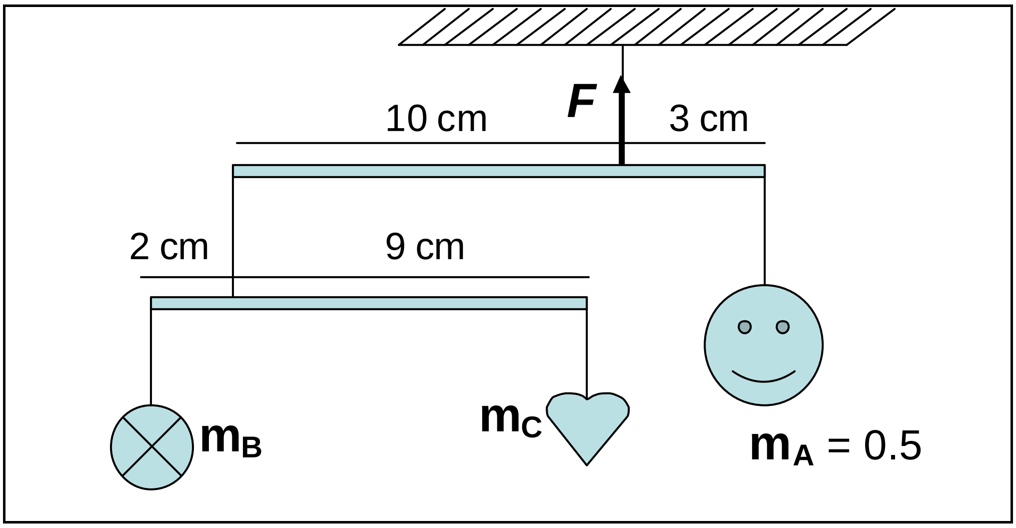
Solutions for TEST COMPETITION

1. The mobile system in the Figure is in the equilibrium condition. The object of m_A has a mass of 0.5 kg and hang at the first crossbar. The second crossbar supports the mass of m_B and m_C. Determine the tension F at the first crossbar and the masses of the objects m_B and m_C by neglecting the weights of crossbars. (g = 9.8 m/s^2).



A. F = 6.37 N, m_B = 0.12 kg, m_C = 0.03 kg

B. F = 5.37 N, m_B = 0.12 kg, m_C = 0.03 kg

C. F = 6.37 N, m_B = 0.10 kg, m_C = 0.03 kg

D. F = 6.37 N, m_B = 0.12 kg, m_C = 0.01 kg

Answer: A

Solution

Look at the sub-system at the upper crossbar, and consider the center of rotation at the F.

$$? \; ? \; ? \; 0$$

$$0 \; ? \; ?0.03 ? 0.5\,kg ? 9.8\,m/s^2 \; ? \; 0.1 F_{CB}$$

$$F_{Bc} \; ? \; \frac{0.03 ? 0.5 ?9.8}{0.1} \; ? \; 1{,}47\;N$$

Look at the sub-system of $m_B m_C$, and consider the center of rotation at the edge of m_B.

$$? \; ? \; ? \; 0$$

$$? \; 0.02 ?F_{BC} \; ? \; 0.11 ?F_C$$

$$F_c \; ? \; \frac{0.02 ?F_{BC}}{0.11} \; ? \; \frac{0.02 ? 1.47\;N}{0.11}$$

$$? \; 0{,}267\;N$$

$$m_C \; ? \; \frac{F_C}{g} \; ? \; \frac{0.267\;N}{9.8\,m/s^2}$$

$$m_C \; ? \; 0.03\;kg$$

Again look at the sub-system of $m_B m_C$, and consider the center of rotation at the edge of m_C.

$? \; ? \; ? \; 0$

$? \; ?0.09 \; ?F_{BC} \; ? \; 0.11 \; ?F_B$

$$F_B \; ? \; \frac{0.09 \; ?F_{BC}}{0.11} \; ? \; \frac{0.09\, m \; ? \; 1.47\, N}{0.11\, m} \; ? \; 1.2N$$

$$m_B \; ? \; \frac{1{,}2\, N}{9.8\, m/s^2} \; ? \; 0.12\ kg$$

Therefore: $F \; ? \; F_A \; ? \; F_{BC} \; ? \; ?0.5 \; ? \; 9{,}8 \; ? \; 1{,}47 \; ?N \; ? \; 6.37\ N$

===

Two identical twin babies are born from one mother. The babies are the result of the fertilization of:

A. One ovum with two sperms

B. Two ovums with one sperm

C. One ovum with one sperm

D. Two ovums with two sperms

Answer: C

? The principle of fertilization: one ovum is fertilized by one sperm. So the answer of (A) & (B) are wrong. The answer of D probably is true but it c accepted since the mother only delivers two identical babies one to each other.

The voltage in household wiring (220 volt) is used for lighting of a 100 W-bulb. The resistance R of the tungsten at 20 ^oC is 89.5 ? . If the temperature coefficient of tungsten ? = 0.0045 $^oC^{-1}$, estimate the temperature of the tungsten used as a wire resistance in the bulb.

A. 1120 ^oC
B. 1020 ^oC
C. 1000 ^oC
D. 980 ^oC

Answer: C

Solution

I = P/V = 100 W/ 220V = 0.4545 A, R(t) = V/I = 484.05 O,

R(t) = Ro [1 + a (T – T_o)] = 89.5 O [1 + 0.0045 $^oC^{-1}$ (T-20) ^oC]

T = 1000 ^oC

==

Select the statement that is **not** an appropriate method for separating and purifying substances:

A. Petroleum is separated from crude oil by fractional distillation
B. The mixture of various compounds could be separated by chromatography
C. Sodium Chloride is separated from the seawater by extraction
D. Iodine contained in sand mixture is separated by sublimation

Answer : **C**

Sodium Chloride in seawater cannot be separated by extraction but crystallization.

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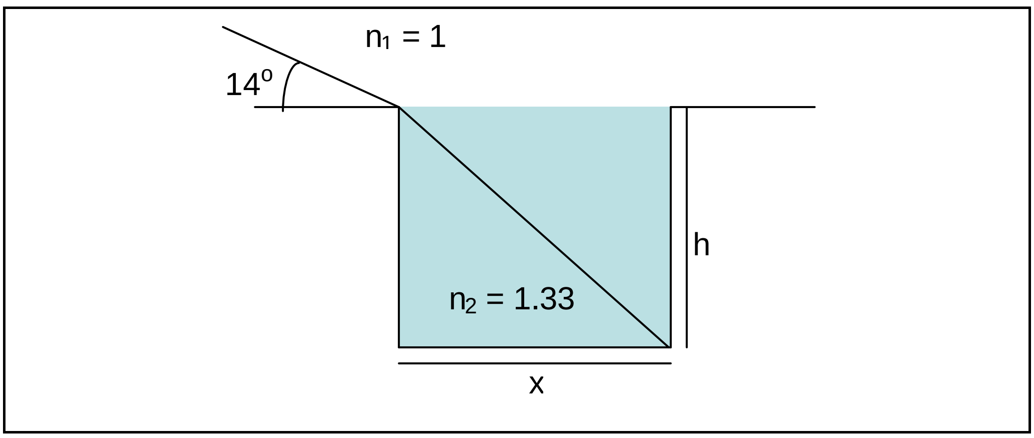
A student sees the top and the bottom edges of a pool simultaneously at an angle of 14^o above the horizontal as shown in the Figure.



What is the new view angle, if he wants to see the top edge and the bottom center of the pool (n = index of refraction, n_{water} = n_2 = 1.33 and n_{air} = n_1 = 1)?

A. 28.4^o
B. 38.0^o
C. 46.8^o
D. 51.3^o

Answer: D

Solution

In order to see the bottom edge of the pool

$n_1 \sin(90^o - 14^o) = n_2 \sin ?$

$\sin 76^o = 1.33 \sin ?$ ✍ ? = 46.85

tan ? = 1.07

In order to see the bottom center of the pool

$\sin(90^o - ?_2) = n2 . \frac{\frac{1}{2}x}{(\frac{1}{4}x^2 ? h^2)} = n2 . \sin((\tan^{-1} \frac{1}{2} \tan ?))$

$= 1.33 \sin(\tan^{-1} 1.07/2)$

$= 0.626$

$?_2 = 90^o - \sin^{-1}[0.626] = 51.3^o$

==

The mechanisms of antibiotics are to inhibit the following processes, **except**:

A. nucleic acid synthesis

B. protein synthesis

C. capsule synthesis

D. cell wall synthesis

Answer: C

The target of antibiotic in the body or cell of organism are: the cell wall, the membrane cell, protein synthesis and nucleic acid synthesis

==

Several indicators are used to determine the pH of river water sample. If an indicator was added to the sample, the color of indicators added to the water sample is shown below:

Indicator added	**Color of indicator in water sample**
Methyl orange	yellow
Methyl red	yellow
Bromthymol blue	blue
Phenolphthalein	colorless

Table: pH range of indicators used:

Indicator	**Range of pH**	**Changes in color**
Methyl orange	3.1 – 4.4	red to yellow
Methyl red	4.2 – 6.2	red to yellow
Bromthymol blue	6.0 – 7.6	yellow to blue
Phenolphthalein	8.3 – 9.6	colorless to red

By using pH range of above indicators, the pH range of the river water is:

A. 3.1 < pH < 7.0

B. 4.4 < pH < 7.6

C. 6.0 < pH < 8.3

D. 7.6 < pH < 8.3

Answer: D

Treatment the sample with indicators gives results:

- Methyl orange changes color to be yellow indicates that pH > 4.4
- Methyl red changes color to be yellow, indicates that pH > 6.2
- Bromthymol blue changes color to be blue, indicates that pH > 7.6
- Phenolphthalein changes color to be colorless, indicates that pH < 8.3

Therefore the pH range of the sample is 7.6 < pH < 8.3

Choose the **incorrect** match between organ, sensory cell and type of receptor from the table below.

Organ	**Sensory cells**	**Type of Receptor**
I. Tongue II. Ear III. Nose IV. Eye	1. Cone cells 2. Chemoreceptor cells 3. Hair cells 4. Taste bud	a. Chemoreceptor b. Photoreceptor c. Mechanoreceptor

A. I, 4, a

B. II, 3, c

C. III, 2, c
D. IV, 1, b
Answer: C Clear

A woman who has four sisters married to a man who has three brothers and one sister. What is the usual probability of having a son if they have a child?

A. 12.5%
B. 25%
C. 50%
D. 75%

Answer: C. The probability to get a boy or a girl is always fifty- fifty
==

). In a chemical reaction, when calcium changes (atomic number, Z = 20) to form calcium ions, the ions react with carbonate ions. In this reaction each calcium atom:

A. releases one electron
B. releases two electrons
C. gains two electrons
D. increases atomic number by two

Answer: B

$_{20}Ca \longrightarrow {}_{20}Ca^{+2} + 2e^-$

$_{20}Ca$ Calcium atom has 20 electrons
$_{20}Ca^{+2}$ Calcium ion has 18 electrons

---

l. X is a white solid substance. When X is heated, it produces a white solid substance Y and gas Z. The produced gas in the reaction is similar to the gas produced by burning carbon in excess of oxygen, and Y is an oxide. From this information, it can be concluded that:

A. X, Y and Z are compounds
B. Only X and gas Z are compounds
C. Y is an element and gas Z is a compound
D. X and Y are pure compounds

Answer: A

The reaction: $X (s) \longrightarrow Y (s) + Z (g)$

Z is CO_2(g) which produced from oxidation of carbon:

$$C(s) + O_2(g) \longrightarrow CO_2(g)$$

Substance X is a carbonate salt, such as MCO_3 (for example M = Ca, Mg, Ba)
(a white solid) substance X is MCO_3 and if MCO_3 is heated, the metal oxide (white solid) and CO_2 (carbon dioxide) gas will be formed.

$$MCO_3(s) \longrightarrow MO(s) + CO_2(g)$$

White white colorless

For test problems No. 12 and 13, read the statement below:

Hypertension is one of diseases that can cause death. The disease is indicated by a high blood pressure (above normal, higher than 140/90 mm Hg). The term blood pressure usually refers to the force pushing against an arterial wall. Hypertension can increase the risk of heart attacks, heart disease, strokes and kidney failure. Hypertension might be related to increasing of sodium ion concentration [atomic mass (A) of sodium = 23; atomic number (Z) = 11]. Diet plays important role in hypertension, additional food such as orange, banana and vegetables could reduce blood pressure. Based on the study, orange, banana and vegetables contain potassium ion, K (A = 39, Z = 19). Fifteen out of twenty people that take those diets have reduction of blood pressure (diastolic & systolic) with obvious reduced of diastolic up to 2.4 mm Hg.

2. Active metal ion that present in orange, banana and vegetable contains .... electrons and ……………protons

A. 10 and 11
B. 11 and 11
C. 18 and 19
D. 19 and 19

Answer = C
Solution
The active metal ion is K^+, which contains 18 electrons and 19 protons

---

3. Based on the above research, hypertension and the kidney failure might indicate

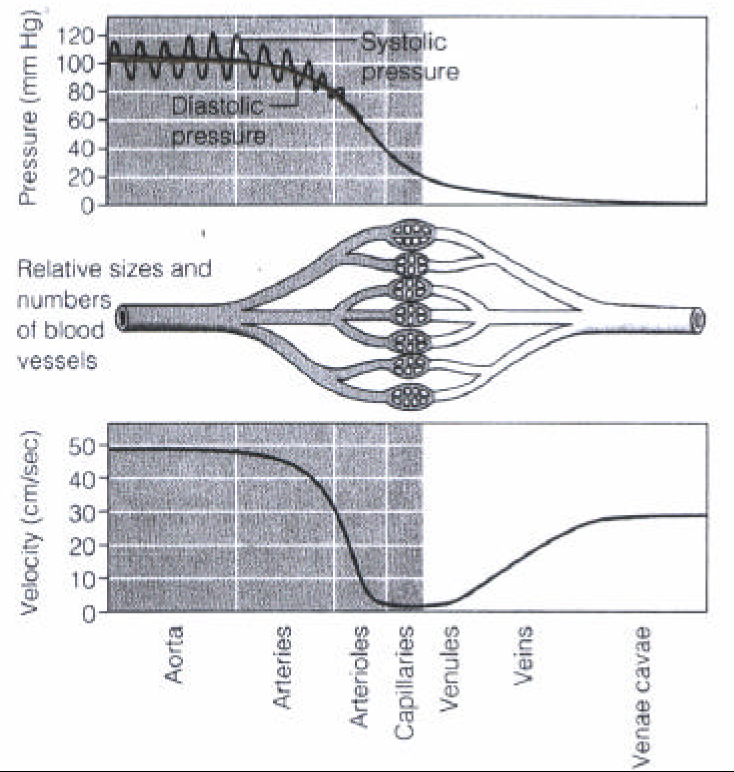
A. imbalance of Na^+ / K^+
B. failure of Na^+ / K^+ re-absorption
C. substitution of Na^+ by K^+
D. retention of K^+ or Na^+

<u>Answer = A</u>
Solution
Hypertension is due to excess of Na^+ which can be balanced by K^+ .
==

<u>For Test Problem No: 14 and 15</u>

Blood Circulatory System

The following curves show the pressure and velocity variation in the blood as it moves through the systemic circulatory system for a normal adult human. From the aorta the blood flows into the major arteries, then into the smaller arteries (arterioles), and finally into the capillaries. At each stage, these blood vessels are divided into many smaller vessels. The fluid flow (Q, volume/unit time) equal to pressure difference divided by R (**Q = ? P/R**), where R is the fluid resistance of a single vessel. This equation is also valid for a complex network of interconnected vessels, such as the blood vessels in the circulatory system when R is taken to be the total resistance of the network.



4. If the radius (r) of the aorta is about 0.9 cm, use the data from the figure to estimate the flow rate of the blood Q:

A. 1.3×10^{-4} m^3/s
B. 2.8×10^{-4} m^3/s
C. 1.2×10^{4} m^3/s
D. 1.3×10^{4} m^3/s

<u>Answer =A</u>
Solution
The flow rate Q = vA = v?r^2 = 0.5 m/s . ? (9 x 10^{-3} m)^2 = 1.3 x 10^{-4} m^3/s
==

5. Assume Q = 1.0 x 10^{-4} m^3/s, then the total fluid resistance R of all the arteries, arterioles, and capillaries in the body is: (density of mercury = 13,600 kg/m^3)

A. 1.1×10^{-7} kg m^{-4} s^{-1}
B. 15 kg m^{-4} s^{-1}
C. 1.2×10^{4} kg m^{-4} s^{-1}
D. 1.1×10^{8} kg m^{-4} s^{-1}

<u>Answer = D</u>
Solution
From the figure above, if v = 0.5 m/s, the pressure difference is about 80 mmHg = 0.08 m x13600 kg/m^3 x 9.8 m/s^2 = 10,662 Pa
Q = ? P/R m^3/s ✍ R = ? P/Q = 10,662 Nm^{-2}/ 1.0 x 10^{-4} m^3/s = 1.1 x 10^8 kg m^{-4} s^{-1}
==

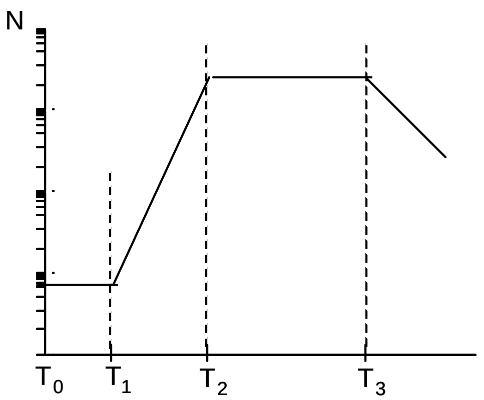
<u>For Test Problems No: 16, 17, 18</u>

Population Growth Pattern of Bacteria

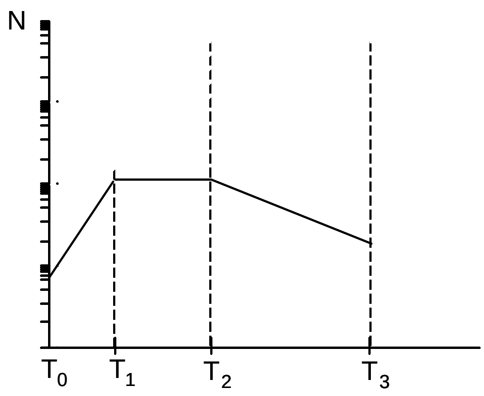
Population growth pattern of bacteria is very important in a fermentation industry. If an Erlenmeyer flask containing nutrient broth was inoculated by a certain amount of bacterial cells (N_o) at T_o, after a certain period of time the bacteria will show a specific growth curve. In the beginning of growth ($T_o - T_1$) the cells are under adaptation phase. After adaptation phase, cells start to multiply by binary fission process. Each cell will divide, and become two cells. In a closed system where the nutrient supply is limited, the population of dividing cells will become relatively the same amount with the dead cells ($T_2 - T_3$). After T_3 the amount of dead cells will be higher than the living ones, then eventually all cells will die.

6. The growth curve (N in logarithmic scale) from the above description is:

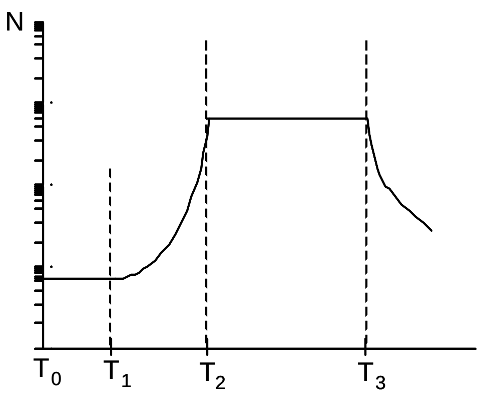
A.



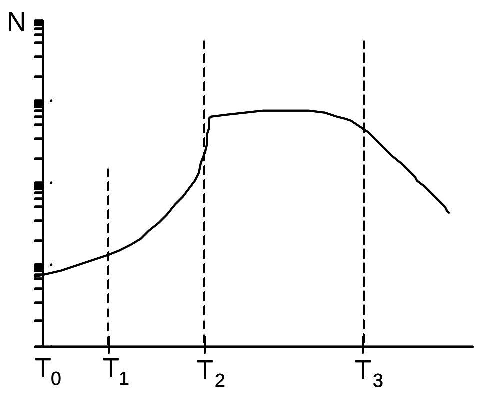
B.



C.



D.



Answer: A Clear

==

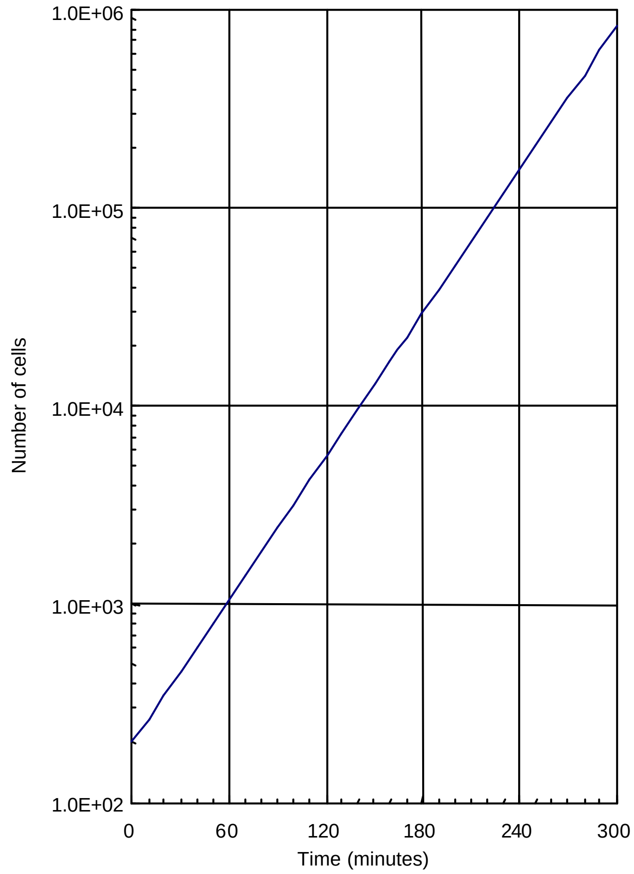
7. Suppose 2×10^2 cells are inoculated (T_o) and the generation time (T_g) is 30 minutes, calculate the amount of the cells after 5 hours (ignore the adaptation time):
   A. 2000
   B. 4000
   C. 2.05×10^5
   D. 1.02×10^{23}

Answer: C

Solution:

Each cell will divide, and become two cells continuously, so it can be formulated by
$N = N_o\, 2^n$
where $n = T/T_g$
$N = 200 \times 2^{(5/0.5)} = 2.05 \times 10^5$
==

18. The relation of cells population as a function of time can be depicted in the figure below:
($1.0E+06 = 10^6$)



Based on the figure above, the generation time of the cells is approximately:

A. 10 minutes
B. 25 minutes
C. 35 minutes
D. 40 minutes

Answer : B

Solution

By using the equation $N = N_o\, 2^n$, and $n = T/T_g$, the equation becomes:
$\log N = \log N_o + T/T_g \log 2$ or

$$\log N \ ?\ \log N_o \ ?\ \frac{\log 2}{T_g} t \, ,$$

gradient curve is $\frac{\log 2}{T_g}$. Taking any two points the gradient of the curve can be calculated.
Example:
Point 1 : $N_1 = 200$, $T_1 = 0$ minutes
Point 2 : $N_2 = 2 \times 10^5$, $T_2 = 250$ minutes
Mean ?log $N_1 = 3$ dan ?T = 250 minutes
Gradient curve = 3/250 minutes^{-1} = 0.012 mins^{-1} ✍ T_g = (log 2)/0.012 ? 25 minutes
==

For Test Problems No. 19, 20

Photosynthesis

Plants need water to produce food by photosynthesis process. The water is transported through specific structures with a speed of 75 cm/min. The plant efficiency in using the water can be determined through the ratio of transpiration to photosynthesis. The ratio can be calculated by the loss of water in every gram of CO_2 used in assimilation. The common ratio is 1:600. During the photosynthesis, carbon-dioxide diffuses into the leaf tissue and oxygen produced diffuses from stomata in the leaf.

). Based on the description above, the reaction that occurred is:

A. $6\ CO_2 + 6\ H_2O$ + Energy ———— $C_6H_{12}O_6 + 6\ O_2$

B. $6\ CO_2 + 6\ H_2O$ + Energy ———— $C_6H_{11}O_6 + 6\ O_2 + \frac{1}{2} H_2$

C. $2\ CO_2 + 3\ H_2O$ + Energy ———— $C_2H_5OH + 3\ O_2$

D. $6\ CO_2 + 3\ H_2O$ + Energy ———— $C_6H_6 + \frac{15}{2}\ O_2$

Answer : A ————clear

). How many liters of CO_2 (at T = 0 °C, P = 1 atm) are required for transpiration of 600g water?

A. 373 L
B. 747 L
C. 1467 L
D. 1494 L

Answer : B

Solution :

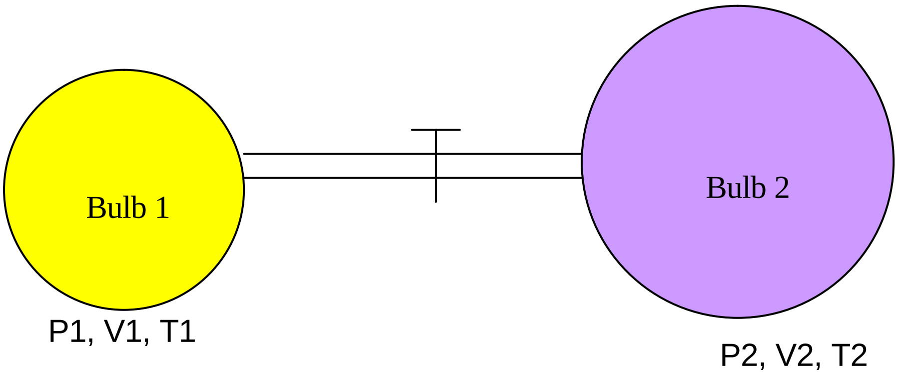
$6\ CO_2 + 6\ H_2O$ ✍ $C_6H_{12}O_6 + 6\ O_2 + E$

mole of H_2O = mole of CO_2 = 600 : 18 = 33.33 mol

Volume of CO_2 = 33.33 x 22.4 L = 747 L.

==

<u>For Test Problem No. 21, 22</u>



In a perfect isolated system, two bulbs are connected with a valve (see Figure above). Both bulbs are filled with a fresh air. When the valve is in closed position, the air in the first bulb has a pressure P_1, volume V_1 and temperature T_1, and the air in the second bulb has a pressure P_2, volume V_2, and temperature T_2. The temperature of $T_1 = T_2$ and $V_2 = 2.8\ V_1$.

1. What is the final pressure (P) of the system if the valve is opened (assume the air in the bulb is an ideal gas)?

A. $\dfrac{P_1 ?\ 2.8P_2}{3.8}$

B. $\dfrac{2.8P_1 ?\ P_2}{3.8}$

C. $\dfrac{P_1 ?\ 0.8P_2}{0.8}$

D. $\dfrac{3.8P_1 ?\ P_2}{2.8}$

<u>Answer: A</u>
Solution
For T= contants, we have:

$$P(V_1+2.8V_1) = P_1 V_1+P_2{\cdot}2.8V_1$$

$$P ?\ \frac{(P_1 ?\ 2.8P_2)(V_1)}{3.8(V_1)}$$

A. $P ?\ \dfrac{P_1 ?\ 2.8P_2}{3.8}$

==

2. If the first bulb is filled by CO gas with pressure of 2 atm and the second bulb is filled by O_2 with pressure of 1 atm. The valve is opened, the gas CO in the first bulb and gas O_2 in the second bulb would mix and react completely according to the following reaction:

$2\ CO_{(g)} + O_{2\,(g)}$? $2\ CO_{2\,(g)}$

After reaction take place completely, the gas in both bulbs consist of :

A. CO, O_2 and CO_2
B. CO and CO_2
C. O_2 and CO_2
D. only CO_2

Answer C
Solution
5 mole CO equivalent to 2.5 mole O_2
There is an excess of O_2, therefore all CO reacts completely
The gas after reaction consists of : CO_2 and unreacted O_2,

==

3. Mars' period (the time needed for one revolution about the Sun) is 684 days (Earth-days). Find the force on the Mars (m_M = 6.59 x 10^{23} kg) due to the gravitational attraction of the Sun (m_S = 1.99 x 10^{30} kg), if the distance of the Earth from the Sun is 1.50 x 10^{11} m. The universal gravitation constant G is 6.67 x 10^{-11} Nm^2/kg^2.

A. 5.82 x 10^{20} N
B. 1.09 x 10^{21} N
C. 1.68 x 10^{21} N
D. 8.96 x 10^{21} N

Answer : C

Solution:

$$\text{From Kepler's third law}: \frac{r_{mars-sun}}{r_{earth-sun}} = \left(\frac{T_m}{T_E}\right)^{2/3}$$

$$= \left(\frac{687}{365}\right)^{2/3}$$

$$= 1{,}52$$

$$\text{so} \quad r_{mars-sun} = 1.52 \times r_{earth-sun} = 1.52 \times 1.5 \times 10^{11} m$$

$$= 2{,}28 \times 10^{11} m$$

The force on the Mars due to the Sun is:

$$F_{ms} = G\frac{m_m m_s}{r_{ms}^2} = \frac{(6.67 \times 10^{-11} N.m^2/kg^2)(m_m \times m_s)}{r_{ms}^2}$$

$$= \frac{8.73 \times 10^{43} Nm^2}{(2.28 \times 10^{11} m)^2}$$

$$= 1.68 \times 10^{21} N$$

==

4. A baby boy was born with a hemophilia disease. What is the possibility of his parents' gene related to this disease?

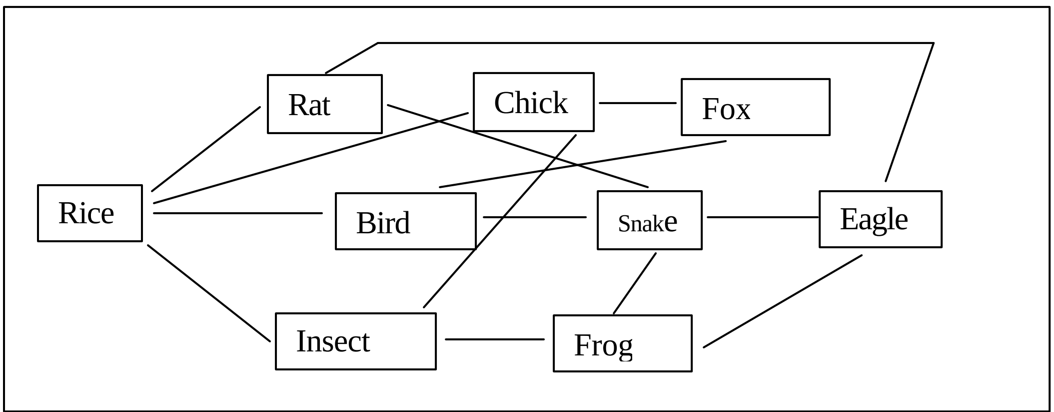
A. The mother is hemophilia, the father is normal
B. The mother and father are both hemophilia
C. The mother carries hemophilia gene
D. The father carries hemophilia gene

Answer: C.

The mother is a carrier of hemophilia gene but she is not hemophilia (hemophilia is lethal for women if it is homozygote)

==

25. Look at the picture carefully! The secondary and the tertiary consumers are:



B. Frog, eagle
C. Snake, eagle
D. Fox, snake

Answer : C

Primary consumer: herbivore; Secondary Consumer : carnivore 1; Tertiary consumer: consumer 2;

INTERNATIONAL JUNIOR SCIENCE OLYMPIAD
Jakarta - Indonesia
December 5-14,2004

THEORETICAL EXAMINATION
December 9, 2004

EXAMINATION RULES

1. All competitors must be present at the front of examination room ten minutes before the examination starts
2. No competitors are allowed to bring any tools except his /her personal medicine or any personal medical equipm ent.
3. Each competitor has to sit according to his or her designated desk.
4. Before the examination starts, the competitor has to check the stationary and tools (pen, eraser, ruler, sharpener, pencil, calculator, and note book) provided by the organizer.
5. Each competitor has to check the question and answer sheets. Rise your hand, if you find any missing sheets. Start after the bell.
6. The competitor must write down their name and country (in Latin) on each answer sheets. The answer must be written on one side of the answer sheet.
7. During examination, competitors are not allowed to leave the examination room except for emergency case and for that they will be accompanied by the examination supervisor.
8. The competitors are not allowed to bother other competitor and disturb the examination. If assistance is needed, competitor may raise his/her hand and the supervisor will come to help.
9. There will be no question or discussion about the examination problems. The competitor must stay at their desk until the examination time is over, although he/she has finished the examination or does not want to continue working.
10. The end of the examination time will be a signal (bell rings). You are not allowed to write anything on the answer sheet after the allotted time has finished. All competitors must leave the room quietly. **The question and answer sheets must be left on your desk.**

INTERNATIONAL JUNIOR SCIENCE OLYMPIAD
Jakarta - Indonesia
December 5-14,2004

THEORETICAL EXAMINATION
December 9, 2004

Read carefully the following instructions:

1. The time available is 2.5 hours.
2. Check that you have a complete set of the test questions and the answer sheet.
3. Use only the pen provided.
4. Write down your name, country and signature in the answer sheet.
5. The question must be answered on one side of the answer sheet.
6. Use 3 significant figures in your results.
7. **All competitors are not allowed to bring any stationary and tools provided outside. After completing your answer, all of the question and answer sheets you must put them on desk.**

THEORETICAL EXAMINATION December 9, 2004	**Name**		**Signature:** **JUROR**
	Country		

ANSWER SHEET (1/16)

PROBLEM I (10 Points)

IA. Human Digestive Systems (6 Points)

1.

a	g	2	1

2.0 Points

2.

g	8 or 6	6 or 8	f or d	d or f

2.0 Points

3.

c	9	7	3	g

2.0 Points

IB. Plant's structure

1.Monocots

a	b	d	e	f

2.0 Points

2.Dicots

c	g	h	i	j

2.0 Points

THEORETICAL EXAMINATION
December 9, 2004

Name		**Signature:**
Country		

ANSWER SHEET (2/16)

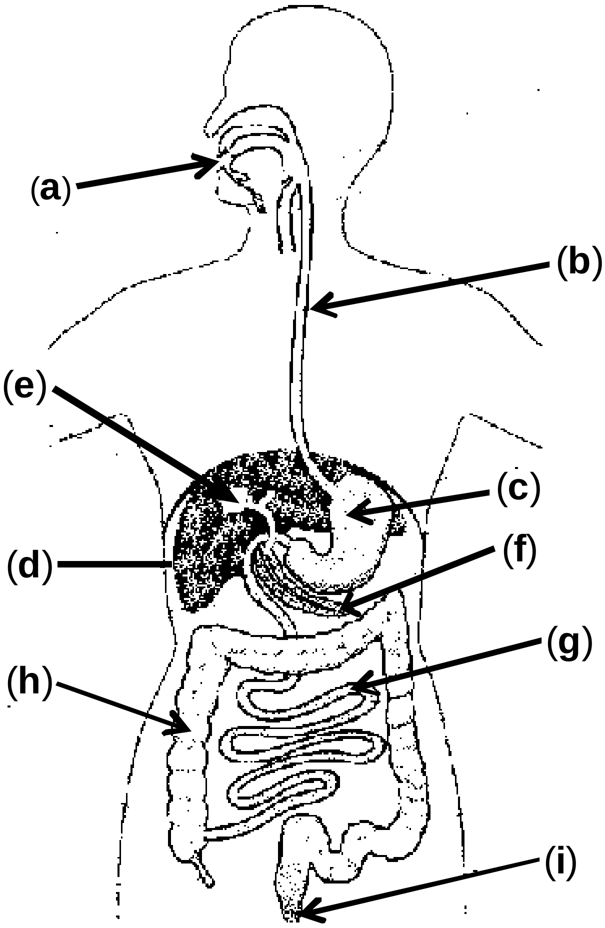
THEORETICAL EXAMINATION
December 9, 2004

Problem I . (***10 points***)

I.A Human digestive system. (***6 points***)

The diagram and the table below show the organs and enzymes or compounds in the human digestive system.

Number	Enzyme or Compounds
1	Amylase
2	Ptyalin
3	Trypsin
4	Maltase
5	aminopeptidase
6	Bile salts
7	HCl
8	Lipase
9	Pepsin



Fill the box with the correct **letter/s** (organs) and **number/s** (enzyme/s or compound/s):

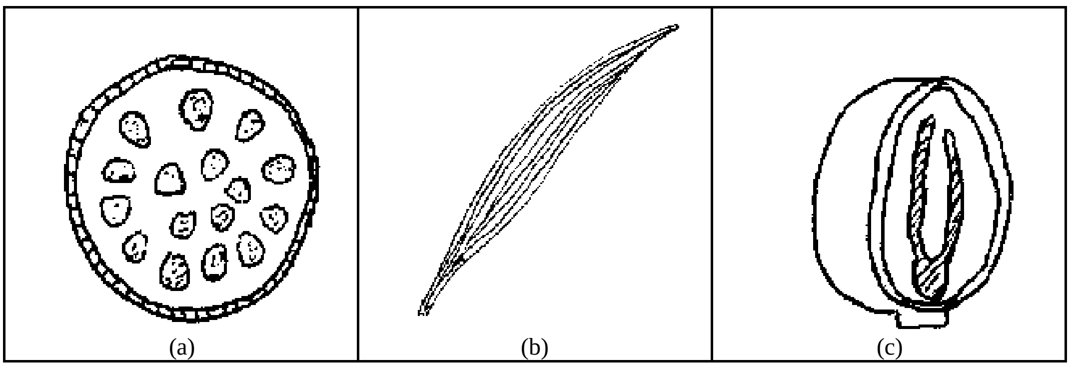
A person eats a meal containing carbohydrates, fats, and proteins.

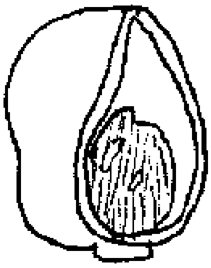
1. Carbohydrates are broken down into disaccharides in the organs …..….and …..…, by enzymes or compound …….. and ……... , respectively. (*2 points*)

2. Fats can be broken down into fatty acids and glycerol in the organ …………...…. by the enzymes or compounds …….…and ………, which are produced by the organs ……..… and ………... , respectively. (*2 points*)

3. Proteins in a meal are first digested in the organ ……..…. by the enzyme or compound ..………..... ,which is activated by enzyme or compound ……………. The resulting products are further digested into oligopeptides by the enzyme or compound …………. produced in the organ .... (*2 points*)

IB. The plant structures (the sketch is not the real size). (*4 points*)

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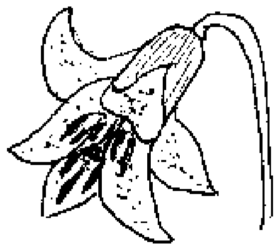
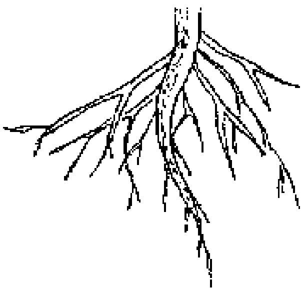
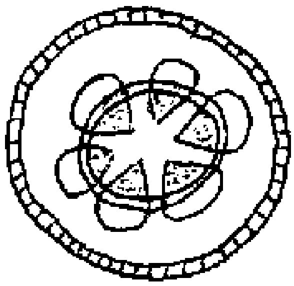
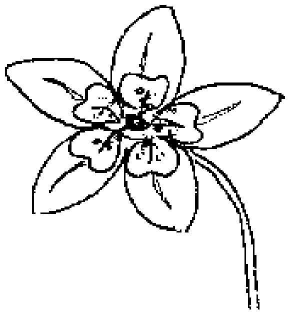

(e)


(f)


(g)


(h)


(i)


(j)

Fill in a box for appropriate plant's organs of:

1. Monocots : (***0.4 x 5 = 2 Points***)
2. Dicots : (***0.4 x 5= 2 Points***)

Problem II. (***10 points***)

A policeman was sitting in his car at rest when a robber's car passed by with a constant velocity of 120 km/h (at time t = 0 s, position S = 0 m), neglecting the length of the cars. He tried to catch the robber but it took 3 s to start moving his car. The police car moved with a constant acceleration and took 20 s to get a velocity of 200 km/h. After that the police car drove behind the robber with this velocity.

The robber saw him and tried to drive away by increasing his car velocity 5 seconds after the police car started to move. He reached his maximum car velocity of 150 km/h within 10 s with a constant acceleration. After that he moved with this maximum velocity.

(Show all your calculation steps)

1. Calculate the car velocity and acceleration as a function of time for those cars (the robber's and police cars) in SI (System International) units. (***2 Points***)
2. Draw the graphs of velocity and acceleration as a function of time for the cars. (***2 Points***)
3. Determine the position of the cars as a function of time. (***2 Points***)
4. Draw the graph for question No. 3 (the position of the cars as a function of time). (***2 points***)
5. When and at which position will the police car overtake the robber's car? (***2 Points***)

Problem III. (***10 points***)

III.A (***5 points***)

Combustion reaction of glucose ($C_6H_{12}O_6$) produces carbon dioxide gas.

The occurring reaction is:

$$C_6H_{12}O_6(aq) + 6\,O_2\,(g) \longrightarrow 6CO_2\,(g) + 6\,H_2O\,(l)$$

(Show all your calculation steps)

1. Calculate the energy produced when 1 mole of glucose is oxidized.

   $[?H^o_{reaction} = ?H^o_{products} - ?H^o_{reactants}]$ (***2 points***)

2. Calculate the volume of air (25^0C, 1 atm) needed to oxidize 10.0 g of glucose

   (Oxygen content in air is 21.0 % volume) (***2 points***)

3. Calculate the volume of dry carbon dioxide gas produced in the combustion of 10.0 g glucose at temperature 37^0C and pressure at 1 atm.

(PV = nRT) (***1 point***)

Data: Enthalpy formation (? H_f^o) of glucose = - 1273 kJ mol^{-1}

? H_f^o $CO_2(g)$ = - 393.5 kJ mol^{-1}

? H_f^o $H_2O(g)$ = - 271.8 kJ mol^{-1}

? H_f^o $H_2O(l)$ = - 285.8 kJ mol^{-1}

? H_f^o $O_2(g)$ = 0 kJ mol^{-1}

Universal gas constant, R = 0.0821 liter.atm.mol^{-1} K^{-1}

Volume of 1 mole gas at 25 °C, 1 atm = 24.5 liters

III.B (***5 points***)

10.0 milliliters of basic solution, $X(OH)_2$, is titrated with 0.100 M hydrogen chloride (HCl) solution using bromothymol blue as an indicator. When 8.00 ml of HCl solution was added, the color of the indicator was immediately changed

(Show all your calculation steps)

1. Calculate the molar concentration (C_X) of the basic solution, $X(OH)_2$ (***1.5 points***)
2. What is the pH of the solution at the equivalent point? (***0.5 point***)
3. What is the color of solution at the end point of titration (the colors of bromothymol blue are yellow at pH<6 and blue at pH>7.6). (***0.5 point***)
4. Predict the period and group of the metal X in the periodic table. Mass of $X(OH)_2$ in 10.0 ml solution is 0.0685g (***2 points***)
5. What metal is X? (***0.5 point***)

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Solut ions for THEORETICAL EXAMNINATION

PROBLEM I (10 Points)
IA. Human Digestive Systems (6 Points)

1.

a	g	2	1

2.0 Points

2.

g	8 or 6	6 or 8	g or d	d or g

2.0 Points

3.

c	9	7	3	f

2.0 Points

IB. Plant's structure

1.Monocots

a	b	d	e	f

2.0 Points

2.Dicots

c	g	h	I	j

2.0 Points

Problem II (10 points)

Conversion: 1 km/h = 5/18 m/s

(1) The velocities and accelerations as function of time **(2 Points)**

Robber's car

At time: 0s < t ? 8s ✍ constant speed

$v_r(t)$ = 120 km/h = 33.33 ms^{-1}

$a_r(t)$ = 0 ms^{-2} **(1/3 Points)**

At time: 8s < t ? 18s ✍ constant acceleration

$v_r(8)$ = 33.33 ms^{-1}

$v_r(18)$ = 150 km/h = 41.67 ms^{-1}

a_r=(41.67-33.33)ms^{-1}/(18-8)s=0.83 ms^{-2}

$v_r(t)$ =33.33+0.83(t -8) **(1/3 Points)**

At time: t >18s ✍ constant speed

$v_r(t)$ = 41.67 ms^{-1} **(1/3 Points)**

Police car

At time: 0s < t ? 3s ✍ at stop condition

v_p = 0 ms^{-1}

a_p = 0 ms^{-2} **(1/3 Points)**

At time: 3s < t ? 23s ✍ constant acceleration

$v_p(3)$=0 ms^{-1}

$v_p(23)$ = 200 km/h = 55.56m/s

a_p=(55.56-0) ms^{-1}/(23-3)s=2.78 ms^{-2}

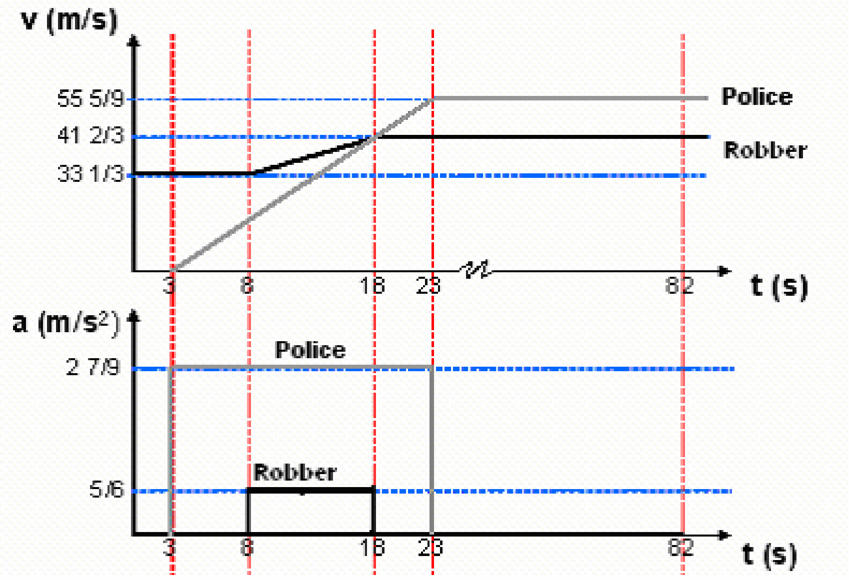
$v_p(t)$ = 55.56+2.78(t -23) **(1/3 Points)**

At time: t > 23s ✍ constant velocity

a_p = 0 m/s^2.

$v_p(t)$ = 55.56m/s **(1/3 Points)**

(2) Figure of velocity and acceleration as a function of time **(2 points)**



(3) Position as a function of time **(2 points)**

Robber's car

At time: 0s < t ? 8s ✍ constant speed, $v_r(t)$ = 33.33 ms^{-1}

$S_r(t)$ = 33.33x t

$S_R(8)$=266.67 m **(1/3 points)**

At time: 8s < t ? 18s ✍ constant acceleration

$S_r(t)$=266.67+33.33x(t-8)+1/2 x 0.83 x $(t-8)^2$ **(1/3 points)**

$S_r(18)$=641.67 m
At time: t >18s ✍ constant speed
$S_r(t)$ = 641.67+41.67x(t-18) **(1/3 points)**

Police car

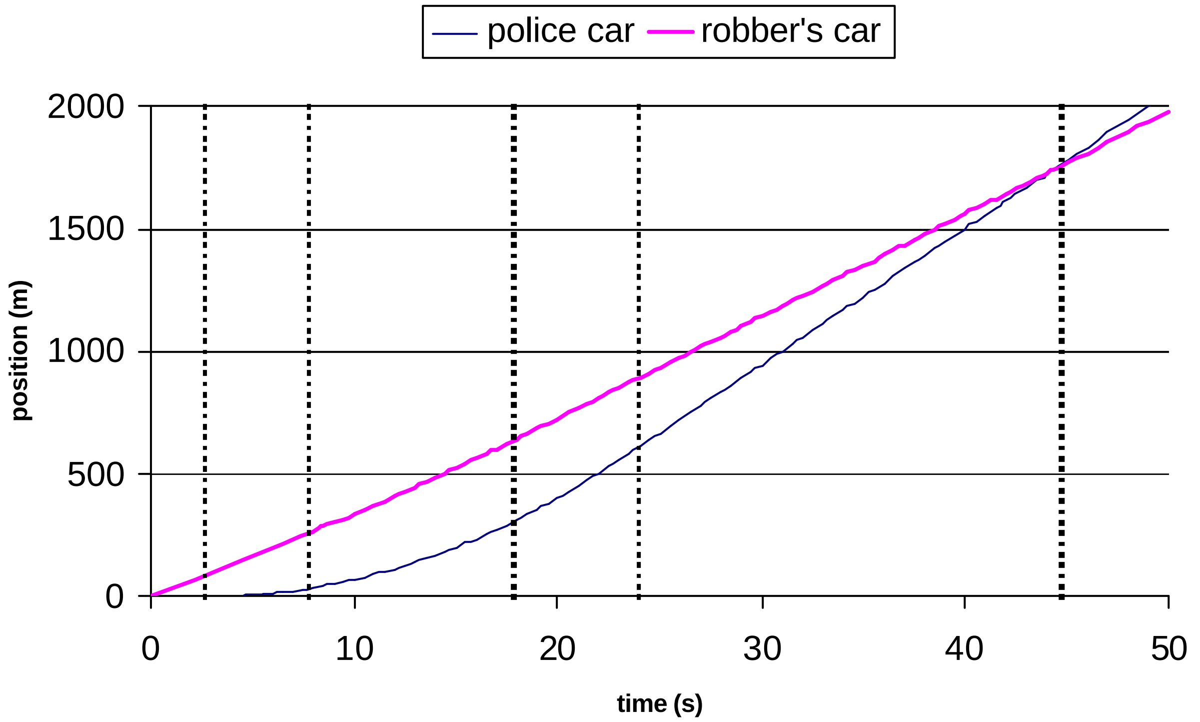
At time: 0s < t ? 3s ✍ at stop condition
$S_p(t)$ = 0 m **(1/3 points)**

At time: 3s < t ? 23s ✍ constant acceleration
$S_p(t)$ =1/2 x 2.83 x $(t-3)^2$
$S_p(23)$= 555.56 m **(1/3 points)**

At time: t >23s ✍ constant velocity
$S_p(t)$ = 555.56+55.56x(t-23) **(1/3 points)**

(4) Graph of positions vs time **(2 points)**

$S_r(t)$ = 33.33 x t; 0=t=8
$S_r(t)$=266.67 + 33.33 x (t-8) + 1/2 x 0.83 x $(t-8)^2$; 8=t=18s
$S_r(t)$ = 641.67 + 41.67 x (t-18); t>18s
$S_p(t)$ =0; 0=t=3s
$S_p(t)$ =1/2 x 2.83 x $(t-3)^2$; 3=t=23s
$S_p(t)$ = 555.56+55.56 x (t-23); t>23s



(5) Police car overtake the Robber's car **(2 points)**

$S_r(t)$ = 641.67+41.67x(t-18)
$S_p(t)$ = 555.56+55.56x(t-23);
Police car meets Robber's car when $S_p(t) = S_r(t)$

$$S_p(23)+ \frac{500}{9}(t ? 23) = S_r(18) + \frac{125}{12} ? (t ? 18)$$

$$555\tfrac{5}{9} + \frac{500}{9}(t ? 23) = 641\frac{2}{3} ? \frac{125}{3} ? (t ? 18)$$

$$555\tfrac{5}{9} ? \frac{11500}{9} ? \frac{500}{9}t ? 641\tfrac{2}{3} ? \frac{125}{3}t ? \frac{2250}{3}$$

$$(\frac{500}{9} ? \frac{375}{9})t ? \frac{6500}{9} ? \frac{1925}{3} ? \frac{6750}{9}$$

$$\frac{125}{9}t ? \frac{5525}{9}$$

t = 44.2s **(1 point)**

at position,

$$S_p(44.2) = 555\tfrac{5}{9} ? 55\tfrac{5}{9} ? (t ? 23) ? 1733\tfrac{1}{3} \text{ m}$$

$$S_r(44.2)= 641\tfrac{2}{3} ? 41\tfrac{2}{3} ? (t ? 18) ? 1733\tfrac{1}{3} \text{ m}$$ **(1 point)**

Alternatively for (5)

All calculations start from t = 23s
Position can be calculated from the area under graph v vs t:
Police car meets Robber's car when $S_p(t) = S_R(t)$

$$555\tfrac{5}{9} + \frac{500}{9}t = \frac{800}{3} ? \frac{(18?8)}{2} ? \frac{100}{3} ? \frac{125}{3} ? ? \frac{125}{3}(23 ? 18) ? \frac{125}{3}t$$

$= \frac{2550}{3} ? \frac{125}{3}t$

t = 21.2s **(1 point)**

Therefore, total time required to chase the robber is 23s + 21.2s = 44.2s

At position,

$S_p = 555\frac{5}{9} ? 55\frac{5}{9} ? t ? 1733\frac{1}{3}$ m

$S_r = \frac{2550}{3} ? \frac{125}{3}t = 1733\frac{1}{3}$ m **(1 point)**

Alternatively for (5)

All calculations start from t = 23s

Relative velocity at t=23s, $V_{rel} = (55\frac{5}{9} ? 41\frac{2}{3})\text{m/s} = \frac{125}{9}$ m/s

Position at t = 23s,

$S_p = 555\frac{5}{9}$ m

$S_r = \frac{800}{3} ? \frac{(18?8)}{2} ?\frac{100}{3} ? \frac{125}{3} ? ? \frac{125}{3}(23 ? 18) = \frac{2550}{3}$ m

Their relative velocity, $V_{rel} = 55\frac{5}{9} ? 41\frac{2}{3} ? \frac{125}{9}$ m/s

Relative positions, $S_{rel} = \frac{2550}{3} ? \frac{5000}{9} ? \frac{2650}{9}$ m

Time they meet, $t_{meet} = \frac{2650/9}{125/9} ? 21\frac{1}{5}$ s = 21.2 s

Therefore, total time required to chase the robber is 23s + 21.2s = 44.2 s **(1 point)**

At position,

$S_p = 555\frac{5}{9} ? 55\frac{5}{9} ? t ? 1733\frac{1}{3}$ m

$S_r = \frac{2550}{3} ? \frac{125}{3}t = 1733\frac{1}{3}$ m **(1 point)**

In Summary:

Time T (s)	Robber				Police			
	v (km/h)	v (m/s)	a (m/s2)	S (m)	v (km/h)	v (m/s)	a (m/s2)	S (m)
0	120	$33\,1/3$	0	0	0	0	0	0
3	120	$33\,1/3$	0	100	0	0	$0 - 2\,7/9$	0
8	120	$33\,1/3$	$0 - 5/6$	$266\,2/3$				
18	150	$41\,2/3$	$5/6 - 0$	$641\frac{2}{3}$				
23	150	$41\,2/3$	0	850	200	$55\,5/9$	$2\,7/9 - 0$	$555\,5/9$
$44\frac{1}{5}$	150	$41\,2/3$	0	$1733\frac{1}{3}$	200	$55\,5/9$	0	$1733\frac{1}{3}$

Problem III. (10 points)

III.A (5 points)

1. **(2 point)**

$C_6H_{12}O_6(aq) + 6\ O_2(g)$ ______________ $6\ CO_2\ (g) + 6\ H_2O\ (l)$

$?H^o_{reaction} = (6\ ?H_f^oCO_2 + 6?H_f^o\ H_2O) - (?H_f^oC_6H_{12}O_6 + 6\ ?H_f^oO_2)$ **(1 point)**

$?H_{reaction} = [6(-393.5) + 6\ (-285.8)] - (-1273)$ **(0.5 point)**

$?H_{reaction} = (-2361-1714.8) + 1273$

$?H_{reaction} = -2802.8 ? 2803\ kJ.mol^{-1}$ **(0.5 point)**

2. **(2 points)**

$C_6H_{12}O_6(aq) + 6\ O_2(g)$ ______________ $6\ CO_2\ (g) + 6\ H_2O\ (l)$

Mol glucose = $\frac{10}{(6 ? 12 ? 12 ? 1 ? 6 ? 16)} ? \frac{10}{180} ? 0.0556$ mol **(0.5 point)**

O_2 is needed = (6 x 0.0556) = 0.333 mol **(0.5point)**

The volume of air (V_{air}) = ($\frac{100}{21.0}$ x 0.333 mol x 24.5 liters.mol^{-1})

= 38.8 liters **(1 point)**
or
=38,9 liters

3. **(1 point)**

Volume of dry CO_2

PV = nRT ;

$$V \; ? \; \frac{nRT}{P}$$ **(0.5 point)**

$$V \; ? \; \frac{0.333 ? \; 0.0821 ? \; 310}{1} \; ? \; 8.47 \text{ liters}$$ **(0.5 point)**

or: V = 8.47 – 8.49 liters

IIIB: (5 points)

1. **(1.5 points)**

10 ml $X(OH)_2$ solution is titrated with 8 ml of 0.1 M HCl.

Molar concentration (C_M) of $X(OH)_2$ solution was 0.04 M

$X(OH)_2$ ~~X^{2+} + 2 O~~H^- **(0.5 point)**

$N_1 V_1 = N_2 V_2$

$2.C_M.10 = 8 \times 0.1$

$$C_M = \frac{8 ? 0.1}{2 ? 10} \; ? \; 0.04 \; M$$ **(1 point)**

2. **(0.5 point)**

pH of the solution at the equivalent point:

Since the $X(OH)_2$ is a strong base, after all base (OH^-) is neutralized, the pH of the solution is 7:

$X(OH)_2$ + 2HCl ~~XCl_2 +~~ $2H_2O$

at equivalent point, the concentration of OH^- = H^+

pH = 7 **(0.5point)**

3. **(0.5 point)**

At the end point the color of solution is green (green = yellow +blue)

The pH of solution at the end point is in between 6 -7.6. The color of solution is a mixture of yellow and blue, giving a **green** color. **(0.5 point)**

4. **(2 points)**

Mass of sample $X(OH)_2$, m = 0.0685 g

$$C_M \; ? \; ?\frac{m \; g}{M \; g.mol^{?1}}? ? \frac{1000 \; ml}{10 \; ml}$$ **(0.5 point)**

$$M = \frac{m}{C_M} ? \frac{1000}{10}$$

$$M = \frac{0.0685}{0.0400} ? \frac{1000}{10} \; ? \; 171 \; g.mol^{?1}$$ **(0.5 point)**

molar mass of $X(OH)_2$, M = 171 $g.mol^{-1}$
Relative mass of $X(OH)_2$= 171
Relative mass of X = 171 – (2·17) = 137 **(0.5 point)**
Element of X is in the **6^{th}** period and **IIA** (or **II**) group **(0.5 point)**

5. **(0.5 point)**

The metal is Ba (Barium) **(0.5 point)**

INTERNATIONAL JUNIOR SCIENCE OLYMPIAD
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EXPERIMENTAL EXAMINATION
December 11, 2004
EXAMINATION RULES

1. All competitors must be present at the front of examination room ten minutes before the examination starts
2. No competitors are allowed to bring any tools except his /her personal medicine or any personal medical equipment.
3. Each competitor has to sit according to his or her designated desk.
4. Before the examination starts, the competitor has to check the stationary and tools (pen, eraser, ruler, sharpener, pencil, calculator) provided by the organizer.
5. Each competitor has to check the question and answer sheets. Raise your hand, if you find any missing sheets. Start after the bell.
6. The competitor must write down their name and country (in Latin) on each answer sheets. The answer must be written on one side of the answer sheet.
7. During examination, competitors are not allowed to leave the examination room except for emergency case and for that the examination supervisor will accompany them.
8. The competitors are not allowed to bother other competitor and disturb the examination. If assistance is needed, competitor may raise his/her hand and the supervis or will come to help.
9. There will be no question or discussion about the examination problems. The competitor must stay at their desk until the examination time is over, although he/she has finished the examination or does not want to continue working.
10. The end of the examination time will be a signal (bell rings). You are not allowed to write anything on the answer sheet after the allotted time has finished. All competitors must leave the room quietly. **The question and answer sheets must be left on your desk.**

INTERNATIONAL JUNIOR SCIENCE OLYMPIAD
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December 5-14,2004

EXPERIMENTAL EXAMINATION
December 11, 2004

Read carefully the following instructions:

1. The time available is 3.5 hours.
2. Check that you have a complete set of the experimental instructions and the answer sheets.
3. On your desk, a complete set of the apparatus and experimental materials are already setup as described in the experimental instructions. Do not touch them before the examination starts.
4. Use only the pen provided.
5. Write down your name, country and signature on the answer sheet.
6. The question must be answered on one side of the answer sheet.
7. You should be careful in using the apparatus and materials:
   a. Glass is easily broken: Erlenmeyer flask, test tube
   b. NaOH, $Ba(OH)_2$: corrosive materials
   c. $Ca(OH)_2$: an irritant material
8. Error analysis is not necessary but you should consider appropriate significant figures.
9. Use the provided graph papers (5 sheets) for drawing your experimental results.
10. **All competitors are not allowed to bring any stationary and tools provided outside. After completing your answer, all questions and answers sheets you must put them on desk.**

EXPERIMENTAL EXAMINATION
December 11, 2004

Name		**Signature:**
Country		

ANSWER SHEET

OBSERVATION SHEET FOR BIOLOGY

1. [2.0 Point]
2. a. **(1.0 Point)**
   The maximum amount of sugar in 250 g salak:

   ……………. X ………… ...... g

= **(0.5 point)**

The maximum percentage of sugar content in salak in 1L solution of salak:

……………. X ………..	=	……%	**(0.5 point)**

b. (**2.0 Points**)

The real amount of sugar cane added to 1 L of salak solution:

………..X……….	…… g	**(0.5 point)**
………..X……….	…… g	**(0.5 point)**

Sugar content in the solution (maximum):

……………g + …………g	…… g	**0.5 point)**

Percentage of of total sugar (maximum) in 1 L salak solution which is used for fermentation on this experiment:

…………… x …………%	……….%	**(0.5 point)**

EXPERIMENTAL EXAMINATION December 11, 2004	**Name**		**Signature:**
	Country		

ANSWER SHEET

OBSERVATION SHEET FOR PHYSICS

1. The level of the palm oil in the U-tube when the right and left side is same: …………..…

2. The initial level of the palm oil:…………………..(t = 0 s)

OBSERVATION SHEET FOR PHYSICS

Table of Physics Experiment (2 Points)

No	**level (mm)**	**time (s)**	**V (m^3)**	**P (Pa)**			
1	……..	0					
2							
3							
4							

5							
6							
7							
8							
9							
10							
11							

EXPERIMENTAL EXAMINATION December 11, 2004	**Name**		**Signature:**
	Country		

ANSWER SHEET

OBSERVATION SHEET FOR CHEMISTRY

Section I (3.4 points)

1. Observation sheet (0.9 point)

Test Tubes	**Solution**	**Observation**	**Result**	
			Yes	**No**
A	$Ca(OH)_2$	is there any white precipitate?		
B	$Ba(OH)_2$	is there any white precipitate?		
C	NaOH	is there any white precipitate?		

2. The white precipitate(s) is(are) probably………. …….. **(0.5 point)**

3. The gas produced from fermented Salak fruit solution is probably ……… **(0.5 point)**

4. Reactions : . **(1.5 points)**

$Ba(OH)_2$ (aq) + ?

$Ca(OH)_2$ (aq) + ?

NaOH (aq) + ?

Section II (2.6 points)

1. Observation sheet: mark on the proper color (1.0 point)

Test Tube	**Indicator**	**Color changed to**		
D	Methyl orange	red	orange	yellow
E	Methyl red	red	orange	yellow
F	Bromothymol blue	yellow	green	blue
G	Phenolphthalein	no change	pink	red

2. The pH range of fermented Salak fruit solution is ……………………… **(1.0 point)**

3. Based on the pH range of the fermented Salak fruit solution, what is the product of fermentation (choose the true one of A, B, or C) **(0.6 point)**

A. acid

B. base

C. salt

INTERNATIONAL JUNIOR SCIENCE OLYMPIAD
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Experimental Examination

Please read carefully before you do the experiment

INTRODUCTION

The fruit in front of you, **Salak** or snake fruit (*Salacca edulis*), is an exotic fruit from Indonesia. This fruit is used as a raw material for making cider (fermented fruit juice) in this experiment. Its sugar content can be utilized as a part of carbon source in the fermentation process productions by a certain microorganism such as yeast. The cider contains alcohol. During the fermentation, a certain gas will be produced.

BIOLOGY
(5 points)

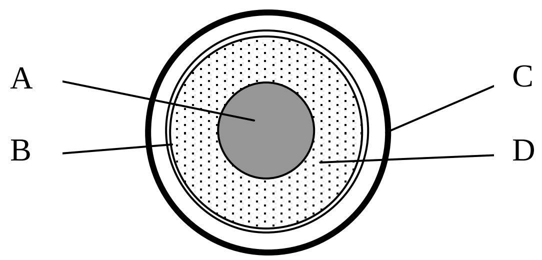
Problem

1. You are given **the whole** and **the cross section** of salak fruit. You are shown a drawing of a hypothetical fruit with complete parts of the fruit. You may peel off the hard covering of the fruit **carefully**. Split the segments of the fruit and peel off the thin semi-transparent layer. Observe the other parts of the fruit. Draw and label schematically the cross section of the salak fruit in front of you by using the notation in column I correspond to the data in column II of Table 1.
(2.0 Points)

Table 1.

I	II
A	Seed
B	Mesocarp
C	Epicarp/ Exocarp
D	Endocarp
E	Endoderm

Hypothetical Fruit



2. The sugar content in the flesh of Salak is about 20% by mass. Pure extract of salak fruit juice was obtained from exactly 250 g of salak flesh. This extract was diluted to a final volume of 1 liter by adding water. A good taste of cider can be obtained by adding 15% (of mass) more of sugar cane to total of 1 liter of solution (by mass) during dilution process. Usually the purity of sugar cane is 97%. The density of solution is assumed to be one (1) g/cm^3.

Questions:

a. Calculate the initial maximum percentage of sugar in one liter of broth or solution of salak fruit (w/v). **(1.0 Point)**

b. What is the maximum % sugar in one (1) liter of Salak solution which is used for fermentation on this experiment? **(2.0 Points)**

PHYSICS

(9 Points)

The change of volume, pressure and the number of molecules of the gas produced in the fermentation process as a function of time can be measured and calculated.

Objectives:

a. To determine the change of volume of the gas as a product of fermentation process.
b. To determine the average production rate of the gas (in mol/s).

Apparatus and materials:

a. A set of U–tube filled with palm oil consists of a support with a scale and a plastic tube connected to a rubber stopper (left hand side of the readings are given in cm).
b. An Erlenmeyer flask of 100 mL
c. A stopwatch
d. A set of graph – paper
e. A cup of Vaseline grease
f. A fermented Salak fruit solution in an Erlenmeyer flask of 200 m

Note:

1 atm = 1.013 x 10^5 N/m^2
Ideal gas equation: PV = nRT
R is universal gas constant = 8.314 J.mol^{-1}.K^{-1}
g is acceleration of gravity = 9.81 m.s^{-2}
Diameter of the tube is 6.00 mm.
Density of the palm oil is 890 kg.m^{-3}.

Experimental procedure:

1. Write down the level of the palm oil on the U-tube scale on your observation sheet when the surface levels of the palm oil in the right and left side of the U-tube are equal.

   NOTICE: The left side of the U-tube is connected with a rubber stopper through a plastic tube.
2. Remove the balloon from the Erlenmeyer flask containing the fermented Salak fruit solution.
3. Pour carefully the solution into the Erlenmeyer flask (100 mL) up to 60 mL mark. You find a marker at the U-tube scale (metal ruler) at 50 cm scale (green marked). This marker is used for the value of total air volume (***v***) between the surface of the solution in Erlenmeyer flask (at 60 mL scale) and the scale of 50 cm on the U-tube, ***v* = 75.0 mL**.
4. Connect the rubber stopper to the Erlenmeyer flask and make sure there is no gas leakage. If necessary, use the Vaseline grease. You will observe the level change of the palm oil inside the U-tube.
5. Decide your initial time (t = 0 s) and record the level of the palm oil in the left side of the U-tube as the initial level. Write it on the table in the observation sheet.
6. Record the time required for every 10 mm level changes of the palm oil in the left side of the U-tube for 10 data on your observation sheet. **Do not touch Erlenmeyer flask during this experiment, because it will momentarily change the volume of the produced gas.**
7. **After you have finished the experiment, remove the rubber stopper from the Erlenmeyer flask.**
8. **Keep the remaining fermented solution for the chemistry experiment**

Questions:

1. Based on your initial level of the palm oil, calculate the initial gas volume from your experiment. [1 point]
2. Determine the change of volume of the gas with time using a suitable graph. [2.5 points]
3. Determine the average production rate (mol/s) of the gas from the fermentation process by using a suitable graph. In this experiment, assume that the gas is an ideal gas. Use the room temperature is 27.0^{o}C for your calculation. [3.5 points]

   (For correct measurement results: [2 points])

   (Give all steps including formulas to answer the questions). Use the available table to answer the questions. You may use the blank columns.

For analyzing data, you have to use SI (system international) units

If you do not use SI units in all calculations, tables, graphs you will lose 0.25 point.

CHEMISTRY

(6 Points)

Objectives:

To identify the gas produced and to determine pH range of fermented salak fruit solution.

Apparatus and Materials:

No	Apparatus	No	Materials
1	Rubber stopper equipped with 3 plastic tubes (1)	1	Phenolpthalein
2	Test tubes (7)	2	Methyl red
3	Test tubes rack (1)	3	Methyl orange
		4	Bromothymol blue
		5	Calcium hydroxide (lime water)
		6	Sodium hydroxide (soda lime)
		7	Barium hydroxide
		8	Tissue paper

Be careful with the chemical solutions**!!!**

NaOH and $Ba(OH)_2$ are corrosive.

$Ca(OH)_2$ is irritant.

Section I. Identification of gas produced in fermentation (3.4 point)

Experimental procedure

1. On your experimental table, there are test tubes labeled as A, B, C and a rubber stopper equipped with 3 plastic tubes.
   a. Test tube A contains calcium hydroxide solution
   b. Test tube B contains barium hydroxide solution and
   c. Test tube C contains sodium hydroxide solution.
2. Take the remaining fermented salak fruit solution in the 100 mL Erlenmeyer flask from previous experiment. Plug in tightly the Erlenmeyer flask with a rubber stopper equipped with 3 plastic tubes. Immerse each plastic tubes to test tube A, B and C respectively. Make sure that the plastic tube is immersed properly in each basic solution. If there is a gas leakage, spread thin Vaseline grease to the surface of the rubber stopper.
3. Shake gently the Erlenmeyer and observe the reaction between the bubbling gas and basic solutions in the test tubes for about 5 minutes.

Questions

1. Write down your observation in the table. **(0.9 point)**
2. Based on your observation between gas and basic solution, predict what the precipitated compound(s) is (are) **(0.5 point)**
3. Based on your observation, predict the gas produced by the fermentation process. **(0.5 point)**
4. Write down the balanced equation of the reaction occurred in each basic solution. **(1.5 points)**

Section II . Identification of pH of fermented solution (2.6 point)

Experimental procedure

In plastic bottles, there are four acid-base indicators, namely: phenolphthalein, bromothymol blue, methyl red, and methyl orange. Take 4 test tubes those are labeled D,E,F and G.

1. Fill the test tubes (D, E, F, G) with the fermented salak solution about one third of tube volume.
2. To each solutions, add five drops of indicators and shake gently.
3. Observe the color of solution in each test tube (use data of pH range indicators below):

Indicator	Range of pH	Changes in color
Methyl orange	3.1 – 4.4	red to yellow
Methyl red	4.4 – 6.2	red to yellow
Bromothymol blue	6.0 – 7.6	yellow to blue
Phenolphthalein	8.3 – 10.0	colorless to pink

Questions

1. Write down your observation in the table. (1.0 point)
2. Based on the color of indicator in the solutions , predict the pH range of fermented Salak fruit solution. (1.0 point)
3. Based on the pH of fermented Salak fruit solution, what is one of the fermented products? (0.6 point)
   - **a. acid**
   - **b. base**
   - **c. salt**

INTERNATIONAL JUNIOR SCIENCE OLYMPIAD
Jakarta - Indonesia
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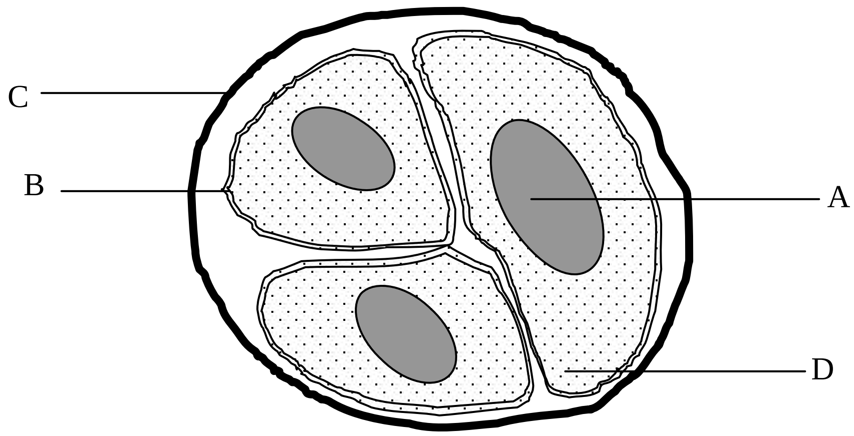
Solutions for EXPERIMENTAL EXAMNINATION

BIOLOGY

1. [2.0 Points]



2. a. **(1.0 Point)**

The maximum amount of sugar in 250 g salak:

20/100 X 250 g	=	50 g	(0.5 point)

The maximum percentage of sugar content in salak in 1L solution of salak:

50g/1000 g X 100%	=	5 %	(0.5 point)

b. (**2.0 Points**)

The real amount of sugar cane added to 1 L of salak solution:

15/100 X 1,000 g	=	150 g	(0.5 point)
97/100 X 150 g	=	145 g	(0.5 point)

Sugar content in the solution (maximum):

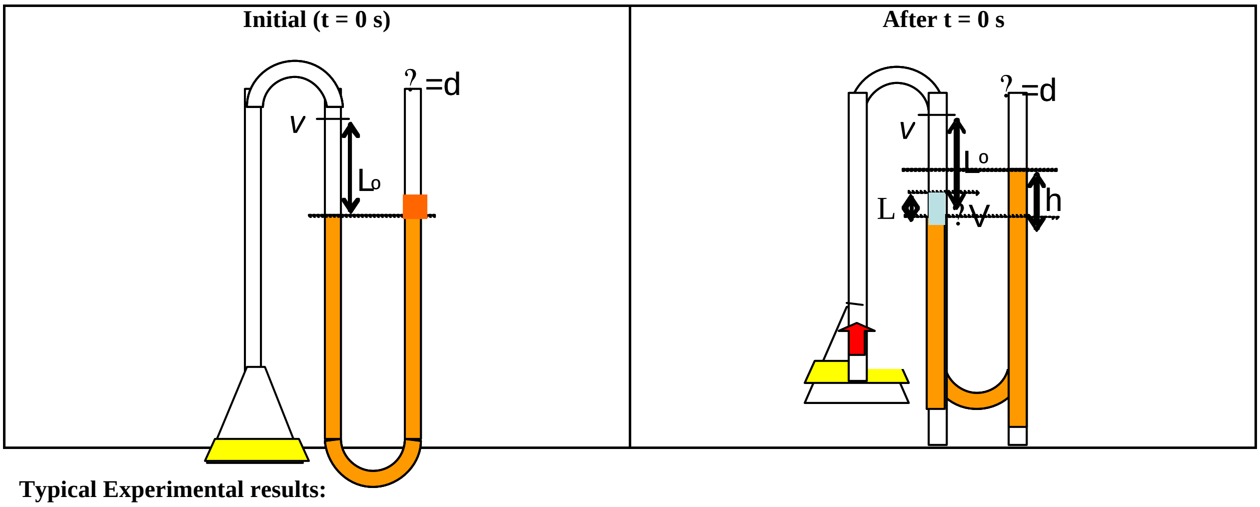
145 g + 50 g	=	195 g	(0.5 point)

Percentage of total sugar (maximum) in 1 L salak solution which is used for fermentation on this experiment:

195 g/1,000 g x 100 %	=	19.5 %	(0.5 point)

Physics

Solution:
Total Mark = 9.0 Points



Typical Experimental results:

1. **[0.0 Point]** Level of the palm oil when the level in right and left side is same. Depend on the experimental set up.
   31.0 cm

2. **[0.0 Point]** The initial level of the palm oil (t = 0s). Depend on student's experiment.
   L_o = 21.0 cm

3. **[1 Point]** Formula for initial volume: $V_{initial} = v + \{(?d^2/4)\ L_o\}$, L_o is the length between *v* and the initial level (t = 0 s)
   $V_{initial}$ = 0.000083 m^3

4. **[0.5 Point]** Formula for the total gas pressure: $P = P_o + ?gh$

   where: P_o = pressure of the atmosphere, ? = density of the palm oil.

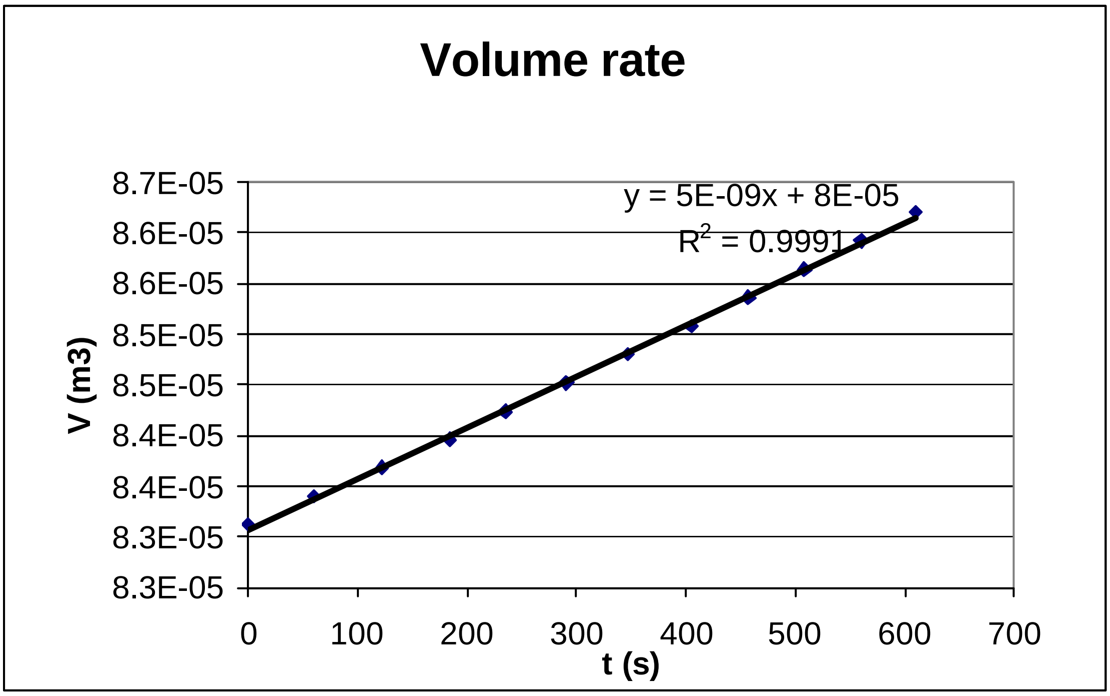
   [2 Points] Tabel of Physics Experiment

Start: 10:30

No.	h (cm) (left side)	T (s)	V (m3)	P(Pa)	PV(J)
0	21.0	0	0.0000831	1.030E+05	8.57
1	20.0	60	0.0000834	1.032E+05	8.61
2	19.0	122	0.0000837	1.034E+05	8.65
3	18.0	184	0.0000840	1.036E+05	8.70
4	17.0	235	0.0000842	1.037E+05	8.74
5	16.0	291	0.0000845	1.039E+05	8.78
6	15.0	347	0.0000848	1.041E+05	8.83

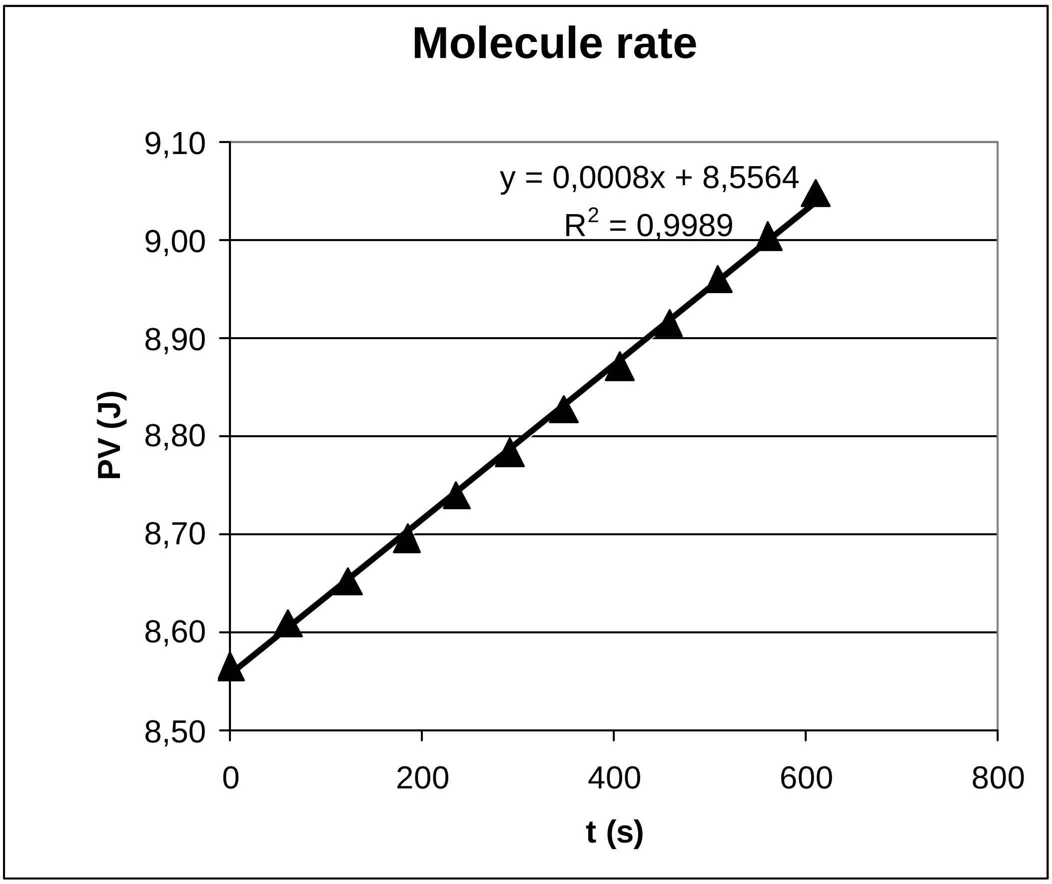
7	14.0	405	0.0000851	1.043E+05	8.87
8	13.0	457	0.0000854	1.044E+05	8.92
9	12.0	508	0.0000856	1.046E+05	8.96
10	11.0	560	0.0000859	1.048E+05	9.00
11	10.0	610	0.0000862	1.050E+05	9.05

5. **[1 Point]** A graph of Volume (m^3) vs. Time (s) in a graph-paper.



6. **[1 Point]** Idea of determining Volume rate of the gas, ? V/? t , gradient of the graph of V vs. t.
7. **[0.5 Point]** Gas volume rate: ? V/? t = 5.05 E-09 m^3/s.

8. **[1 Point]** A graph of PV (J) vs. time (s) in a graph-paper or any other suitable graph



9. **[1 Point]** Idea of determining the average gas production rate:

Ideal gas: PV = nRT , from the graph PV vs. t we find the gradient m, therefore PV = mt,
so, nRT = mt ? ? n/? t = m/RT.

10. **[1 Point]** Average gas production rate: ? n/? t = 4.34 E-07 mol/s.

Chemistry

Section I (3.4 points)

1. Observation sheet (0.9 point)

Test Tubes	Solution	Observation	Result	
			Yes	No
A	$Ca(OH)_2$	is there any white precipitate?		
B	$Ba(OH)_2$	is there any white precipitate?		
C	NaOH	is there any white precipitate?		

2. The white precipitate(s) is(are) probably………. …….. **(0.5 point)**
3. The gas produced from fermented Salak fruit solution is probably ……… **(0.5 point)**

4. Reactions : . **(1.5 points)**

$Ba(OH)_2$ (aq) + ?

$Ca(OH)_2$ (aq) + ?

NaOH (aq) + ?

Section II (2.6 points)

1. Observation sheet: mark on the proper color (1.0 point)

Test Tube	Indicator	Color changed to		
D	Methyl orange	red	orange	yellow
E	Methyl red	red	orange	yellow
F	Bromothymol blue	yellow	green	blue
G	Phenolphthalein	no change	pink	red

2. The pH range of fermented Salak fruit solution is ………………………….. **(1.0 point)**

3. Based on the pH range of the fermented Salak fruit solution, what is the product of fermentation (choose the true one of A, B, or C) **(0.6 point)**

A. acid
B. base
C. salt