



Answer sheet

*11th International Junior Science Olympiad,
Mendoza, Argentina*

Time : 3 hs 30 min
Marks : 30



11th International Junior Science Olympiad

Theoretical Competition

December 6, 2014

(Answer Sheet)



Answer sheet

FILL IN THE FOLLOWING INFORMATION

FIRST NAME	
LAST NAME	
COUNTRY	
CODE	
SIGNATURE	

PROBLEM 1

1.1.1. Fill in Table 3 in the Answer sheet with the information related to each community.

Community	Species Richness (S)	Total number of individuals (N)	Name of dominant species	Abundance of dominant species	J
Sample 1: Community revegetated with <i>Larrea</i>					
Sample 2: Community left to natural succession					

Table Nº 3

1.1.2. Indicate which community has a greater biological diversity.

Answer:

1.1.3 Mark true (T) or false (F) appropriately for each explanation shown on the answer sheet, in order to justify the answer given in 1.1.2.

A. After ten years, the community revegetated with jarilla and the community left to natural succession have a wide difference in species richness, related to <i>Larrea spp.</i> 's facilitating effect.	
B. The presence of <i>Larrea</i> in sample 1 increased the abundance of shrubs and herbaceous forms. This could indicate that <i>Larrea</i> favors the settling of other species, augmenting the evenness of this community.	
C. The favoring effects are indicating that the revegetated community (sample 1) presents less distribution of forms of life than the community left to natural succession.	

1.2. Calculate the areas A, B, C, D, and calculate total surface area of the region. Express the final result in square meters.

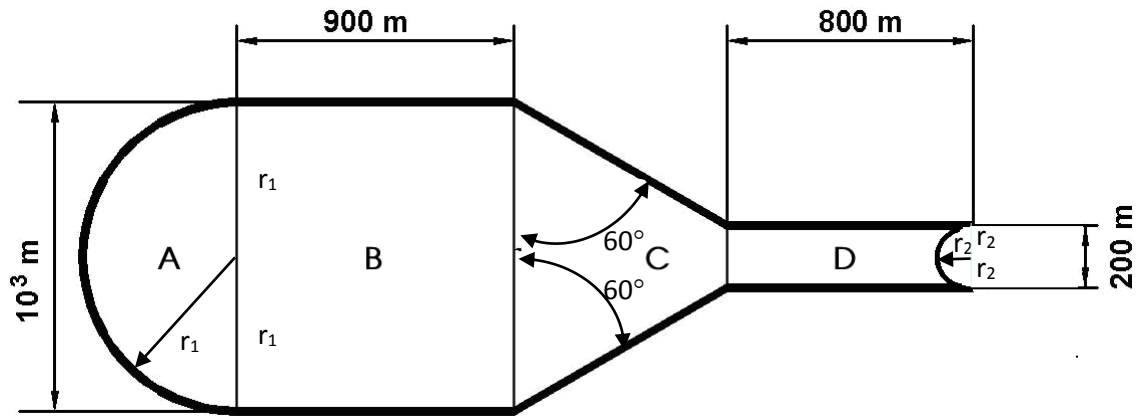


Figure N° 4: Schematic representation of the region to be revegetated.

RESOLUTION:



Answer sheet

ANSWER: Total Area=

1.3.1. Find the velocity of the rock when it passes by point II.

RESOLUTION:

ANSWER: $V_{II} =$

1.3.2. Find the kinetic friction coefficient of this stretch, assuming it is constant throughout it.

RESOLUTION:



Answer sheet

ANSWER: $\mu =$

1.4.1. Determine which nutrient you would choose as a guide for establishing the amount of fertilizer to be used.

ANSWER:

1.4.2 Compute how many kilograms of fertilizer must be added per square meter of terrain. Round results using two decimal after the unit.



RESOLUTION:

ANSWER:



Answer sheet

1.4.3. Determine the concentration of hydroxide ions (OH)¹⁻ responsible for the pH value measured in the disturbed soil shown in Table 4.

RESOLUTION:

ANSWER:

1.4.4. Indicate which of the pH indicators shown in Table 5 you would choose to determine qualitatively the disturbed soil pH, and what color the chosen indicator would take. Write the indicator and the color using the code in parentheses)



Answer sheet

RESOLUTION:

Indicator:

Color:

ANSWER:

1.4.5. Write the balanced chemical equation for the total ionization reaction of Na_2CO_3 in water.

ANSWER:

1.4.6. Write the balanced ionic hydrolysis equation that justifies the pH elevation in the soil due to the carbonate ion.

ANSWER:

1.5.1. Indicate which illustration best expresses the description given in 1.5.

ANSWER:

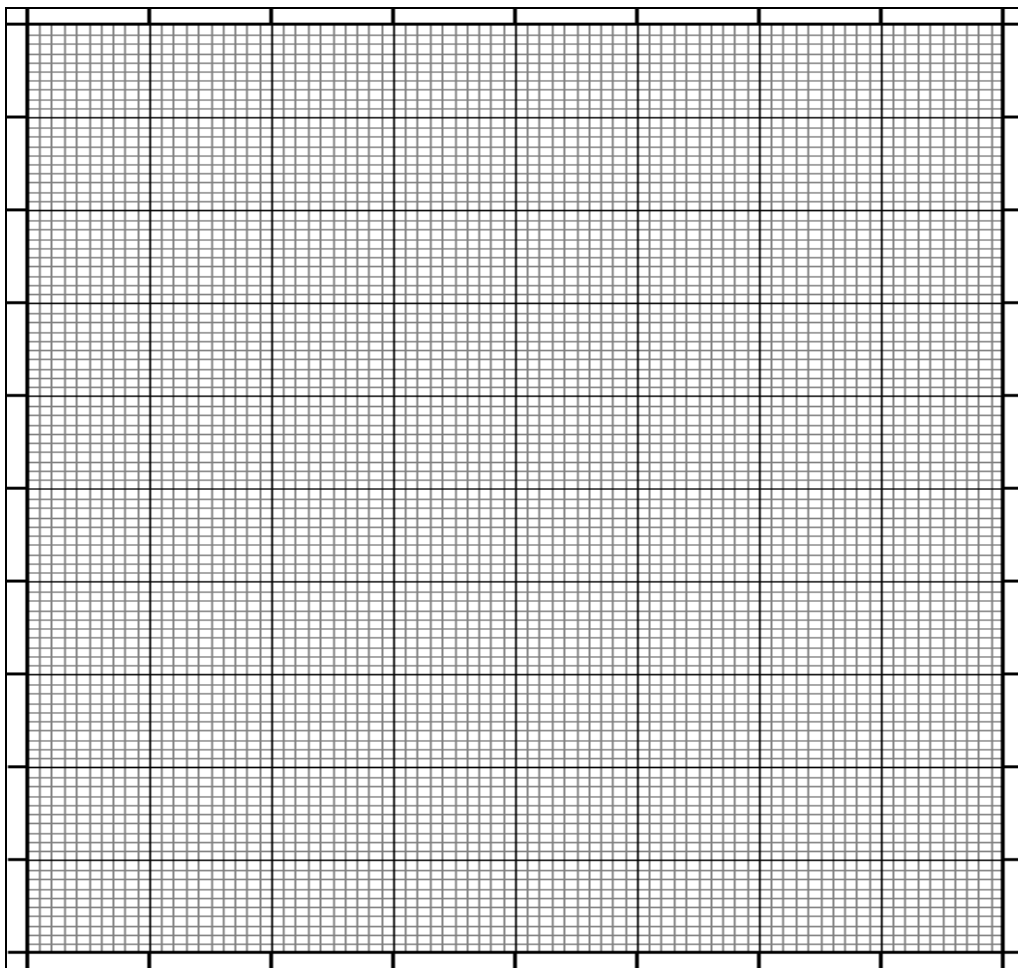


Answer sheet

1.5.2. Select from the following options the statement that provides the reason to the answer to 1.5.1:

ANSWER:

1.6.1. Draw a Cartesian graph of comparative lines for absorbance as a function of wavelength for the three samples, based on Table 6. Use different colors for each type of absorbance line.





1.6.2. Using the information given in Table 6, indicate the wavelength that is needed to best distinguish NDGA from other substances.

ANSWER:

1.6.3. Calculate the NDGA concentration (mg L^{-1}) in each extract. Consider the extract was purified from other substances.

RESOLUTION

ANSWER:

1.6.4. Using the information in Table 6 and the values for each absorbance, indicate the species corresponding to each extract.



Answer sheet

ANSWER:

Extract A:

Extract B:

1.6.5. Determine the mass of fresh *L. divaricata* leaves that you need considering that fresh leaves have a moisture content of 8% w/w (water density at 20°C is 1 g cm⁻³).

RESOLUTION

ANSWER:



Answer sheet

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PROBLEM 2

2.1.1. Write the chemical reactions needed to obtain the acids derived from SO_3 and CO_2 when combined with water.

Answer:

2.1.2. The unbalanced formation reaction of nitric acid in acid rain is:



Write the half-reactions and the balanced equation.

RESOLUTION:



Answer sheet

Answer:

2.2.1. Determine the solubility in moles per liter of aluminum hydroxide ($\text{Al}(\text{OH})_3$) in the lake water which has a pH value of 5.2, knowing that the K_{sp} (solubility product) value is 5×10^{-33} .

RESOLUTION

Answer:

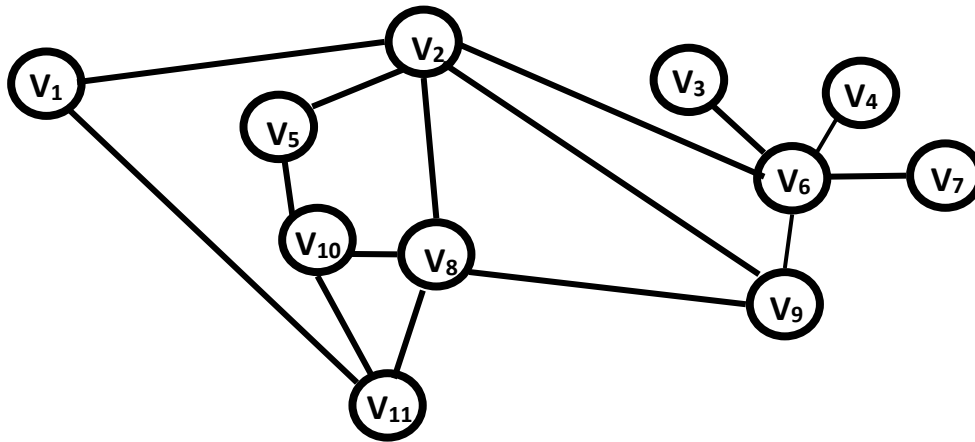


Figure 8: Water piping network

2.3.1. Determine the maximum number of pipes that can be removed without interrupting the water supplying every distribution point.

Answer:

2.4.1. Compute the average value of lead in blood for each sample. Indicate which of them, if any, is above the toxicity levels, writing an A for adults, a C for children, and a B for both

Answer:

Adults' sample mean:

Children's sample mean:

Sample/s above the toxicity levels:



2.5.1. Calculate Earth's equilibrium temperature without the absorption of the atmosphere (Figure 9a). Express your results in K and °C.

The intensity I (W m^{-2}) radiated by a black body follows Stefan-Boltzmann's Law:

$$I = \sigma T^4, \text{ where } \sigma = 5,67 \times 10^{-8} \text{W m}^{-2} \text{K}^{-4}$$

Assume that the Earth radiates energy as a black body.

RESOLUTION:

Answer:

2.5.2. Find the equilibrium temperature of the Earth with the atmosphere (Figure 9b), assuming that the atmosphere absorbs all the radiation emitted by the surface, and reemits it back to both the Earth and Space in equal proportions. Start out with intensity balance on the Earth surface and on the atmosphere.

Hint:

Assume that the atmosphere only absorbs energy from the Earth surface, and that both emit energy as a black body.



RESOLUTION:

Answer:

2.6.1. In this context, calculate the minimum amount of energy needed to completely melt a block of 10000kg of ice, initially at -10°C .

Thermodynamic constants:

Specific heat capacity of Ice: $c = 2.093 \text{ Jg}^{-1}\text{K}^{-1}$

Latent heat of ice fusion: $l = 333.7 \text{ J g}^{-1}$

RESOLUTION:



Answer sheet

Answer:

PROBLEM 3

3.1.1. Based on the information shown on Table A and Table B, mark with a cross (X) on Table A the secretory structure which produces the enzyme involved in digesting the starch that is present in the slice of toast. Then, use the corresponding number given to the enzyme shown on Table B, to match the Structure where this enzyme is produced.

Hint: the same enzyme may be produced by more than one structure.

Table A		
STRUCTURE	SECRETORY STRUCTURE INVOLVED IN THE DIGESTION OF STARCH	ENZYME
Liver		
Stomach		
Salivary Glands		
Large intestine		
Pancreas		
Esophagus		
Small Intestine		

Table B	
1	Phospholipase
2	Maltase
3	Amylase
4	Lipase
5	Glucosidase
6	Sucrase

3.1.2. Fill in Table C (indicated on the Answer Sheet) which shows enzymatic reactions. Write the corresponding letter of the enzyme in the green box and the corresponding number for the products in the blue boxes (each number may be used more than once).

ENZYMES		PRODUCTS	
A	Creatin kinase	1	Maltose
B	Amylase	2	Glucose
C	Lactase	3	Fructose
D	Glucosidase	4	Lactose
E	Sucrase	5	Galactose
F	Maltase	6	Saccharose (sucrose)

Table C	
starch	<div style="display: flex; align-items: center; gap: 10px;"> <div style="border: 1px solid green; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> → <div style="border: 1px solid blue; width: 40px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> </div>
maltose	<div style="display: flex; align-items: center; gap: 10px;"> <div style="border: 1px solid green; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> → <div style="border: 1px solid blue; width: 40px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> + <div style="border: 1px solid blue; width: 40px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> </div>
lactose	<div style="display: flex; align-items: center; gap: 10px;"> <div style="border: 1px solid green; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> → <div style="border: 1px solid blue; width: 40px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> + <div style="border: 1px solid blue; width: 40px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> </div>
saccharose (sucrose)	<div style="display: flex; align-items: center; gap: 10px;"> <div style="border: 1px solid green; width: 30px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> → <div style="border: 1px solid blue; width: 40px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> + <div style="border: 1px solid blue; width: 40px; height: 30px; display: flex; align-items: center; justify-content: center;"> </div> </div>

3.2.1 Table D shows muscular contraction processes. Complete Table E (indicated in Answer Sheet), indicating the letter of the process in the order in which they occur.

Table D: Processes of muscle contraction	
A.	ATP is hydrolyzed to ADP + Pi (inorganic phosphorus) and the myosin head is separated from the active site.
B.	Acetylcholine acts on a local area of the sarcolemma to open multiple membrane protein channels. This allows the entry of large amounts of sodium ions into the sarcolemma, which initiates an action potential in the muscle fiber.
C.	The action potential depolarizes the sarcolemma. The release of Ca ⁺⁺ ions from the sarcoplasmic reticulum occurs.
D.	Ca ⁺⁺ ions are pumped back into the sarcoplasmic reticulum, where they remain until the arrival of a new action potential to the muscle.
E.	An action potential reaches the neuromuscular junction (synapse) of a motor neuron and a muscle, acetylcholine is released from the axon terminal.
F.	Ca ⁺⁺ ions initiate attractive forces between the actin and myosin. Filaments of myosin and actin are arranged next to each other within the sarcomere so that that they can interact in an organized fashion resulting in muscle contraction. During contraction, myosin heads bind actin and pull the filaments in towards the center.

Tabla E	
ORDER	CORRESPONDING LETTER
1	
2	
3	
4	
5	
6	

3.2.2 Figure 11 represents muscle contraction. Write the letter corresponding to each process in the space provided.

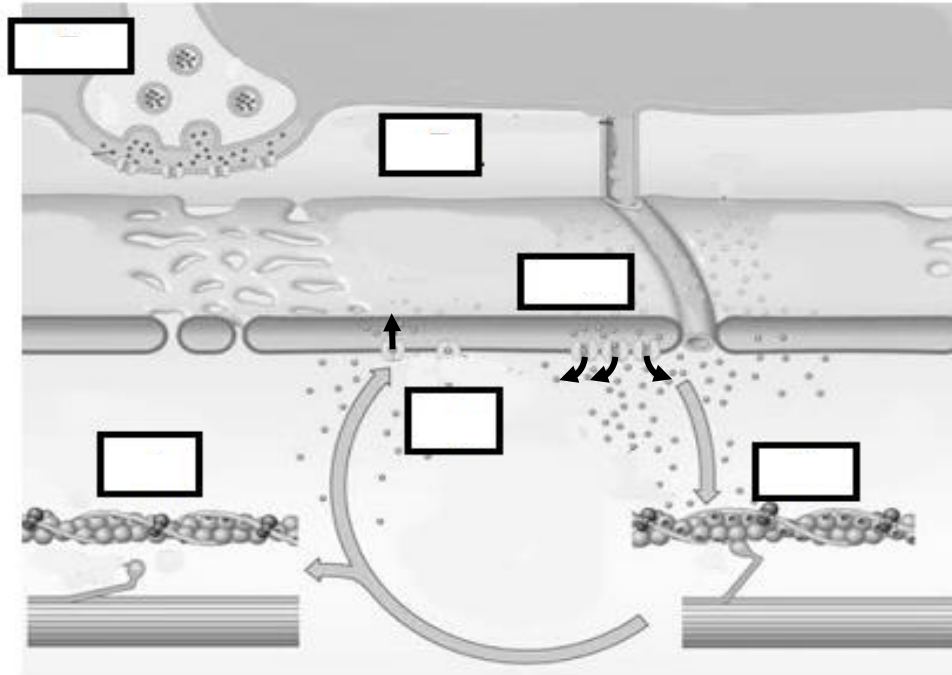


Figure 11: Muscle contraction representation.

3.3.1. Calculate the minimum amount of "engines" a muscle should utilize in lifting a mass of 50 kg. (Acceleration of gravity: 9.81 m s^{-2})

RESOLUTION:

ANSWER:



3.3.2. Calculate the power developed by the myosin engine measured in J s^{-1} .

RESOLUTION:

ANSWER:

3.4.1. If the food ingested at breakfast by the athlete is equivalent to 90 g of glucose, calculate the mass of carbon dioxide (CO_2) produced as a result of complete combustion. (Relative atomic mass C= 12; O=16; H=1).

RESOLUTION:

ANSWER:

3.4.2. Calculate the number of oxygen atoms in 90 g of glucose molecules.

RESOLUTION:

ANSWER:

3.5.1. During her straight line path, her velocity follows the graph as shown in the figure below. Find the instantaneous acceleration at points A, B and C.

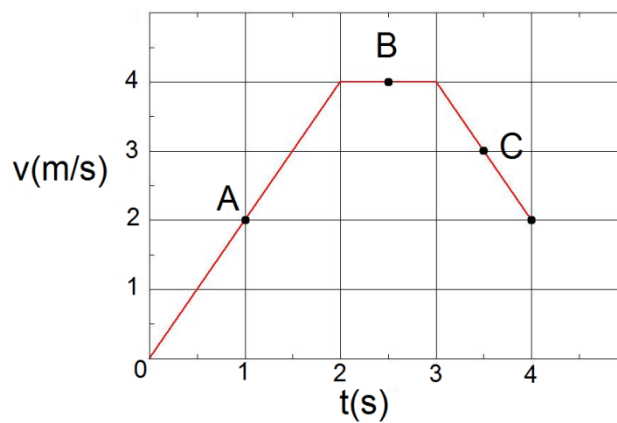


Figure 12: Velocity as a function of time

RESOLUTION

ANSWER:

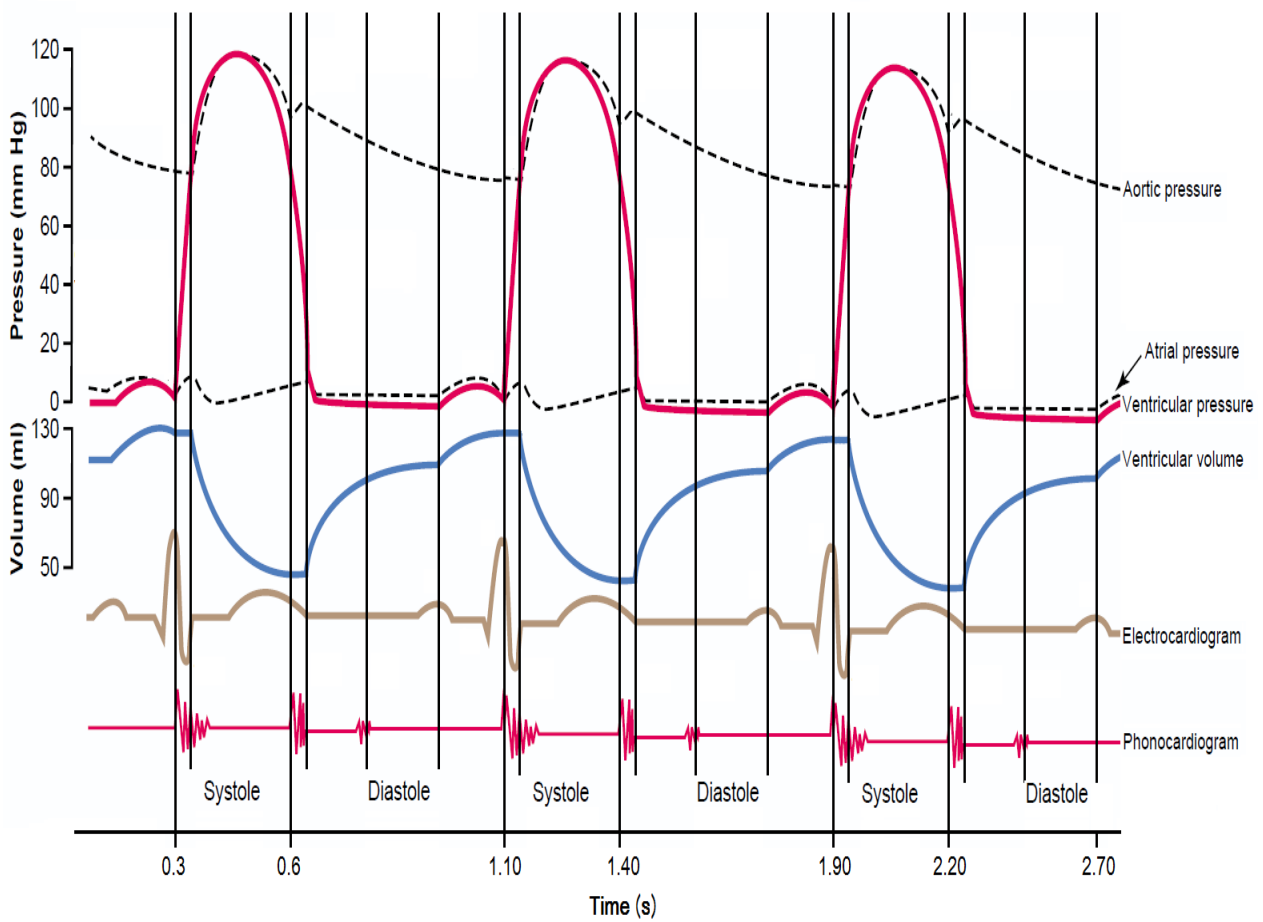


Figure 13: Various events occurring during three cardiac cycles, for different parts of the heart



Answer sheet

3.6.1. Using the information shown in the graph, compute the time period of one cardiac cycle (in seconds).

RESOLUTION:

ANSWER:

3.6.2. Calculate the corresponding heart rate (cardiac cycles per minute).

RESOLUTION:

ANSWER:

3.6.3. Indicate in which time intervals ventricular volume decreases considering that intervals in which the volume remains constant last 0.05 seconds.

ANSWER:

3.6. 4. Indicate the maximum value observed for ventricular pressure.

ANSWER:

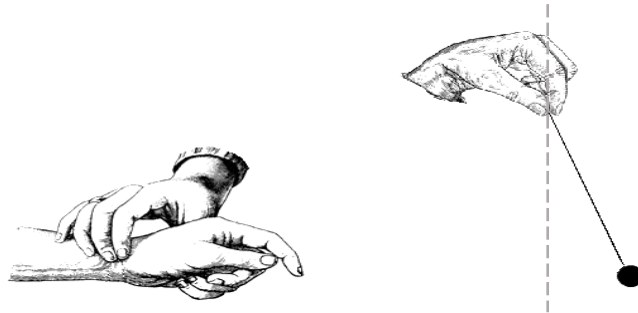


Figure 14: Pulse measurement using a simple pendulum.

3.7.1. Calculate the length of the pendulum used by the student, the period of simple pendulum is

given by $T = 2\pi \sqrt{\frac{L}{g}}$

Being:

L the length of the pendulum

$g = 9.81 \text{ m s}^{-2}$

RESOLUTION:



Answer sheet

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ANSWER:
