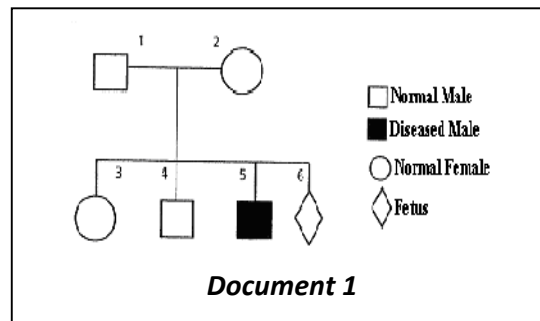
Aspect of the cells taken from the oviducts one day after the insemination			
		X	Y
 Site from where sperm cells were removed.	Head of the epididymis	100%	0%
	Testicle	85%	15%
	Proximal part of the body of the epididymis	35%	65%
	Distal part of the body of the epididymis	8%	92%
Tail of the epididymis			

Document 1

- **Answer:** The scheme X represents an oocyte II blocked at metaphase II after having released the first polar body. Once fertilized by a sperm cell, this cell releases the content of its cortical granules forming the fertilization membrane and resumes meiosis II **and** releases the second polar body. The male and female pronuclei are formed. This is how the cell passes from aspect X to aspect Y.

14- Identify: Recognize “something” based on its characteristics or its properties.

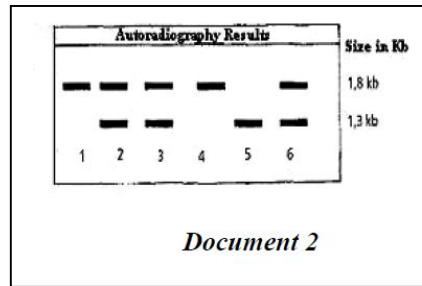
- **Example 1:** Duchene Myopathy is a degenerative disease of muscle fibers which is due to a gene carried on the non-homologous segment of chromosome X.



Document 1

Boys affected with myopathy do not synthesize the muscle protein, dystrophin, or synthesize an inactive form of dystrophin. Document 1 represents the pedigree of a family having one of its members affected with the disease.

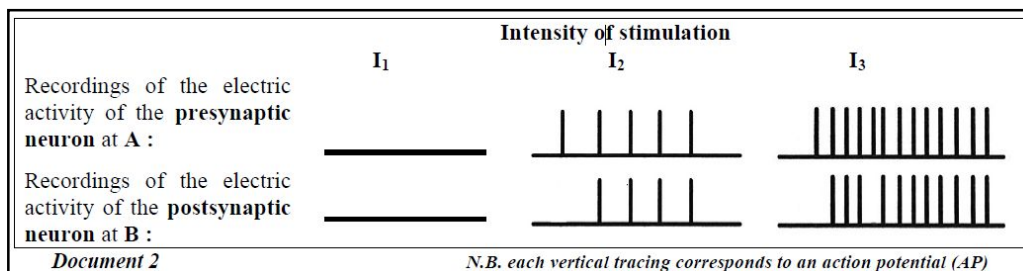
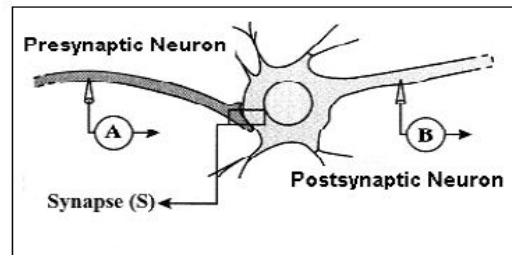
Parents (1&2) who are expecting a baby want to know whether their fetus is at risk of developing the disease. They consult a doctor who proposes a prenatal diagnostic test by applying Southern Blot technique. The results are shown in document 2.



Identify, by referring to document 1 and the autoradiography of document2, the allele responsible for the disease..

➤ **Answer:** Male 5 is diseased and has the genotype X^m/Y (document 1) and the autoradiography(doc 2) shows that he possesses the allele of length 1.3Kb. This means that the allele responsible for the diseases corresponds to the fragment 1.3Kb.

➤ **Example 2:** We perform a series of electric stimulations of increasing intensity on a presynaptic neuron, and we record the electric activity of the presynaptic and post synaptic neurons. Document 1 shows the experimental set-up, and document 2 represents the recordings obtained during a certain time (t).

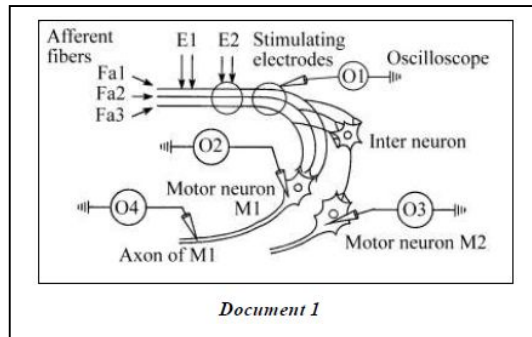


Identify the type of the synapse based on document 2.

➤ **Answer::** After the stimulation of presynaptic neuron, the electric activity recorded at the level of the postsynaptic neuron shows a number of AP. This means synapse S allows the transmission of nerve messages from the presynaptic neuron to the post synaptic neuron which means that this synapse is excitatory.

15- Interpret: Analyze and give significance to the result.

➤ **Example 1:** In order to study the characteristics of a nerve message in an achillian reflex before and after it passes through the spinal cord, we use the experimental set up presented in



document 1 and we realize the experiments described below. The experimental set up in document 1 shows the location of the stimulating electrodes on the afferent fibers and that of recording electrodes on different oscilloscopes. Oscilloscope O1 permits recording the effect of stimulations of one or more afferent fibers; Oscilloscopes O2 and O3 permit the recording of the electric responses of motor neurons M1 and M2 respectively at the level of the implantation cone.

Oscilloscope O4 permits recording of the electric activity at the level of the axon of motor neuron M1.

We apply two successive effective stimulations on one of the afferent fibers Fa1, and we vary the time between these two stimulations. The results, recorded by O2, are shown in document 2.

Time separating the two successive stimulations	Responses recorded by oscilloscope O ₂
5 ms 1 2	
1 2	
1 2	
1 2	

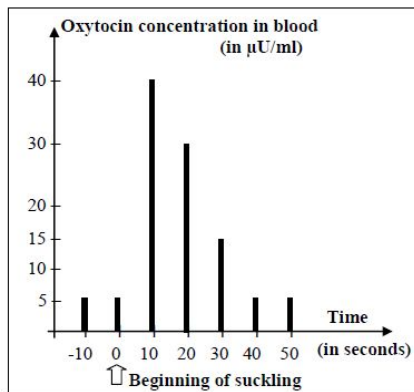
AP: Action Potential

Document 2

Interpret the results obtained in document 2.

➤ **Answer:** Two hypopolarizations, of the same amplitude are obtained after two successive stimulations separated approximately with a time difference of 16 ms. These two hypopolarizations get closer and sum up, producing an action potential with an amplitude 100 mV when the time difference between the two stimulations decreases to 6 msec. This means that the motor neuron M1 integrates the successive messages arriving from the same afferent neuron Fa1 by performing temporal summation of EPSP.

- **Example 2:** Oxytocin is a hormone produced by the posterior pituitary gland. It stimulates milk ejection by mammary glands. In vitro, the muscle cells of the mammary glands contract under the effect of oxytocin added into the culture medium. In order to determine the stimulus at the origin of oxytocin secretion, we measure its concentration in the blood of a lactating female (ewe or goat) before and during suckling (breast feeding) periods by withdrawing 15 ml of blood each 10 seconds. The obtained results are presented in the adjacent document.



Interpret the obtained results.

- **Answer:** 10 seconds before the beginning of suckling, the concentration of oxytocin was 5 µU/ ml. After the beginning of suckling , this concentration increases to reach a max of 40 µU/ ml after 10 seconds, then decreases to 5 µU/ ml after 40 seconds from the beginning of suckling, then stabilizes at this level till the 50th second inspite of the persistence of suckling. This implies that suckling stimulates the secretion of oxytocin, but this effect is momentary as it does not last during the time of suckling.

16- Indicate: Designate “something” without justification.

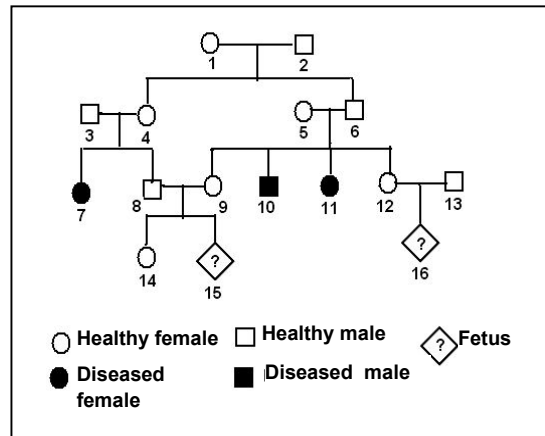
- **Example 1:** *Indicate* the true statements.
1. Proteins are long chains of fatty acids.
 2. Energy expenditures of the body depend on the activity of its cells.
 3. In order to form blood hemoglobin, the body needs calcium.
- **Answer:** 2: Correct
- **Example 2:** In an attempt to study autosomal heredity in drosophilae, we cross a drosophila of pure race having gray body, red eyes and well-formed wings with another drosophila of pure race having black body, purple eyes and deformed wings. We obtain in F1 100% drosophilae having gray body, red eyes and well-formed wings.

Indicate the dominant allele and the recessive allele for each of the studied genes.

- **Answer:** For the first trait, body color, the allele coding for gray body is dominant over the allele coding for black body which is recessive.
For the second trait, eye color, the allele coding for red eyes is dominant over the allele coding for purple eyes which is recessive.
For the third trait, appearance of wings, the allele coding for normal wings is dominant over the allele coding for malformed wings which is recessive.

17- Justify: Prove “something” as true and real.

- **Example 1:** The following pedigree represents a family whose some members are affected by phenylketonuria.



Justify that this disease is recessive.

- **Answer:** Couples (3-4) and (5-6) are normal but their children (7,10, and 11) are diseased. This means that the allele for the diseases is present in each of the normal parents ,but it is masked. Then the allele responsible for the disease is recessive.

➤ **Example 2:**

In an attempt to know the reason that makes smokers continue smoking, doctors put rats in a cage having two holes. When the rats put their heads into one hole, nothing happens. When they put their heads into the second hole, they receive a nicotine dose.

At the beginning of the experiment, rats move toward the two holes in the same way, then gradually, they start going toward the hole where they receive nicotine.

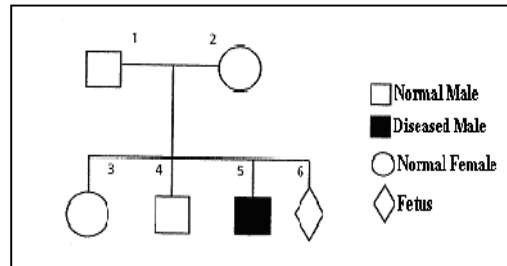
Cerebral tissue analysis of the rats at the end of the experiment shows that certain modifications appear: The links between the neurons are weakened, a number of neurons are degenerated, and a number of neurons are not renewed.”

Justify, based on the text and your knowledge, that nicotine found in tobacco is a drug.

- **Answer:** Throughout the experiment, more & more rats moved toward the hole where they receive nicotine. So, nicotine altered the behavior of rats by inducing a state of dependence. Also, nicotine affects the function of cerebral neurons and their renewal. As the drug modifies the function of the neuron and induce a state of dependence, we can say that the nicotine in tobacco is a drug.

18- Specify: Indicate and justify

- **Example 1:** Duchene Myopathy is a degenerative disease of muscle fibers which is due to a gene carried on the non-homologous segment of chromosome X.

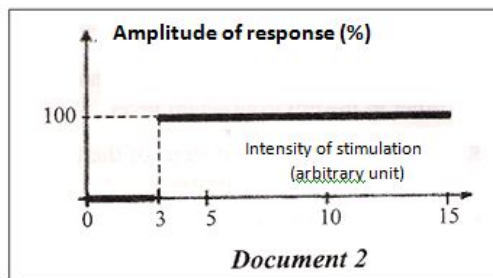
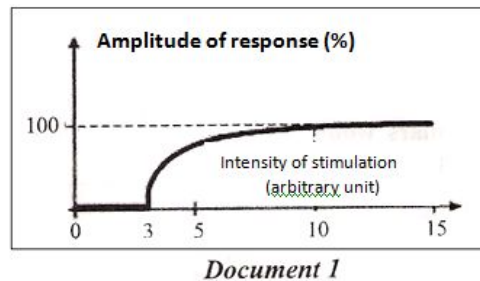


Boys affected with myopathy do not synthesize the muscle protein, dystrophin, or synthesize an inactive form of dystrophin. The adjacent document represents the pedigree of a family having one member of its family affected with this disease.

Specify the genotypes of the parents.

- **Answer:** The genotype of the father is X^N/Y , and the genotype of the mother is X^N/X^m .
The father is normal, so he carries allele N on the only X chromosome that he owns.
The mother is normal so she has allele N (X^N), and her son (5) of genotype X^mY is diseased, so he takes from his mother (X^m).

- **Example 2:** We apply stimulations of increasing intensities to a nerve and a nerve fiber, and we record the electrical activity of each of them. The amplitudes of the responses are represented in documents 1 and 2.



Specify which of the two documents corresponds to a nerve fiber and which one to a nerve.

➤ **Answer:** Document 1 corresponds to the response of a nerve.
Document 2 corresponds to the response of a nerve fiber.
Document 1 corresponds to the response of a nerve since the amplitude of the response increases from 0% to a max of 100% as the intensity of stimulation increases from a minimal effective intensity of stimulation or threshold intensity (3 a.u) to a maximal Intensity of stimulation(10 a.u).

Document 2 corresponds to the response of a nerve fiber since from the minimum effective intensity or the threshold intensity (3 a.u.) and on, there is maximum response of amplitude (100%) for any effective stimulation, whatever, the intensity of stimulation is above 3 a.u,

19- Pick out (Extract): Select one or more information from a document.

➤ **Example 1:** In the framework of studying some aspects of the control mechanism of muscle activity during dancing, studies were carried out and summarized in the document below.

The movements of a dancer are performed in sequences, which are not always predictable since each of these movements is triggered by an intention: the body is then used as a means of expression.

However, any body's movement is hindered by a force – gravity – which attracts it towards the ground. To control body movement and to reach equilibrium, the dancer uses muscles that block some joint movements and prevent falling down. The posture is thus maintained thanks to a constant adjustment of the muscle: for instance, every time a muscle is stretched, it contracts.

Pick out from the document a statement that justifies the presence of a myotatic reflex, and another one that justifies the presence of a voluntary motor activity.

➤ **Answer:**

- 1- Myotatic reflex: Each time the muscle is stretched it contracts.
- 2- Voluntary motor activity: Certain movements are triggered by an intention

➤ **Example 2:**

Over the last 5 years, rice production has been sharply falling, even though the Chinese population has not ceased growing. In China, Pyralids (insects) attack 75% of rice fields causing the loss of one billion dollars every year. Researchers have elaborated insect-resistant rice that inhibits ravagers from digesting it. This transgenic insect-resistant rice which has the CPTi gene, a gene taken from pea plants, will help avoiding thousands of poisoning cases by pesticides. It will also save fish and crabs living in the flooded rice fields and will improve the health of Chinese consumers who regularly ingest toxic products in their food. Other transgenic rice that is resistant to herbicides, salinity or dryness, has been also elaborated. If all Chinese rice farmers adopt the transgenic rice (GMO), then 4 billion dollars would be saved annually due to the usage of less pesticides and the employment of fewer handworkers.

Pick out from the text

- 1-1- The origin of the CPTi gene introduced in rice.
- 1-2- Two types of transgenic rice.
- 1-3- The advantage of transgenic rice on human health.

➤ **Answers:**

- 1-1- Origin : Pea plants.
- 1-2- Insect resistant transgenic rice and transgenic rice that is resistant to herbicides, or to salinity or to dryness
- 1-3- It will help avoiding thousands of poisoning cases by pesticides

20- **Verify:** Confirm using arguments, logical reasoning, whether “something” is true or false.

➤ **Example 1:** To determine the cause of juvenile diabetes in humans, we performed on the same strain of mutant rats, which developed diabetes in the first months of life, the following set of experiments.

1st experiment: We take 100 mutant newly born mice and divide them into two

	Number of diabetic rats
Lot A	5/ 50
Lot B	30/ 50

lots, A and B. We subject the rats of Lot A to removal of the thymus, an organ where T cells undergo maturation, and kept the rats of lot B as control. A few months later, we determined the number of rats that had diabetes, the above document.

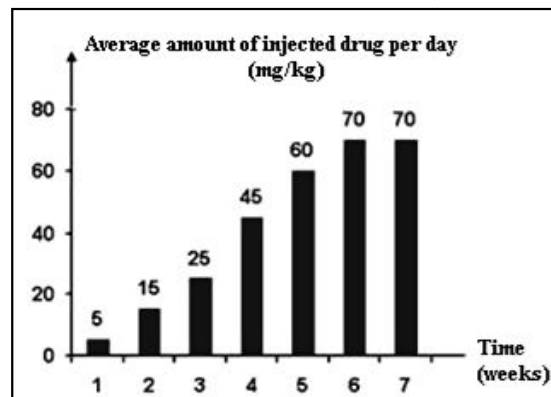
2nd experiment: We take 2 lots of normal healthy non-mutant mice, C and D. We injected rats of Lot C by LT derived from mutant diabetic rats and rats of Lot D by LT derived from healthy rats. Only rats of Lot C develop diabetes.

Verify, based on results of the two experiments, that the LT obtained from mutant mice are responsible for juvenile diabetes.

- **Answer:** The Document of experiment 1 reveals that the removal of the thymus, just at birth, in mutant rats (lot A), allowed the onset of juvenile diabetes in the proportions of 5/50 less than that developed in (Lot B)control rats 30/50 which still have their thymus. This allows us to say that the thymus, which is the site of maturation of T cells, is responsible for the onset of diabetes. In Lot A mice, the LT is not mature, so the number of rats with diabetes decreased.

Experiment 2 reveals that the healthy rats of Lot C, injected with LT from mutant mice develop diabetes while healthy rats of Lot D, injected with LT from healthy rats do not develop diabetes. This signifies that the appearance of the disease is related to the presence of LT from mutant rats. This means that the onset of the disease is related to the presence of LT from mutant rats. So, these two experiments verify that the LT are responsible for juvenile diabetes

- **Example 2:** A fasting monkey is placed in a cage supplied with a lever. When the monkey hangs to the lever, it receives a drug injection. In the course of a few hours, the monkey steps on the lever repeatedly.



The average quantity of drug injected into the monkey is measured for 7 weeks. The results are shown in the next document.

Verify that the monkey is in a state of tolerance with respect to the drug.

- **Answer:** Tolerance is the increase in the dose of the drug consumed in order to obtain the same pleasure of sensations felt with the lower previous doses. The histogram reveals that the monkey is gradually increasing the doses with time from 5mg/kg per day in the first week to a max of 70mg/kg per day in the sixth week in order to obtain the same previous effects; this means the monkey is in a state of tolerance.