Physics

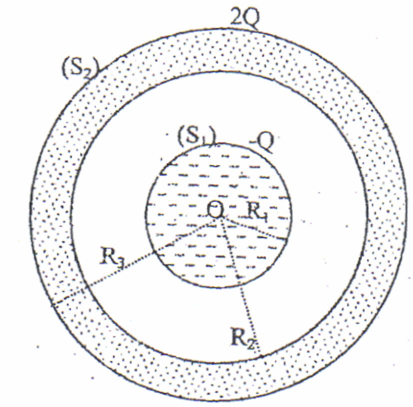
Lebanese University
Faculty of medical sciences
Faculty of Dentistry
Faculty of pharmacy

Le 30/9/2003

Entrance exam
Academic second year 2003-2004
Physics - duration 1 h

I- [7 pts]

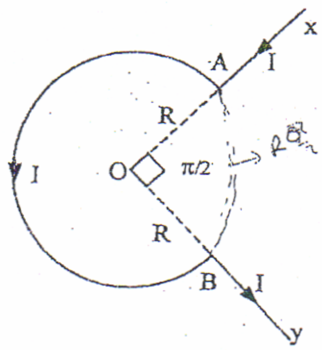
Given the bulk spherical conductor (S_1) of radius R_1 having the charge $-Q$ (Q being positive). A second spherical conductor (S_2) of internal radius R_2 and of external radius R_3, initially having on its external surface the charge 2Q. (S_1) and (S_2) are concentric.



1. Determine the characteristics of the electric field vector at a point M so that $OM = r$ with $r > R_3$.
2. Give the repartition of the charges on (S_2).
3. Indicate, without calculation, the direction and the sense of the electric field between (S_1) and (S_2).

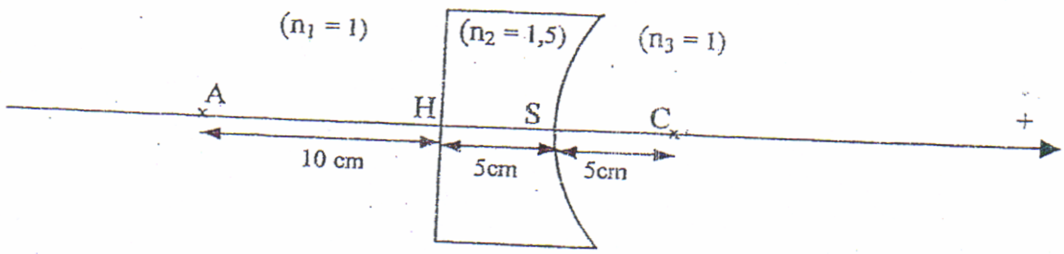
II- [6 pts]

Given the adjacent conductor traversed by a constant electric current I.
Determine the characteristics (direction, sense and magnitude) of the magnetic field at the point O.



III- [7 pts]

Given the optical system indicated in the figure below.



1. Determine the position of the image focus F' of the system.
2. Determine the position and the nature of the image A' of a point object A situated at a distance 10 cm in front of the system.

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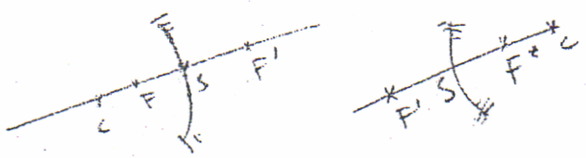
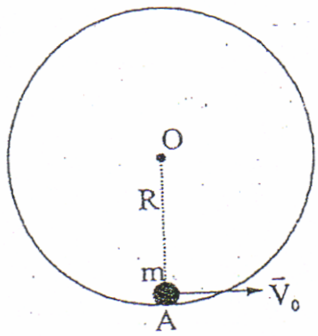
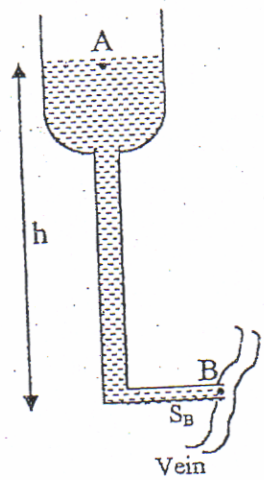


IV- A marble m is launched horizontally with an initial velocity $V_0 = 9$ m/s from the lowest point A of a circular vertical frictionless loop of radius $R = 2$ m. Does the marble complete the entire round of the loop? (given: $g = 10 m/s^2$) (8 pts)



V- The blood bottle in a blood transfusion is at a constant average height $h = 1m$ above the vein of a patient where the pressure is $P_0 + \Delta P$
(P_0= normal atmospheric pressure = $10^5 p_a$, $\Delta P = 2000\ p_a$)
given : $S_B = 0.1mm^2$, $S_A = 20cm^2$, $\rho_{blood} = 1200\ kg/m^3$, $g = 10m/s^2$

1- Show that V_A is very small with repect to V_B.
2- Knowing that the blood is an ideal fluid, determine the speed V_B of the blood at B.
3- Find the volume (in liters) of blood passing through the vein during 1 hour. (6 pts)

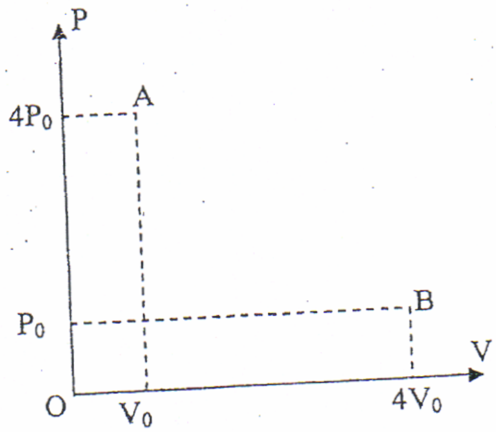


$\gamma = 1.41$
$l = 2$

VI- One mole of a diatomic ideal gas passes from the state A to the state B as in the adjacent figure.

Given: $C_p = \frac{7}{2}R$, $C_v = \frac{5}{2}R$

1) Compare between the temperatures T_A and T_B. Deduce the nature of the simplest transformation between A and B.
2) The cycle is completed with an isobaric process followed by an adiabatic process. Draw the corresponding cycle.
3) Find the variation of entropy between A and B in terms of R. (6 pts)



LEBANESE UNIVERSITY

FACULTY OF MEDICAL SCIENCES

FACULTY OF DENTAL MEDECINE

FACULTY OF PHARMACY

Date: 9/10/2002

ENTRANCE EXAM SECOND YEAR
ACADEMIC YEAR 2002-2003

Subject: Physics

Time: 1 hour

I- [5 pts]

The position of a point-mass M of 2 kg, moving in an horizontal plane (xoy) is given by:

$$x = 2\cos t$$
$$y = 3\sin t$$

Determine:

a) The trajectory of M.

b) The instantaneous velocity and acceleration OF M.

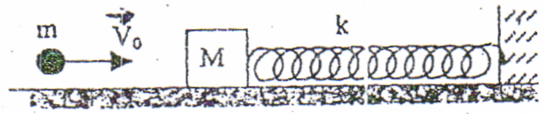
c) The force $\vec{F}$ producing this motion.

d) The moment $\vec{M}$ of $\vec{F}$ with respect to the origin.

-What can you say about the angular momentum of M with respect to the origin?

II. [8 pts]

A bullet of mass m = 50 g is fired with an initial speed V_0 against a block of mass M = 950 g initially at rest, attached to the extremity of a spring of constant k = 2400N/m.



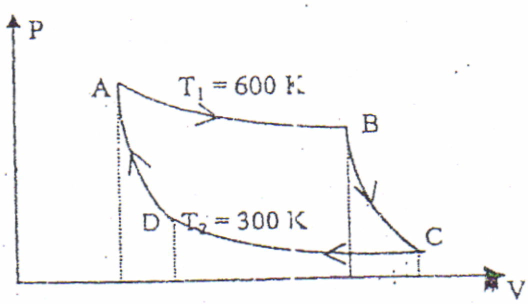
The bullet collides with the block, and stuck with it just after collision, the system moves with an initial velocity $\vec{V}$, compressing the spring by a maximum of x_0=40cm.

a) Knowing that a constant friction force f = 20N, works against the motion of the system, find the speed V of the system just after collision.

b) Find the initial speed V_0 of the bullet.

III. [7 pts]

An ideal gas describes the figured Carnot-Cycle.



a) Find the nature of the transformations AB, BC, CD and DA.

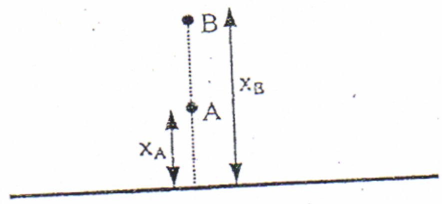
b) Knowing that the work of AB-transformation is: $|W_{AB}| = 1200$ J, deduce the value of Q_{AB}.

c) Find the efficiency of the cycle. Deduce Q_{CD}.

d) Find ΔS_{AB}

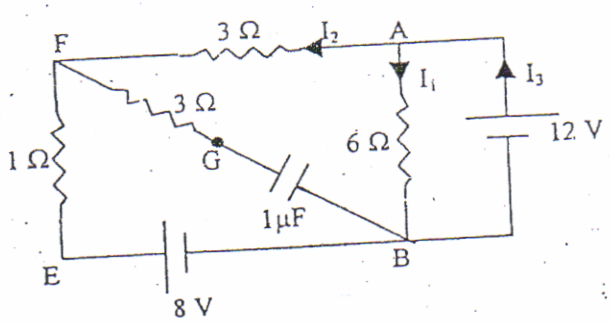
IV. [7 pts]
An indefinite plane is uniformly charged on its surface with a charge density $\sigma > 0$.

a. Use Gauss' theorem to determine the electric field at a point M situated at a distance x away from the plane.
b. Deduce the potential difference between two points A ans B situated respectively at x_A and x_B from the plane.

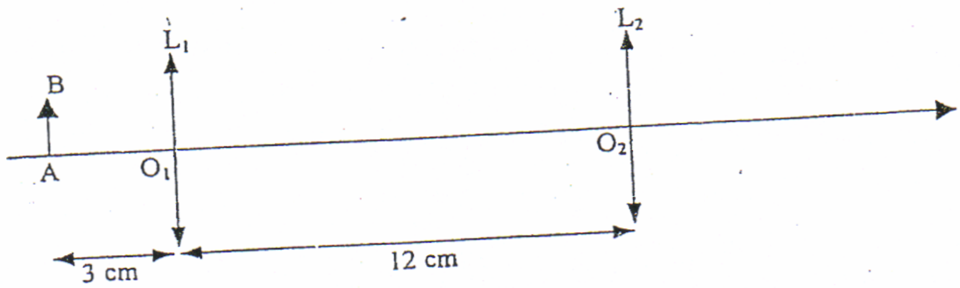


V. [6 pts]
Consider the circuit of the adjacent figure:

Determine, at equilibrium (standing mode), the currents I_1, I_2, I_3, and the charge of the capacitor.



VI. [7 pts]
A luminous object AB = 1 cm is placed at 3 cm in front of a converging lens (L_1) of focal length 2 cm; a second converging lens (L_2) of focal length 3 cm is placed at 12 cm from (L_1) as indicated.
Find the position, nature and size of the final image given by the system.



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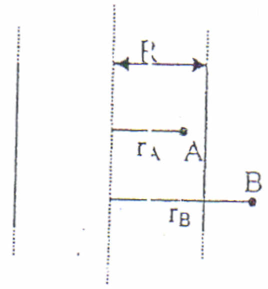
LEBANESE UNIVERSITY
Faculty of Medical Sciences

Date: 28/9/2004
Duration: 1 h

Entrance exam for the 2nd year
of the academic year 2004-2005
Subject: Physics

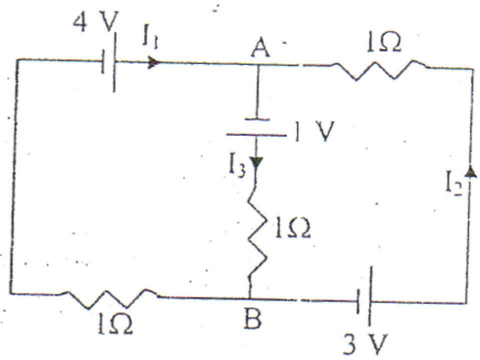
I- [6 pts]

An infinite cylindrical conductor, of radius R, is uniformly charged over its surface by a positive surface charge density $\sigma > 0$.
Determine the electric field at points A and B inside and outside the cylinder, respectively.



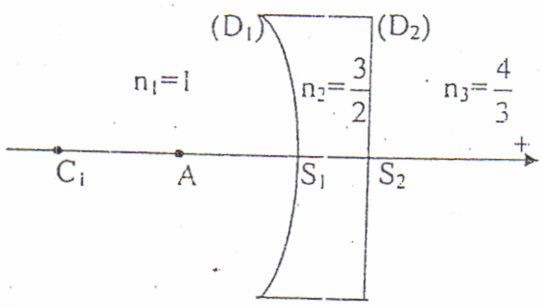
II- [7 pts]

Consider the circuit shown in the adjacent figure.
1. Determine the value of the current in each branch of the circuit.
2. Deduce the electric potential difference between points A and B.



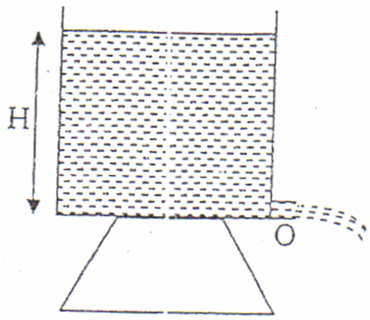
III- [7 pts]

The optical system of the adjacent figure consists of a spherical diopter (D_1), of radius of curvature 10 cm and of center of curvature C_1, and of a plane diopter (D_2). The distance between S_1 and S_2 is 3 cm.
1. Determine the object focus F of the system.
2. Find the position and the nature of the image A' of a point object A placed at 5 cm from S_1.



IV- [5 pts]

A tank, of large cross-sectional area, contains water (ideal liquid). A hole, of cross-section area $s = 1\ cm^2$, is made at a point O at the bottom of the tank as shown in the adjacent figure. The water flows out of the hole with a volume flow rate $Q = 5\times10^{-4}\ m^3/s$.
1. Calculate the speed of flow of water at point O.
2. Calculate the value of the initial height H.
3. If water is replaced by another ideal liquid, does the speed of flow change?
Take: $\rho_{water} = 1000\ kg/m^3$ and $g = 10\ m/s^2$.



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V [7 pts]

One mole of a diatomic ideal gas ($C_p = \frac{7}{2}R$, $C_V = \frac{5}{2}R$) passes from a state A to a state B.

($P_B = \frac{P_A}{2}$) through an isochoric transformation during which the gas loses a quantity of heat equal to 375 R; R being the universal gas constant.

1. Calculate T_B.
2. The gas then undergoes an isothermal expansion BC, followed by an adiabatic compression CA. Draw the corresponding cycle of the transformations.
3. Calculate, in terms of R, the work W_{CA}.

VI- [8 pts]

A ball (A), of mass m, is released without initial velocity from a height h and moves along a frictionless track as shown in the adjacent figure. The ball (A) collides elastically with a block (B), of mass M = 2 m, attached to spring of constant K.

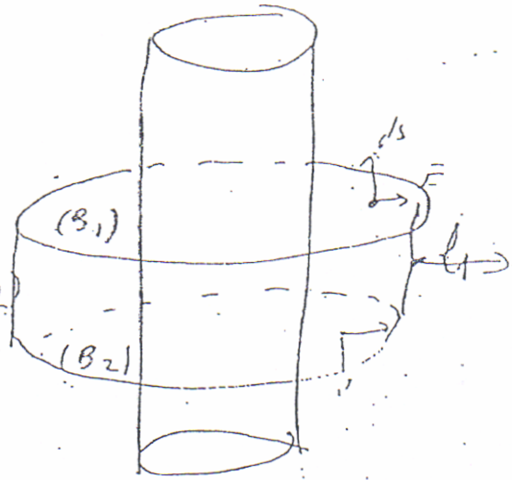
1. Determine, in terms of m, g and h, the velocity of (A) just before and just after the collision.
2. Determine the velocity of (B) just after collision. Deduce the maximum compression of the spring.

$\vec{E}$ radial ($\perp$ à l'axe) et ne dépend que de (r). $E = E(r)$

1) $r > R$:

$$\oint_{(\Sigma)} \vec{E}\,\vec{ds} = \frac{\sum q_i}{\varepsilon_0}$$

$$\underbrace{\int_{B_1} \vec{E}.\vec{ds}}_{\boxed{0}\ E\perp ds} + \underbrace{\int_{S_L} \vec{E}.\vec{ds}}_{\boxed{1}\ E//ds} + \underbrace{\int_{B_2} \vec{E}\,\vec{ds}}_{E\perp ds} = \frac{Q_i}{\varepsilon_0}$$

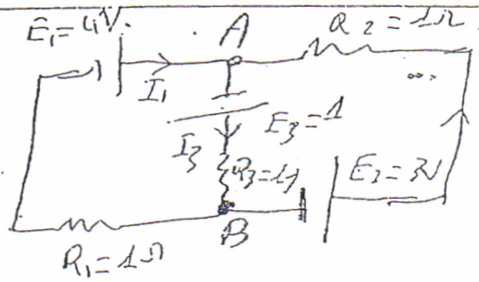


$$\int_{S_L} E\,ds = E \times 2\pi r h = \frac{Q_i}{\varepsilon_0} = \frac{1}{\varepsilon_0}(\sigma \times 2\pi R h) \quad \boxed{1}$$

$$\Rightarrow \boxed{E = \frac{\sigma R}{\varepsilon_0 r}} \quad \boxed{1}$$

2) $r < R$ $\quad Q_i = 0 \Rightarrow E \times 2\pi r h = 0 \Rightarrow E = 0$ $\boxed{1}$

) $\boxed{I_3 = I_1 + I_2}$ $\boxed{1}$



$A(E_1)BA \Rightarrow E_1 - R_1 I_1 - R_3 I_3 + E_3 = 0$

$+4 - I_1 - (I_1 + I_2) + 1 = 0$ $\boxed{1}$

$\Rightarrow \boxed{2I_1 + I_2 = 5}$ (1)

$A(E_2)BA \Rightarrow -R_2 I_2 + E_2 - R_3 I_3 + E_3 = 0 \Rightarrow$

$-I_2 + 3 - (I_1 + I_2) + 1 = 0$ $\boxed{1}$

(2) $\boxed{I_1 + 2I_2 = 4}$ $\times(-2) \Rightarrow \left.\begin{array}{l} -2I_1 - 4I_2 = -8 \\ (1)\ 2I_1 + I_2 = 5 \end{array}\right) \Rightarrow -3I_2 = -3$

$\boxed{I_2 = 1A}$

(2) $\Rightarrow I_1 = 4 - 2I_2 = 4 - 2 = 2A$

$\boxed{I_1 = 2A}$

$\Rightarrow I_3 = I_1 + I_2 = 3A$

$\boxed{I_3 = 3A}$

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) $V_A - V_B = E_1 - R_1 I_1 = 4 - 2 = 2V$ $\boxed{1}$

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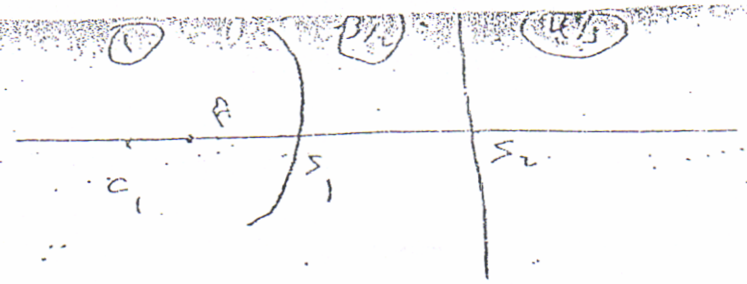

a- Foyer objet F:

$$F(1) \xrightarrow{D_1(S_1C_1)} F_1(3/2) \xrightarrow{D_2(S_2,C_2)} F_2(4/3)$$

* F_2 à l'∞ $\Rightarrow$ F_1 à l'∞

D * $\dfrac{1}{\overline{FS_1}} + \cancel{\dfrac{3/2}{\overline{S_1F_1}}} = \dfrac{3/2 - 1}{\overline{S_1C_1}} = \dfrac{1/2}{-10} \Rightarrow \boxed{\overline{FS_1} = -20\,cm}$

D

$$A(1) \xrightarrow{D_1(S_1C_1)} A_1(3/2) \xrightarrow{D_2(S_2)} A'(4/3)$$

$\dfrac{1}{\overline{AS_1}} + \dfrac{3/2}{\overline{S_1A_1}} = \dfrac{3/2 - 1}{\overline{S_1C_1}}$;

$\dfrac{1}{5} + \dfrac{3/2}{\overline{S_1A_1}} = \dfrac{1/2}{-10}$; $\dfrac{3}{2}\dfrac{1}{\overline{S_1A_1}} = -\dfrac{1}{20} - \dfrac{1}{5} = \dfrac{-5}{20} \Rightarrow$

D $\boxed{\overline{S_1A_1} = -6\,cm}$

$\overline{A_1A'} = \overline{A_1S_2}\left(1 - \dfrac{4/3}{3/2}\right) = (+6+3)\left(1 - \dfrac{8}{9}\right) = +1$

D $\boxed{\overline{A_1A'} = +1\,cm}$; $A' = A$ ou $\overline{S_2A'} = -8\,cm$

D image virtuelle

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1°/ $D = S_0 V_0 \Rightarrow V_0 = \frac{D}{S_0} = \frac{5\times 10^{-4}}{10^{-4}} = 5\,m/s.$ 1/2 pts 1/2 pts

2°/ Entre O et A :

3 pts

$$P_0 + \frac{1}{2}\rho V_0^2 + \rho g h_0 = P_A + \frac{1}{2}\rho V_A^2 + \rho g h_A$$ 1 pt

$P_A = P_0 = 1\,atm$ $\quad h_0 = 0$

$h_S = H$

or $S_0 V_0 = S_A V_A \Rightarrow V_A = \frac{S_0 V_0}{S_A} \rightarrow 0$ 1/2 pts

$$\Rightarrow \frac{1}{2}\rho V_0^2 = \rho g h_A = \rho g H$$

$$\boxed{H = \frac{V_0^2}{2g} = \frac{25}{2\times 10} = 1{,}25\,m.}$$ 1 pt 1/2 pt

3°/ Liquide parfait et $V = \sqrt{2gH}$ la vitesse ne depend pas de la masse volumique du liquide. 1 pt

III.

1/ $Q_{AB} = -\frac{1500}{4} R = n C_v (T_B - T_A)$ or $\frac{p_B \cancel{V_B}}{T_B} = \frac{p_A \cancel{V_A}}{T_A}$

$\frac{p_A}{2T_B} = \frac{p_A}{T_A}$

$-\frac{1500}{4} R = 1 \times \frac{5R}{2}(T_B - 2T_B)$

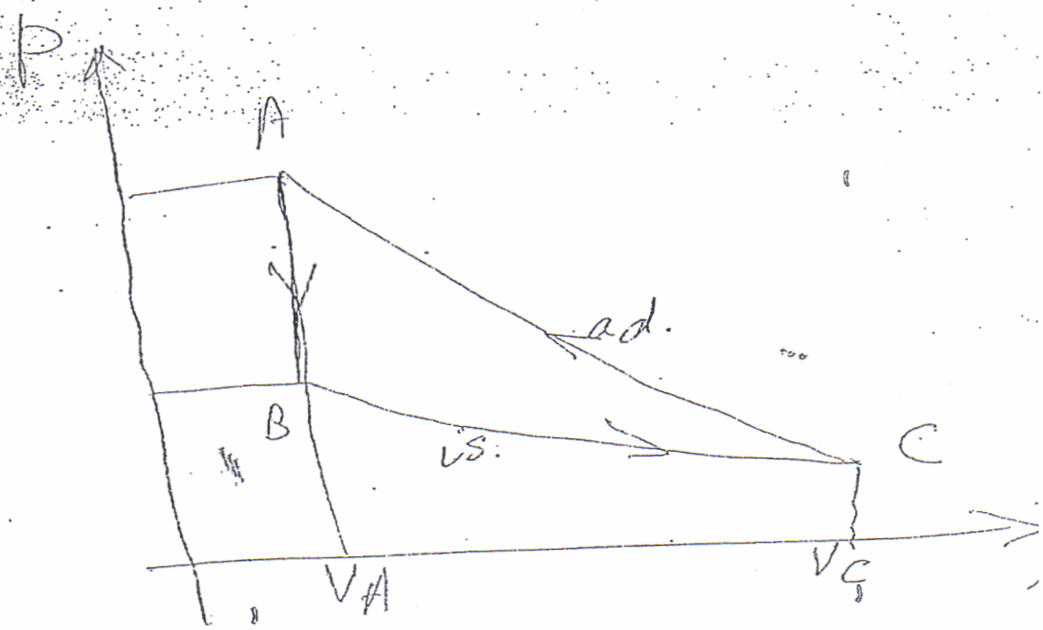
$= -\frac{5R}{2} T_B$

(1) $\Rightarrow T_B = \frac{T_A}{2}$ ou $T_A = 2T_B$

(2)

$T_B = \frac{1500}{2 \times 5} = 150\ °K$

2/



(2)

3/ $\underline{W_{CA}}$?

(2)

$\Delta U_{CA} = n C_v (T_A - T_C) = \cancel{Q_{CA}} + W_{CA}$

$1 \times \frac{5R}{2} (T_A - T_B) = W_{CA}$

$\frac{5R}{2} (2T_B - T_B) = W_{CA}$

$W_{CA} = \frac{5R}{2} (T_B) = \frac{5R}{2} \times 150 = \frac{750}{2} R =$

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I - Mechanics - solution.

1) for m : conservation of ME : (2pts)

$0 + mgh = \frac{1}{2} m V_1^2 + 0 \Rightarrow V_1 = \sqrt{2gh}$ before collision

• during collision / isolated system :

$\vec{P}_1 = \vec{P}_2 \Rightarrow m\vec{V}_1 + \vec{0} = m\vec{V}_1' + M\vec{V}_2$

$\vec{V}_1 = \vec{V}_1' + 2\vec{V}_2 \Rightarrow 2\vec{V}_2 = \vec{V}_1 - \vec{V}_1'$ (1)

Elastic: $\frac{1}{2} m V_1^2 + 0 = \frac{1}{2} m V_1'^2 + \frac{1}{2} M V_2^2$

$V_1^2 = V_1'^2 + 2V_2^2 \Rightarrow 2V_2^2 = V_1^2 - V_1'^2$ (2)

$\frac{(2)}{(1)} \Rightarrow \boxed{\overline{V_2} = \overline{V_1} + \overline{V_1'}}$ (3)

$2\overline{V_2} = \overline{V_1} - \overline{V_1'}$ (1)

$(3) \rightarrow 2\overline{V_2} = 2\overline{V_1} + 2\overline{V_1'}$

$2\overline{V_1} + 2\overline{V_1'} = \overline{V_1} - \overline{V_1'}$

$3\overline{V_1'} = -\overline{V_1} \Rightarrow \boxed{\overline{V_1'} = -\frac{\overline{V_1}}{3}} = -\frac{1}{3}\sqrt{\ }$ (2pts)

$\boxed{\overline{V_2} = V_1 - \frac{V_1}{3} = \frac{2}{3}}$

2) (spring + M) isolated system (2pts)

$V_2 = \frac{2}{3}\sqrt{2gh}$ (2pts)

$\frac{1}{2} K x^2 = \frac{1}{2} M V_2^2 \Rightarrow x = V_2\sqrt{\frac{M}{K}} = \frac{2}{3}\sqrt{\frac{2gh \cdot 2m}{K}}$

LEBANESE UNIERSITY

Faculty of Medicine, Dentistry and Pharmacy

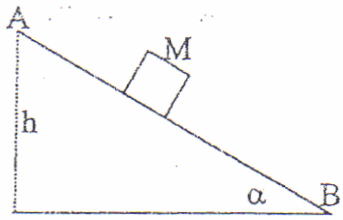
Time : 1 hour
Date : 31/10/2006

Entrance Exam to 2nd year
Academic year 2006-2007

Subject : Physics

I- [8 pts]

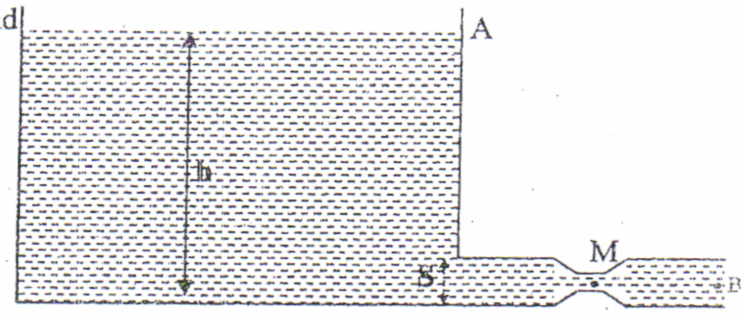
A block, of mass M, slides on a plane presenting a friction coefficient μ and inclined by an angle α with respect to the horizontal.



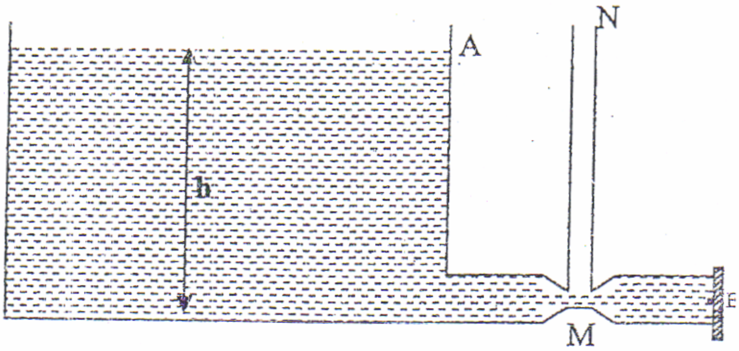
1. Starting from rest at point A, determine in terms of g, α, μ and h, the speed of the block at point B.
2. Deduce the relation between α and μ so that the block can slide.

II- [5 pts]

A tank of large section, of height $h = 20$ m and filled with water of density $\rho = 10^3$ kg/m^3, is connected to a horizontal tube of section S having a narrower section $s_M = \dfrac{S}{2}$.



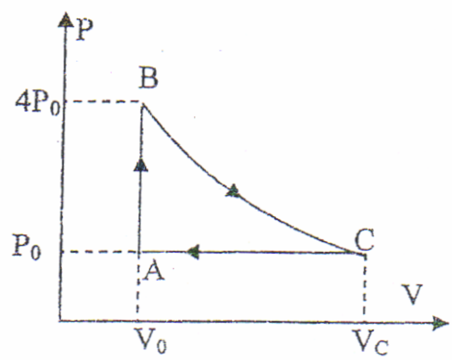
1. Calculate the speed of water at M. Take $g = 10$ m/s^2.



2. If we close the horizontal tube at B, at what height h' does the water rise up in the vertical tube MN open to air?

III- [7 pts]

One mole of a diatomic ideal gas ($C_P = 7/2\ R$ and $C_V = 5/2\ R$) performs the adjacent cycle of transformations in a Clapeyron diagram (P, V). Let T_0 be the temperature of the gas at state A.



1. Find V_C in terms of V_0 so that the transformation BC is isothermal.
2. Calculate, in terms of R and T_0, ΔU_{AB}, ΔU_{BC} and deduce ΔU_{CA}.

$$A(1) \xrightarrow{D_1(0)} A_1(3/2) \xrightarrow{D_2(S,C)} A_2(1)$$

$$\frac{1}{\overline{AO}} + \frac{3/2}{\overline{OA_1}} = \cancel{\frac{3/2}{}} = 0$$

$$\frac{1}{\overline{AO}} = -\frac{3}{2}\frac{1}{\overline{OA_1}} \Rightarrow \overline{OA_1} = \cancel{\ } = -\frac{3}{2} \times \overline{AO}$$

$$= -\frac{3}{2}\,10 = -15\,\text{cm}$$

$$\frac{3/2}{\overline{A_1OS}} + \frac{1}{\overline{SA_2}} = \frac{-1/2}{-10}$$

$$\frac{3/2}{30} + \frac{1}{\overline{SA_2}} = \frac{+1}{20}$$

$$\frac{1}{\overline{SA_2}} = +\frac{1}{20} - \frac{3}{60} = -\frac{6}{60} = 0$$

$$\overline{SA_2} = \cancel{-10\,\text{c}}$$

$$A_1 \to \infty$$

A_1 est le foy objet du syst don

$$A_0(1) \longrightarrow A_1(3/2) \xrightarrow{D_2(S,C)} F'(1)$$

$$A_1 \to \infty$$

$$\frac{3/2}{\infty} + \frac{1}{\overline{SF'}} = \frac{1-3/2}{-10} = -\frac{1/2}{-10} = +\frac{1}{2}$$

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$$\overline{SF'} = +20\,\text{cm}$$

Solution

1/ (D_1) : $\frac{1}{-10} = \frac{3}{2\overline{OA_1}} \Rightarrow 2\overline{OA_1} = -30 \Rightarrow \boxed{\overline{OA_1} = -15 \text{ cm}}$

$\Rightarrow \overline{SA_1} = -30 \text{ cm}$. (1)

/ (D_2) : $\frac{3}{2(-30)} - \frac{1}{\overline{SA'}} = \frac{0,5}{-10} = -\frac{1}{20}$ (2)

$\frac{1}{\overline{SA'}} = \frac{3}{-60} + \frac{1}{20} = \frac{-3+3}{60} = 0 \Rightarrow A' \to \infty$

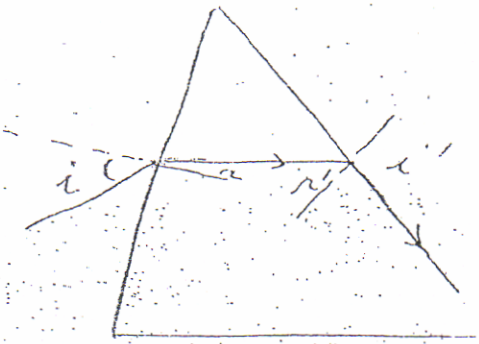
2/ ~~A se comporte comme étant le foyer objet du système~~

(1) $F \equiv A$ car $A' \to \infty$

$\infty \xrightarrow{(D_1)} \infty \xrightarrow{(D_2)} F'$ (1)

/ (D_2) : $\frac{3}{2(\infty)} - \frac{1}{\overline{SF'}} = \frac{0,5}{-10} = -\frac{1}{20}$

$\Rightarrow \boxed{\overline{SF'} = 20 \text{ cm}}$ (2)



1°)

$\sin i = \frac{3}{2} \sin r$ ①   1

$\sin i'' = \frac{3}{2} \sin r'$ ②

② $\Rightarrow \sin 90° = \frac{3}{2} \sin r' = 1$ 1

$\Rightarrow \sin r' = \frac{3}{2} \Rightarrow r' = 41{,}8°$

$r + r' = 60° \Rightarrow r = 18{,}2°$ 1

$\sin i' = \frac{3}{2} \sin 18{,}2 \Rightarrow$

$= 0{,}47 \Rightarrow$

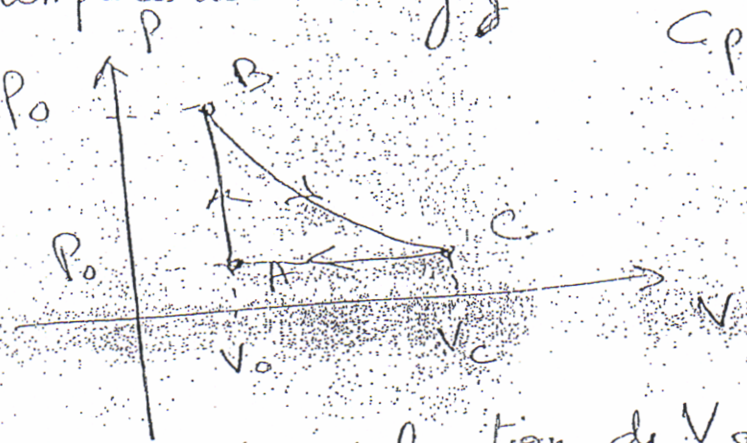
$\boxed{i = i'_m = 27{,}94°}$ 1

2°) Il faut que $i < i_m$ 1

38

5/5

III – Une mole d'un gaz parfait diatomique effectuant le cycle des transformations ci-contre dans le diagramme de Clapeyron (P,V). Soit T_0 la température du gaz à l'état A ; $C_p = \frac{7}{2}R$, $C_v = \frac{5}{2}R$



1°/ Trouver V_c en fonction de V_0 pour que la transformation BC soit isotherme.

2/ Calculer, en fonction de R et T_0, ΔU_{AB} ; ~~Variation~~ ΔU_{BC} et déduire ΔU_{CA}

(7 points)

2 1°/ BC isotherme $\Rightarrow P_B V_B = P_C V_C$
$4P_0 V_0 = P_0 V_C \Rightarrow$

$\boxed{V_C = 4V_0}$

2/ $\Delta U_{AB} \overset{1}{=} n C_v (T_B - T_A) = 1 \times \frac{5}{2}R(T_B - T_0)$

or $T_B = 4T_0$ $\Rightarrow$ 1 $\Delta U_{AB} = \frac{15}{2} R T_0$

1 $\Delta U_{BC} = 0$ car BC est isotherme

2 $\Delta U_{CA} = -\Delta U_{AB} = -\frac{15}{2} R T_0$ car $\Delta U_{cycle} = 0$.

(7 points)

II 1°/ Appliquons le théorème de Bernoulli entre A et B :

1 $P_A + \rho g h_A + \frac{1}{2}\rho V_A^2 = P_B + \rho g h_B + \frac{1}{2}\rho V_B^2$

or $P_A = P_0 = P_B$

1 et $V_A \longrightarrow 0$ Réservoir de très grande section

$h_B = 0 \Rightarrow \frac{1}{2}\rho V_B^2 = \rho g h_A$

1

$\Rightarrow V_B = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = \boxed{20\,m/s}$

or $S_B V_B = S_M V_M \Rightarrow V_M = \frac{S_B}{S_M} V_B$

1 $= 40\,m/s$.

1 2°/ Robinet fermé, l'eau est alors à l'état statique :

$h' = h_A = 20\,m$

(5 points)

Ou (1) $M\vec{a} = M\vec{g} + \vec{N} + \vec{f}$ (1)

proj (1) $Ma = Mg\sin\alpha - f$ et $f = \mu N = \mu Mg\cos\alpha$.

$Ma = Mg\sin\alpha - \mu Mg\cos\alpha$

(1) $a = g(\sin\alpha - \mu\cos\alpha) = c^{te}$

(1) $v = g(\sin\alpha - \mu\cos\alpha)t + \cancel{v_0}^{0}$

$v^2 - 0 = 2a \times AB$ et $AB = \frac{h}{\sin\alpha}$

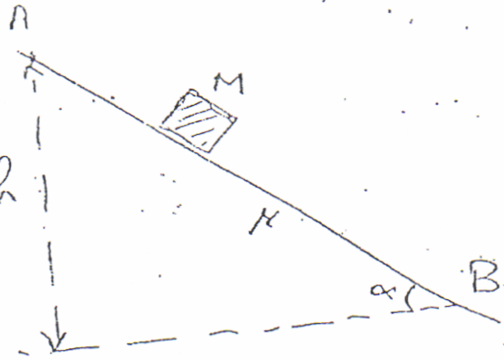
$= 2g(\sin\alpha - \mu\cos\alpha)\frac{h}{\sin\alpha}$

$= 2gh\left(1 - \mu\frac{\cos\alpha}{\sin\alpha}\right)$

(1) $v = \sqrt{2g\alpha}\sqrt{1 - \mu\frac{\cos\alpha}{\sin\alpha}}$

(2)

F

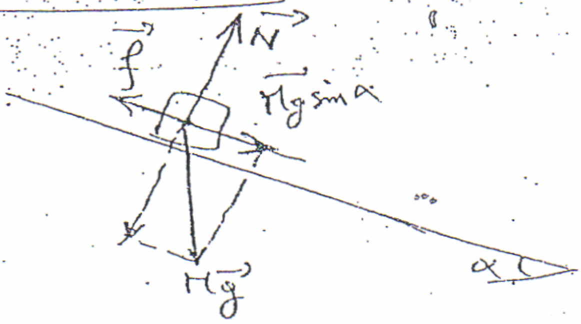


I – Un bloc de masse M glisse sur un plan ~~pre~~ présentant un coefficient de frottement μ, et incliné d'un angle α par rapport à l'horizontale.

Partant du repos d'un point A, déterminer en fonction de g, α, μ et h, la vitesse de ce bloc au point B.

– Déduire la relation entre α et μ pour que le mouvement soit possible. (8 points)

Sol. $A \longrightarrow B$



(1) $f = \mu N = \mu . Mg\cos\alpha$

(2) $\Delta E_m \Big)_A^B = W_{\vec{f}} = -f . AB$

$$\sin\alpha = \frac{h}{AB} \Rightarrow AB = \frac{h}{\sin\alpha}$$

B : origine des hauteurs

$$E_{mB} - E_{mA} = -f . AB$$

(2) $$0 + \frac{1}{2} M V_B^2 - (Mgh + 0) = -\mu . Mg . \cos\alpha . \frac{h}{\sin\alpha}$$

$$\Rightarrow V_B^2 = 2gh \left(1 - \mu . \frac{\cos\alpha}{\sin\alpha}\right)$$

(1) $$\boxed{V_B = \sqrt{2gh} \sqrt{1 - \mu \frac{\cos\alpha}{\sin\alpha}}}$$

– Possible si $\mu \frac{\cos\alpha}{\sin\alpha} < 1 \Rightarrow \boxed{\mu < tg\,\alpha}$

(1) (1)

LEBANESE UNIVERSITY
Faculty of Medicine, Dentistry and pharmacy

Date: 18/10/2007
Duration: 1 hour

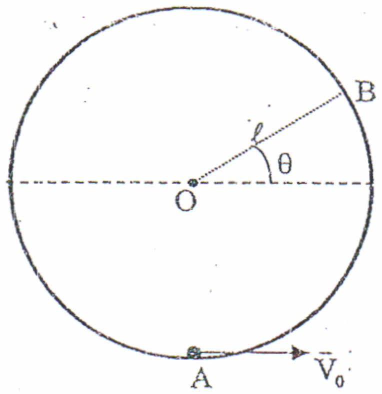
Entrance Exam – Academic Year 2007-2008

Physics

I- [8 points]

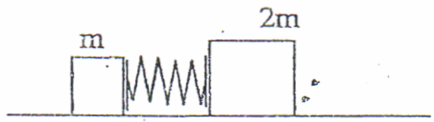
A particle of mass m is launched from point A with a velocity $\vec{V}_0$ inside a vertical circular track of radius ℓ.

1) Determine the speed of the particle at point B as a function of V_0, θ, ℓ and g.
2) For $V_0 = 6$ m/s and $\ell = 1$ m, determine the value θ_m of θ for which the particle leaves the track.



II- [4 points]

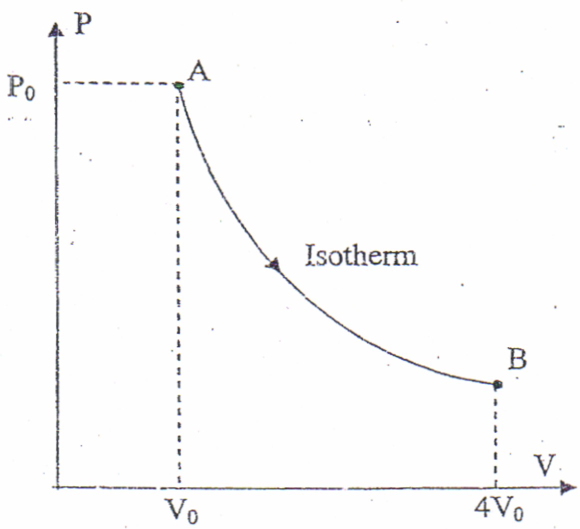
A massless spring of constant k is compressed by a distance x by two blocks of masses m and 2m. The two blocks are not attached to the spring. When the spring is released, the two blocks move in opposite directions. Applying the necessary laws of conservation, determine as a function of k, x and m the speed of each block just after the release.



III- [8 points]

One mole of an ideal diatomic gas undergoes an isothermal expansion AB from state A (V_0, P_0) to state B $(4V_0, \frac{P_0}{4})$ as shown in the adjacent figure.

1) After the isothermal expansion AB, the gas undergoes an isobaric compression BC followed by an adiabatic transformation CA. Sketch the two processes on the PV-diagram to complete the cycle ABCA.
2) If the expression of the work done during the AB expansion is $|W_{AB}| = 2 P_0 V_0 \ln 2$, determine Q_{AB}.
3) Calculate the variation in entropy ΔS_{AB}.
4) If the efficiency of the cycle is $\eta = \frac{1}{4}$, calculate Q_{BC}.



|3|

IV- [8 points]

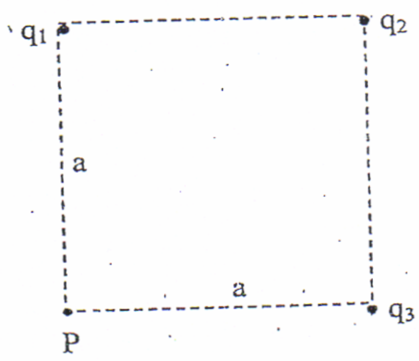
A straight wire of infinite length is uniformly charged with a linear charge density $\lambda > 0$.

1) Determine the electric field $\vec{E}$ at a point M situated a distance r from the wire.
2) A point charge $q < 0$ is placed at M. Determine the electric force $\vec{F}$ exerted on this point charge.

V- [4 points]

Consider the system formed of three point charges q_1, q_2 and q_3 placed at the vertices of a square as shown in the adjacent figure.

1) Determine the electric potential created by the system of charges at point P.
2) What is the work done by an external agent to bring a point charge q from infinity to the point P



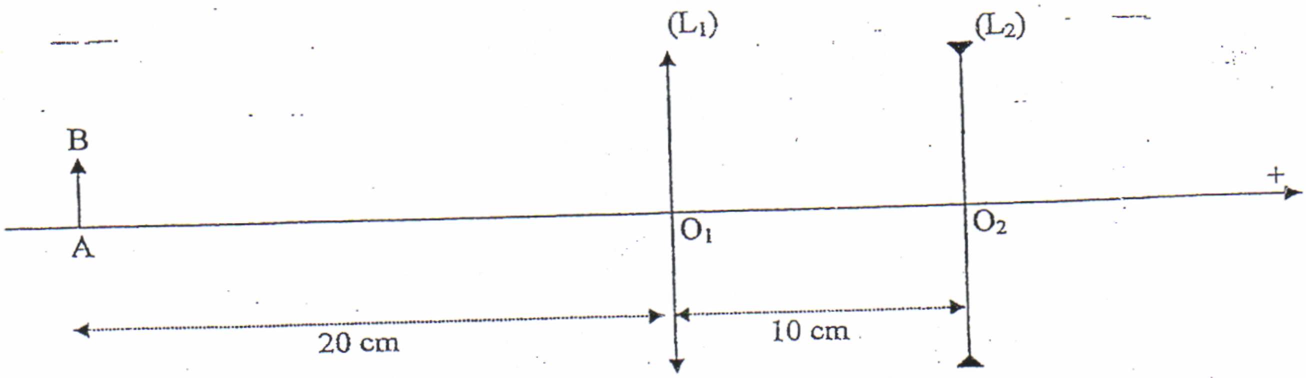
VI- [8 points]

The optical system shown in the below figure is formed of the following two lenses:

- Converging lens (L_1) of focal length 10 cm;
- Diverging lens (L_2) of focal length 5 cm.

A real object AB of size 1 cm is placed 20 cm in front of (L_1). The two lenses (L_1) and (L_2) are separated by a distance 10 cm.

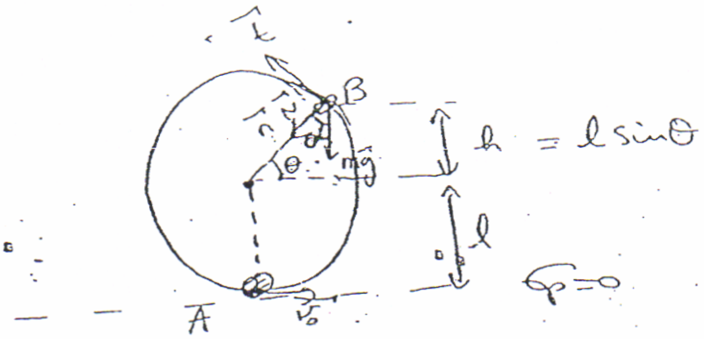
Determine the position, nature and size of the final image formed by the system.



Mécanique

$$\begin{cases} \sin\alpha = \cos\theta \\ \cos\alpha = \sin\theta \end{cases}$$

I



1) v_B ? $= f(v_0, g, l, \theta)$.

(1) Csvt de l'E_m entre A et B $\to E_A = E_B$

1 $\to \frac{1}{2} m v_0^2 = \frac{1}{2} m v_B^2 + mg(l+h)$

$\Rightarrow \frac{1}{2} m v_0^2 = \frac{1}{2} m v_B^2 + mgl(1+\sin\theta)$

1 $\Rightarrow \boxed{v_B^2 = v_0^2 - 2gl(1+\sin\theta)}$

2) si $v_0 = 6\,m/s$ et $l = 1\,m$. ⚠ faut-il peut être préciser que $\theta_m < \pi/2$.

θ_m?? En quel point la particule quitte l'anneau?

Soit C, ce point $\boxed{v_C^2 = v_0^2 - 2gl(1+\sin\theta_m)}$ (*)

PFD en C $\to m\vec{g} + \vec{N} = m\vec{a} \Rightarrow \begin{cases} \vec{t} \to -mg\cos\theta = ma_t \\ \vec{N} \to +mg\sin\theta + N = ma_n \end{cases}$ 1

La particule quitte la piste $\xrightarrow{1} N = 0$ (2) $\to mg\sin\theta_m = m$

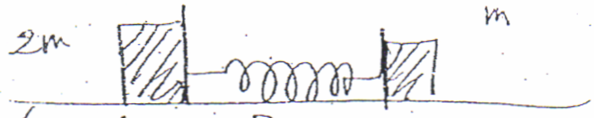
$\Rightarrow a_n = \frac{v_C^2}{l} = g\sin\theta_m$ 1

(*) $\Rightarrow g\sin\theta_m = \frac{v_0^2 - 2gl(1+\sin\theta_m)}{l} = \frac{v_0^2}{l} - 2g(1+\sin\theta_m)$ 1

44

$3g\sin\theta_m = \frac{v_0^2}{l} - 2g \Rightarrow \boxed{\sin\theta_m = \frac{v_0^2}{3gl} - \frac{2}{3}} = \frac{36}{30} - \frac{2}{3} = \frac{1,6}{3} \Rightarrow \theta$

II- Conservation de l'énergie ; $\frac{1}{2}$



(1) $\frac{1}{2}Kx^2 = \frac{1}{2}m v_1^2 + \frac{1}{2}(2m)\, v_2^2$

$$\boxed{Kx^2 = m v_1^2 + 2m v_2^2}$$

$\frac{1}{2}$ Conservation de la quantité de mouvement ;

(1) $m\vec{v}_1 + 2m\vec{v}_2 = \vec{0} \quad (\vec{P}_i = \vec{P}_f)$

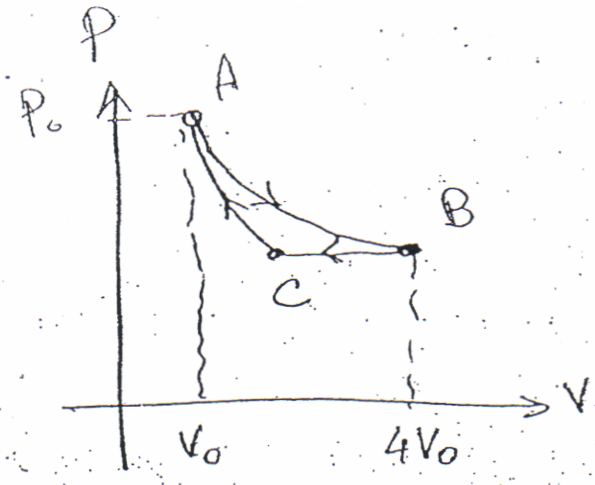
$$m v_1 = 2m v_2 \Rightarrow \boxed{v_1 = 2 v_2}$$

(1) $\Rightarrow v_1 = \sqrt{\dfrac{2Kx^2}{3m}}$

$$v_2 = \frac{1}{2}\sqrt{\frac{2Kx^2}{3m}} = \sqrt{\frac{Kx^2}{6m}}$$

III —

(2) 1°/ $\boxed{\text{figure}}$.



2°/ $|W_{AB}| = 2P_0V_0 \ln 2$

(2) $W_{AB} = -2P_0V_0 \ln 2$ (J)

$\Rightarrow W_{AB} + Q_{AB} = 0 \Rightarrow \boxed{Q_{AB} = +2P_0V_0 \ln 2}$ (J)

3°/ $\Delta S_{AB} = \int \frac{\delta Q}{T} = \frac{Q_{AB}}{T_0} = \frac{2P_0V_0 \ln 2}{T_0}$

(2) $\boxed{\Delta S'_{AB} = 2R \ln 2}$ J/K

4°/ $\rho = \frac{1}{4} = 1 + \frac{Q_{BC}}{Q_{AB}} \Rightarrow Q_{BC} = -\frac{3}{4} Q_{AB}$

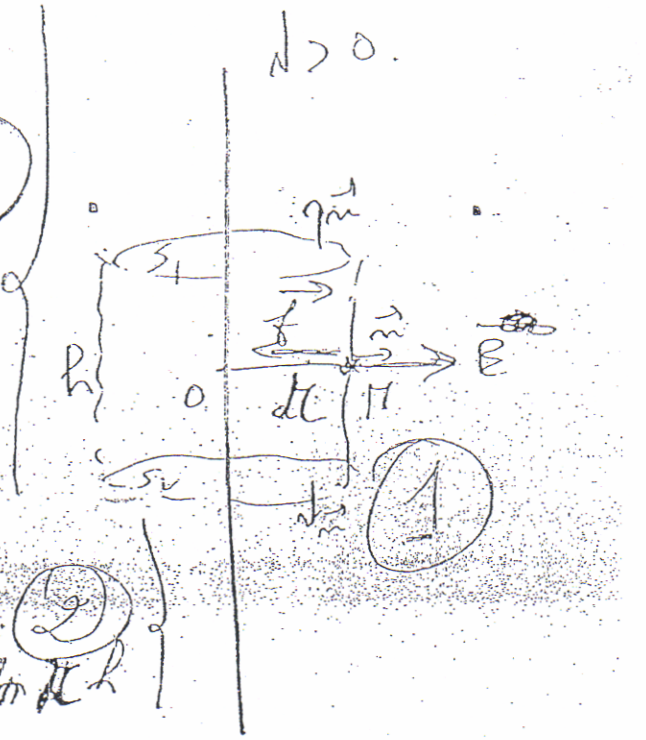
(2) $Q_{BC} = -\frac{3}{4} \times 2P_0V_0 \ln 2$

$\boxed{Q_{BC} = -\frac{3}{2} P_0V_0 \ln 2}$ (J)

65
220
220

فادي عمار —
سمير توزيم —

IV La surface de Gauss choisie est un cylindre coaxial passant par M et limité par 2 surfaces de base ⊥ au fil. (2)
Par raison de symétrie, le champ est ⊥ au fil dirigé vers l'extérieur car $\lambda>0$.



$$\Phi = \int_{S.L}\vec{E}\,\vec{n}\,ds + \underbrace{\int_{S_1}\vec{E}\,\vec{n}\,ds}_{=0} + \underbrace{\int_{S_2}\vec{E}\,\vec{n}\,ds}_{=0} \quad (2)$$

$$= \int_{S.L} E\,ds = E\int_{S.L} dS = E\,S_{S.L} = E.\,2\pi r h$$

$$\Phi = \frac{1}{\varepsilon_0}\sum_i q_i = \frac{1}{\varepsilon_0}Q = \frac{1}{\varepsilon_0}\lambda h \quad (1)$$

$$\Rightarrow \boxed{E = \frac{\lambda}{2\pi\varepsilon_0 r}}$$

b) $q<0$; $f = qE$ (2) f a le sens opposé à E car $q<0$. vers le fil

(8 pts)

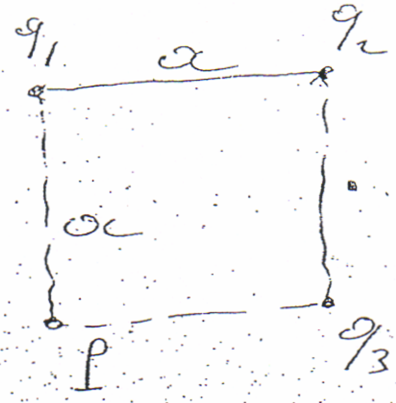
Solution

I

a/ $$V_p = K\frac{q_1}{a} + K\frac{q_2}{a\sqrt{2}} + K\frac{q_3}{a}$$

2pts $$= \frac{K}{a}\left(q_1 + \frac{q_2}{\sqrt{2}} + q_3\right)$$

avec $K = \frac{1}{4\pi\varepsilon_0}$



b/ $W = q(V_{final} - V_{init})$ avec $V_f = V_p$, $V_i = V_\infty = 0$

2pts

$$W_{ext} = q V_p = \frac{Kq}{a}\left(q_1 + \frac{q_2}{\sqrt{2}} + q_3\right)$$

(4pts)

Solution

$\overline{AO_1} = 20cm \quad \overline{O_1F_1'} = +10cm \;, \; \overline{O_2F_2'} = -5cm \;, \; \overline{O_1O_2} = 10cm$

$$AB \xrightarrow{L_1(O_1)} A_1B_1 \xrightarrow{L_2(O_2)} A_2B_2$$

$$A \xrightarrow{L_1} A_1 \xrightarrow{L_2} A_2$$

$$\frac{1}{\overline{AO_1}} + \frac{1}{\overline{O_1A_1}} = \frac{1}{\overline{O_1F_1'}}$$

2 $\frac{1}{20} + \frac{1}{\overline{O_1A_1}} = \frac{1}{10} \; ; \; \frac{1}{\overline{O_1A_1}} = \frac{1}{10} - \frac{1}{20} = \frac{1}{20} \Rightarrow \boxed{\overline{O_1A_1} = +20cm}$

1 $\gamma_1 = \frac{\overline{A_1B_1}}{\overline{AB}} = -\frac{\overline{O_1A_1}}{\overline{AO_1}} = -\frac{20}{20} = -1 \Rightarrow \overline{A_1B_1} = -\overline{AB}$

$\boxed{\overline{A_1B_1} = -1cm}$

$$\frac{1}{\overline{A_1O_2}} + \frac{1}{\overline{O_2A_2}} = \frac{1}{\overline{O_2F_2'}}$$

2 $\frac{1}{10} + \frac{1}{\overline{O_2A_2}} = \frac{1}{-5} \Rightarrow \frac{1}{\overline{O_2A_2}} = -\frac{1}{5} + \frac{1}{10} = -\frac{1}{10}$

$\Rightarrow \boxed{\overline{O_2A_2} = -10 \text{ cm} \quad \text{1 virtuelle}}$

1 $\gamma_2 = \frac{\overline{A_2B_2}}{\overline{A_1B_1}} = -\frac{\overline{O_2A_2}}{\overline{A_1O_2}} = -\frac{-10}{-10} = -1$

$\Rightarrow \overline{A_2B_2} = -\overline{A_1B_1} = +1$

$\boxed{\overline{A_2B_2} = +1cm}$ 1

8 pts

49

$\gamma = \gamma_1 \gamma_2 = (-1).(-1) = 1$

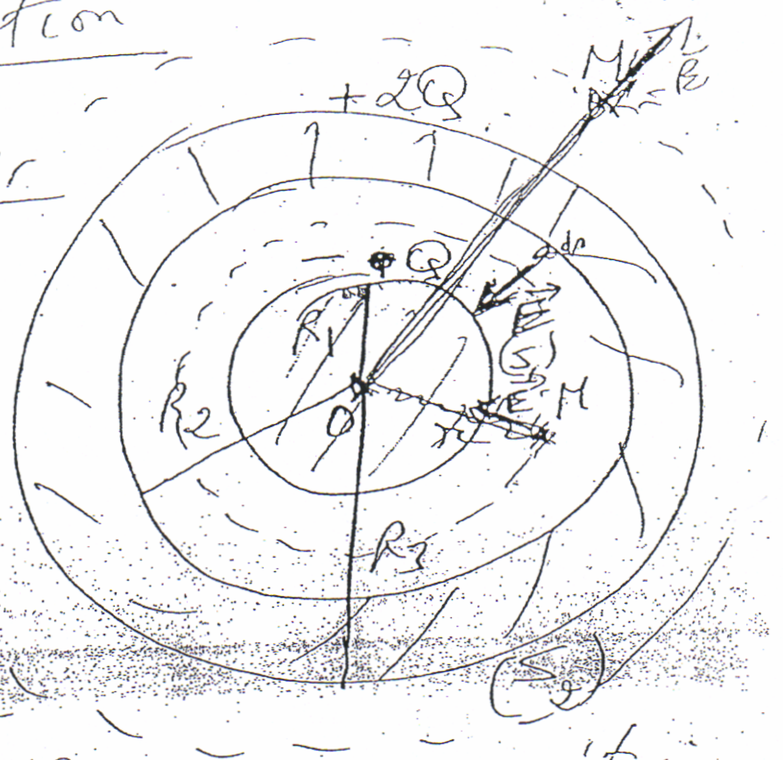
Solution 2003-2004) Solution

a/ Répartition des charges

Influence totale

sur P_i : $+Q$ (2)

P_e : $2Q - Q = +Q$



b/ Surface de Gauss

sphère concentrique passant par M tel que $OM = r$, $R_1 < r < R_2$. Par raison de symétrie le champ est radial c-à-d passe par O, dirigé vers (S_1) puisque la ~~(S1)~~ charge de (S_1) est négative

$$\Phi = \int_\Sigma \vec{E}\cdot\vec{n}\,dS = +E\,4\pi r^2$$

$$\Phi = \frac{1}{\varepsilon_0}\sum_i q_i = \frac{1}{\varepsilon_0}(+Q)$$

$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\,\frac{+Q}{r^2}}$$ 2 pts

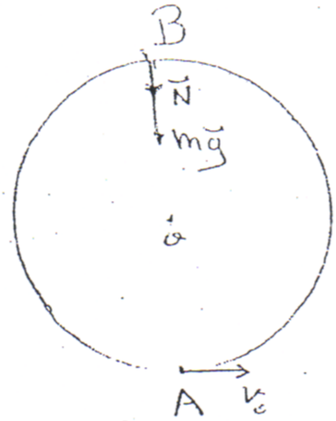
c) Par raison de symétrie E est radial (passe par O) dirigé vers (S_1) puisque la charge de (S_1) est négative (1)

(7 pts)

50 pts

que la bille ne tombe pas il faut $\vec{N}$ soit $\neq 0$ au pt. le plus haut.

P.F.D. : $m\vec{g} + \vec{N} = m\vec{a}$



au pt. B. $mg + N = ma_n \Rightarrow \boxed{mg + N = m\frac{V^2}{R}}$ 1

$N \geq 0 \Rightarrow m\left(\frac{V^2}{R} - g\right) \geq 0 \Rightarrow \boxed{V_B^2 = gR}$ 1

ou

$f_c \geq mg$ ou

$m\frac{V^2}{R} \geq mg$ 3

$\boxed{V^2 \geq Rg}$

Or $E_M = cte$ (Forces conservatives). 1

$(E_c + E_{P/A})_A = (E_c + E_{P/A})_B \Rightarrow$

$\frac{1}{2}mV_A^2 + 0 = \frac{1}{2}mV_B^2 + 2mgR \Rightarrow$ 1

$V_A^2 = V_B^2 + 4gR \Rightarrow V_A^2 = gR + 4gR \Rightarrow V_A^2 = 5gR \Rightarrow$

$\boxed{V_A = 10\,m/s}$ 1

or la vitesse initiale de la bille est $V_0 = 8\,m/s < V_A$

2 donc, elle ne peut pas compléter le tour de la piste.

Méthode :

$$\frac{1}{2} m v_B^2 + mg\,2R = \frac{1}{2} m v_A^2$$

$$v_B^2 = v_A^2 - 4gR \quad (1)$$

$$= 81 - 80 = 1 > 0 \quad (1)$$

(2)

(1) D'autre part en B : $m a_B = mg + N_B$

$$N_B = m\left(\frac{v_B^2}{R} - g\right)$$

$$= m\left(\frac{1}{2} - 10\right) < 0$$

(2)

(1) Donc elle ne peut pas atteindre B.

Mécanique des fluides.

a) $A_A V_A = A_B V_B$ (1)

$V_A = \frac{A_B}{A_A} V_B = \frac{0,1}{20 \times 10^2} V_B = \frac{1}{20000} V_B \Rightarrow V_A << V_B$ ($\frac{1}{2}$)

b) Th. de Bernouilli :

(2) $\frac{1}{2}\rho v_A^2 + \rho g h + \cancel{p_0} = \frac{1}{2}\rho v_B^2 + 0 + \cancel{p_0} + \Delta p$

$\frac{1}{2}\rho v_B^2 = \rho g h - \Delta p$

$\frac{1}{2}\rho v_B^2 = 1200 \times 10 \times 1 - 2000$

$= 10000$

(1) $v_B^2 = \frac{20000}{1200} = \frac{200}{12} = \frac{100}{6} = 16,66$

$v_B \simeq 4,08 \, m/s$

c) (1) $D = \frac{vol.}{temps} = A_B v_B$

$volume = 0,1 \times 10^{-6} \times 4,08 \times 3600 \; m^3$

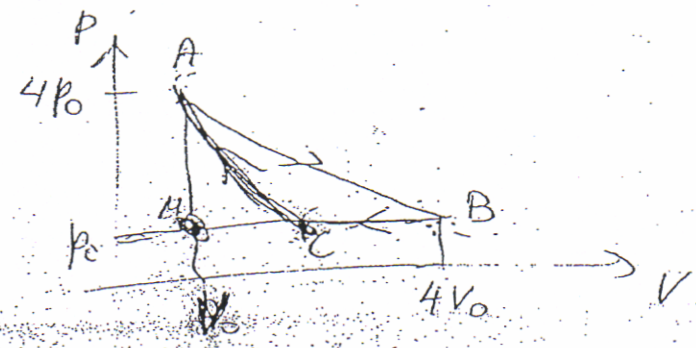
$= 1,46$ litre ($\frac{1}{2}$)

1/ $\dfrac{P_A V_A}{T_A} = \dfrac{P_B V_B}{T_B}$

① $\dfrac{4P_0 V_0}{T_A} = \dfrac{P_0 \times 4V_0}{T_B} \Rightarrow T_B = T_A$

(1/2) * transformation isotherme.

2/



(2)

3/ 1ère méthode :

$$\Delta S_{AB} = \int_A^B \frac{\delta Q}{T} = \frac{1}{T_A}\int_A^B \delta Q = \frac{Q_{AB}}{T_A} = -\frac{W_{AB}}{T_A} \text{ car } \Delta U_{AB}$$ (1)

$$W_{AB} = \int_A^B -p\,dV = -\int_A^B RT_A \frac{dV}{V} = -RT_A \ln\frac{V_B}{V_A}$$

$$= -RT_A \ln 4 = -2RT_A \ln 2$$ (1)

(2 1/2)

$$\Delta S_{AB} = +\frac{2RT_A \ln 2}{T_A} = +2R\ln 2$$ (1/2)

2ème méthode :

$$\Delta S_{AB} = \Delta S_{AM} + \Delta S_{MB}$$ (1/2)

(2)

$M \begin{cases} P_M = P_0 \\ V_M = V_0 \\ T_M \end{cases}$

$$\Delta S_{AB} = \int_A^M \frac{\delta Q_p}{T} + \int_M^B \frac{\delta Q_v}{T}$$

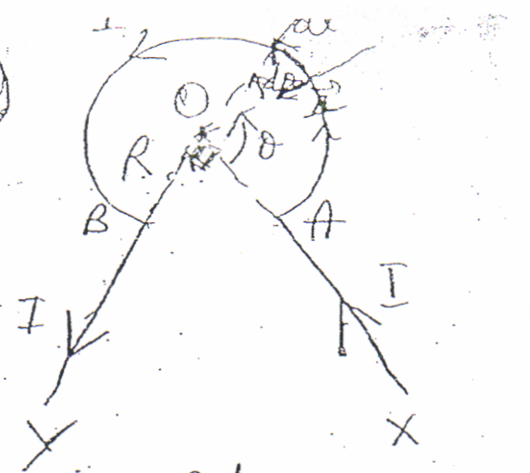
$\dfrac{P_M V_M}{T_M} = \dfrac{P_0 \times 4V_0}{T_A}$

$T_M = \dfrac{T_A}{4}$

$$= C_p \ln\frac{T_M}{T_A} + C_v \ln\frac{T_A}{T_M}$$ (1)

$$= \frac{5R}{2}\ln\frac{1}{4} + \frac{3R}{2}\ln 4 = -5R\ln 2 + 3R\ln 2 = -2R\ln 2$$ (1)

$B_{XA} = 0$ car $\vec{dl} \wedge \frac{\vec{r}}{r} = 0$ (1/2)



$B_{BY} = 0$ car $\vec{dl} \wedge \frac{\vec{r}}{r} = 0$ (1/2)

B_{AB} ? $\vec{dB} = \frac{\mu_0 I}{4\pi r^2} \vec{dl} \wedge \frac{\vec{r}}{r}$ avec $r = R$ (1)

$\vec{dl}$ a le sens de I

$dB = \frac{\mu_0 I}{4\pi R^2} dl$ avec $dl = R\,d\theta$ (1)

$dB = \frac{\mu_0 I}{4\pi R} d\theta$

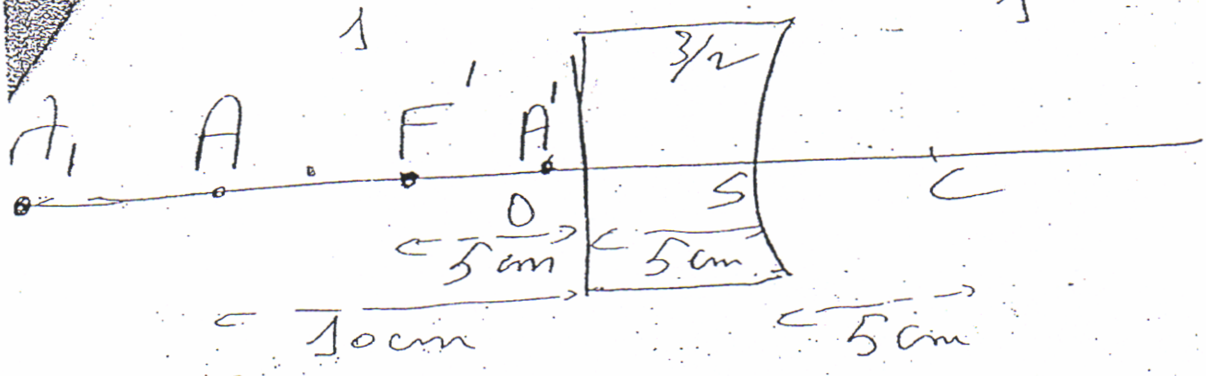
$B = \int dB = \frac{\mu_0 I}{4\pi R} \int_0^{3\pi/2} d\theta = \frac{\mu_0 I}{4\pi R}\left(\frac{3\pi}{2}\right)$ (1)

$B = B_{XA} + B_{AB} + B_{BY}$

(1) $B_{AB} = \frac{3}{4} \frac{\mu_0 I}{2R}$ $\odot$ $\vec{B}$ (1)

(6/5)

55



1) F' ?

$\infty \xrightarrow{DP} \infty \xrightarrow{DS} F'$ (1)

DS : $\frac{n_1}{p_1} - \frac{n_2}{p_2} = \frac{n_1 - n_2}{R}$

$\frac{3}{2(\infty)} - \frac{1}{\overline{SF'}} = \frac{\frac{3}{2} - 1}{5} = \frac{1}{10} \Rightarrow \boxed{\overline{SF'} = -10\,cm}$ (2)

2) $A \xrightarrow{DP} A_1 \xrightarrow{DS} A'$ (1/2)

DP : $\frac{n_1}{p_1} = \frac{n_2}{p_2} \Rightarrow \frac{1}{\overline{OA} = -10} = \frac{3}{2 \cdot \overline{OA_1}}$ (1)

$\boxed{\overline{OA_1} = -\frac{30}{2} = -15\ cm} \Rightarrow \boxed{\overline{SA_1} = -20\ cm}$

DS : $\frac{n_1}{p_1} - \frac{n_2}{p_2} = \frac{n_1 - n_2}{R}$

$\frac{3}{2 \cdot (20)} - \frac{1}{\overline{SA'}} = \frac{\frac{3}{2} - 1}{5}$ (2)

$-\frac{3}{40} - \frac{1}{\overline{SA'}} = \frac{1}{10} \Rightarrow \frac{1}{\overline{SA'}} = -\frac{3}{40} - \frac{1}{10} = \frac{-3-4}{40}$

$\overline{SA'} = -\frac{40}{7} = -5{,}71\ cm$ virtuelle

LEBANESE UNIVERSITY
Faculty of Medical Sciences
Faculty of Dentistry
Faculty of Pharmacy

Date : October 8th 2008
Duration : 1 hour

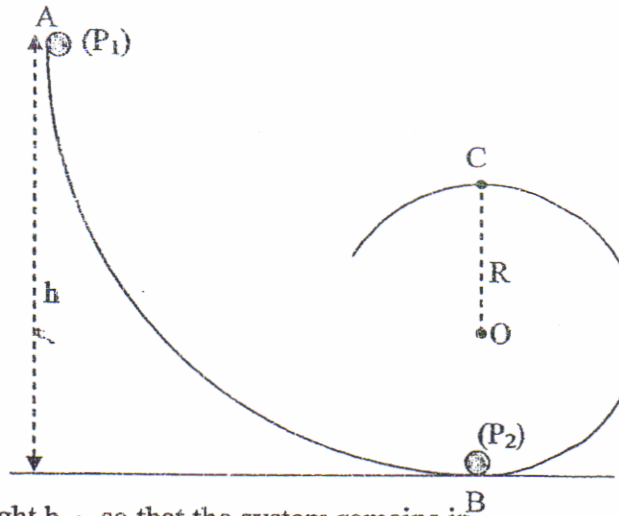
Entrance exam to 2nd year
Academic year 2008-2009

Subject : Physics

I- [12 pts]

The vertical track shown in the adjacent figure is formed of a curved part AB and a circular part BC of radius R.

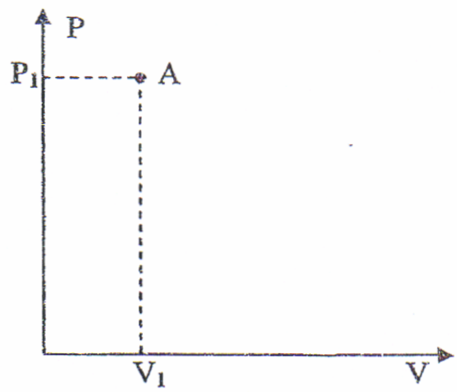
A particle (P_1), of mass m_1, is released from rest from the point A which is at a height h. At point B of the track there is another particle (P_2) of mass $m_2 = m_1$ initially at rest. (See figure).



1. Determine, in terms of h and g, the speed V_1 of (P_1) just before hitting (P_2).
2. After collision, (P_1) sticks to (P_2) to form one system [(P_1), (P_2)]. Determine, in terms of h and g, the speed V_B of this system just after collision.
3. Determine, in terms of R, the minimum height h_{min} so that the system remains in contact with the circular part.

II- [8 pts]

An ideal gas undergoes a reversible cycle ABCA formed of:
- an isothermal expansion AB ($V_B = 8\ V_1$);
- an adiabatic compression BC ($V_C = 2\ V_1$) ;
- an isobaric compression CA.



1. Sketch the (P, V) diagram of the cycle ABCA.
2. Knowing that the work done by the gas during the BC transformation is $|W_{BC}| = 500$ J, deduce ΔU_{CA}.
3. Knowing that $Q_{AB} = +\ 500$ J and $T_B = 200$ K, find ΔS_{AB}. Deduce ΔS_{CA}.

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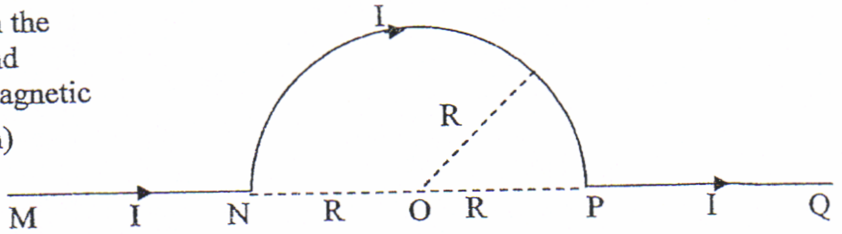
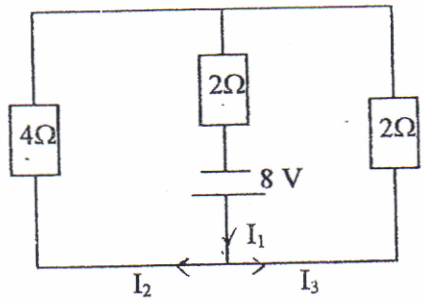
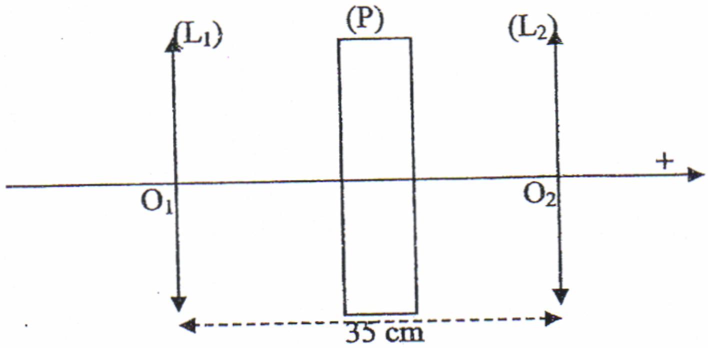
III- [7 pts]
Consider the conductor shown on the adjacent figure. Applying Biot and Savart law, determine the total magnetic field $\vec{B}$ (magnitude and direction) created at point O.



IV- [6 pts]
Find the currents I_1, I_2 and I_3 in the circuit of the adjacent figure.



V – [7 pts]
Consider the optical system formed of two converging lenses (L_1) and (L_2) of focal lengths10 cm and 12 cm respectively. The distance between the two lenses is $O_1O_2 = 35$ cm.. A plate of parallel faces (P), of index n = 1.5 and thickness e = 3 cm, is placed between (L_1) and (L_2). (See figure)
Determine the position of the image focus F' of the optical system (L_1, P, L_2).



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Physique 2008-2009

1°/ (1) $E_m = cte \Rightarrow E_c + E_p = cte$

(1) $m_1 g h = \frac{1}{2} m_1 v_1^2 \Rightarrow \boxed{v_1 = \sqrt{2gh}}$ (1)

2°/ (1) $\vec{P} = \vec{cte} \Rightarrow m_1 \vec{v_1} = (m_1 + m_2)\vec{V_B}$ (1)

$\Rightarrow \boxed{V_B = \frac{v_1}{2} = \sqrt{\frac{gh}{2}}}$ (1)

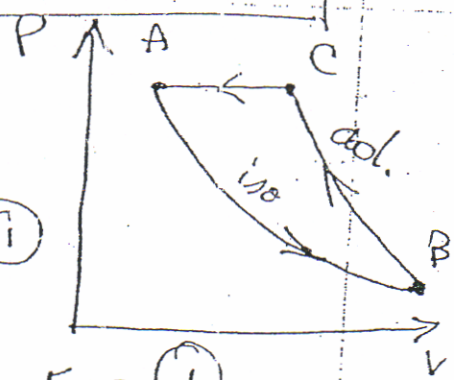
3°/ En C : $N \geq 0$ (1) $\quad 2m_1\vec{g} + \vec{N} = 2m_1\vec{a}$ (1)

$2m_1 g = 2m_1 \frac{V_C^2}{R} \Rightarrow \boxed{V_C^2 = gR}$ (1)

(1) $E_m = cte \Rightarrow$ (1) $\frac{1}{2}(2m_1)V_B^2 = 2m_1 g(2R) + \frac{1}{2}(2m_1 V_C^2)$

$g\frac{h_{min}}{2} = 4gR + gR \Rightarrow \boxed{h_{min} = 10R}$ (1)

II 1°/ Voir figure (2)



2°/ $\Delta U_{AB} = 0 \quad (T = cte)$ (1)

$\Delta U_{BC} = W_{BC} + Q_{BC} = W_{BC} = 500\,J$ (1)

or $\Delta U_{cycle} = 0 \Rightarrow \Delta U_{CA} = -\Delta U_{BC} = -500\,J$ (1)

3°/ $Q_{AB} = 500\,J$ et $T_B = 200\,J$ (2)

$\Delta S_{AB} = \int_A^B \frac{\delta Q}{T} = \frac{Q_{AB}}{T_A} = 2{,}5\,J/°K$

$\Delta S_{cycle} = 0 \Rightarrow \Delta S_{CA} = -\Delta S_{AB} = -2{,}5\,J/K$ (1)

III (7 points)

1°/ fil AB : $B = 0$ $(\vec{dl}, \vec{r_0}) = 0$ 1

2°/ De même pour CD : $B = 0$ $(\vec{dl}, \vec{r_0}) = \pi$ 1

3°/ fil BC : 1 $B = \frac{\mu_0 I}{4\pi} \int \frac{\vec{dl} \wedge \vec{r_0}}{r^2}$ $\quad r = cte = R$

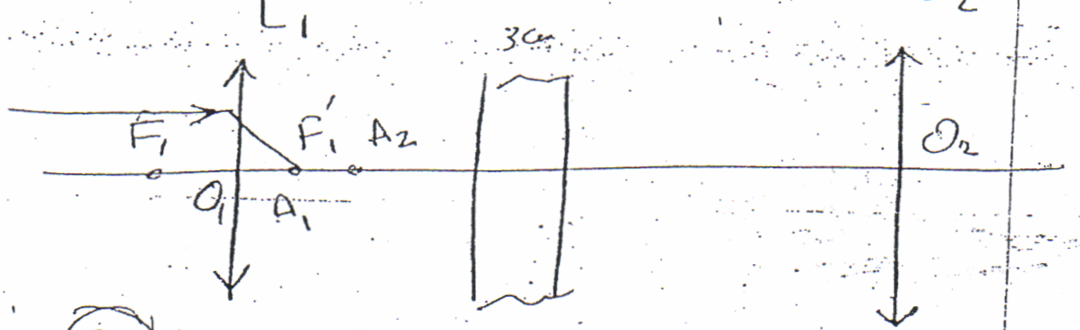
$(\vec{dl}, \vec{r_0}) = \frac{\pi}{2} \Rightarrow B = \frac{\mu_0 I}{4\pi R^2} \int_0^{\pi R} dl$ 3

$\vec{B} = \frac{\mu_0 I}{4R} \vec{u}$ $\otimes$ 1

$dl = R d\theta$

$\boxed{\Rightarrow B = \frac{\mu_0 I}{4\pi R} \int_0^{\pi} d\theta = \frac{\mu_0 I}{4R}}$

V (7 points)



1 $\underline{A_1 \text{ en } F_1'}$

2 $\overline{A_1A_2} = e\left(1 - \frac{1}{n}\right) = 1cm \Rightarrow \overline{O_1A_2} = 11cm$

1 $\overline{O_2A_2} = \overline{O_2O_1} + \overline{O_1A_2} = -35 + 11 = -24\,cm.$

$\overline{A_2O_2} = +24\,cm.$

1 $\frac{1}{\overline{A_2O_2}} + \frac{1}{\overline{O_2A'}} = \frac{1}{\overline{O_2F'}}$ $\Big\} \Rightarrow \overline{O_2F'} = +24\,cm.$

$\frac{1}{24} + \frac{1}{\overline{O_2A'}} = \frac{1}{\overline{O_2F'}} = \frac{1}{12}$ 2

$\overline{O_2A'} = \overline{O_2F'}$ 60

$\frac{1}{p'} - \frac{1}{p} = \frac{1}{f'}$ 1

$\frac{1}{\overline{O_2F'}} + \frac{1}{24} = \frac{1}{12}$

$\overline{O_2F'} = \ldots$ 2

IV

$1\frac{1}{2}$ $4I_2 + 2I_1 = 8$

1

$I_1 = I_2 + I_3$

$1\frac{1}{2}$ $2I_3 + 2I_1 = 8$

$$\Rightarrow \begin{cases} I_1 = \frac{12}{5} = 2.4\,A \\ I_2 = \frac{4}{5}\,A = 0.8\,A \end{cases}$$

2

$I_3 = 1.6\,A$

LEBANESE UNIVERSITY
Faculty of Medical Sciences
Faculty of Dentistry
Faculty of Pharmacy

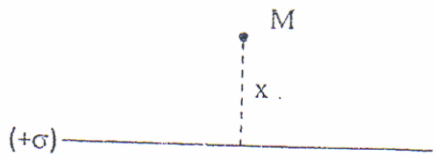
Date: 13 October, 2009
Time: 1 hour

Entrance Exam to 2nd year (2009-2010)

PHYSICS

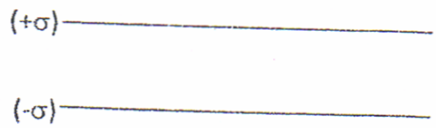
Problem (I): 8 points

An infinite plane is uniformly charged with a positive surface charge density ($+\sigma$).



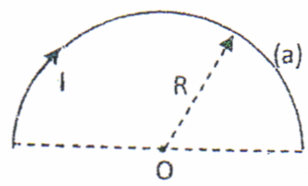
1. Using Gauss' law, find the electric field vector (magnitude and sense) created at a point M situated at a distance x from the plane.

2. Consider two parallel infinite planes uniformly charged with densities $+\sigma$ and $-\sigma$. Determine the total electric field vector (Magnitude and sense) at every point in space.

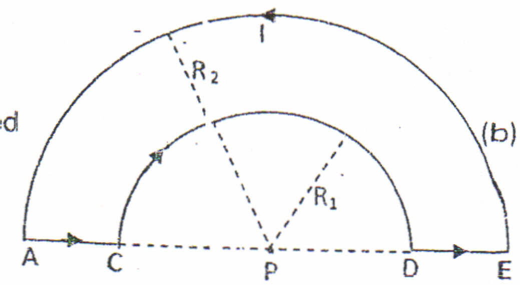


Problem (II): 7 points

1. Consider a semi-circular wire of radius R and center O traversed by an electric current of intensity I (figure 'a'). Derive the magnitude of the magnetic field vector created at the center O and indicate its sense.

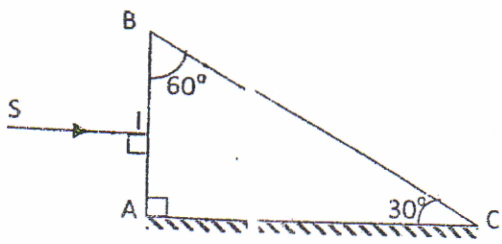


2. Deduce the total magnetic field vector at point P created by the circuit shown in figure 'b'.



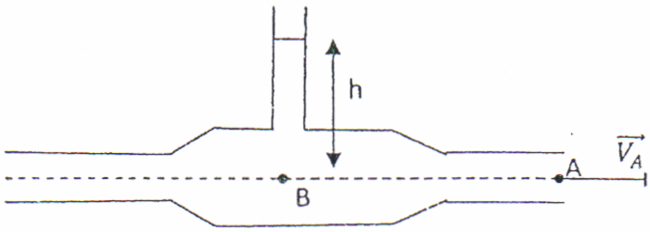
Problem (III): 5 points

The prism ABC in the adjacent figure is of index of refraction n = 1.5, and has a reflecting surface AC. Draw - with justification - the path of the luminous ray SI incident normal to the face AB of the prism.



Problem (IV): 8 points

An ideal liquid of density ρ is flowing in a horizontal flow tube of cross-sectional areas S_A and S_B at A and B respectively, such that end A is open to free air. The liquid leaves the tube from A with a speed v_A.

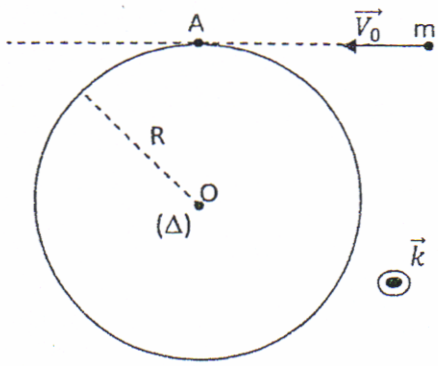


1. Find the expression of the fluid pressure at B as a function of v_A, ρ, S_A, S_B and the atmospheric pressure P_o.

2. Deduce the expression of the height h of the fluid above B (assumed static) as a function of v_A, S_A, S_B and the gravitational acceleration g.

Problem (V): 12 points

Consider a homogeneous disc of mass M and radius R of moment of inertia $I_\Delta = \frac{1}{2}MR^2$ relative to the horizontal axis Δ passing through the center O and perpendicular to the plane of the disk. The disc is situated in a **vertical** plane and could rotate around Δ.



A particle of mass m = M/10 moving with a constant velocity $\vec{v_o}$ in the plane of the disc, hits the disc tangentially at the highest point A and sticks to it (see the figure).

1. Determine the moment of inertia I_S of the system with respect to Δ.

2. Calculate the angular velocity $\vec{\omega}$ of the system just after the collision.

3. Calculate the angular speed of the system at the instant when the particle reaches the lowest point.

Remark: Take the horizontal plane passing through the lowest point as a reference for the gravitational potential energy of the system.

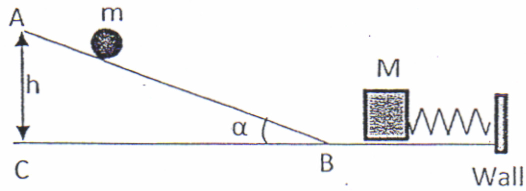
LEBANESE UNIVERSITY
Faculty of Medicine
Faculty of Pharmacy
Faculty of Dentistry

Date: 21/9/2010
Duration:1 hour

Entrance Exam – 2^{nd} Year (2010-2011)
Subject: Physics

I- [13 pts]

A solid sphere of mass m, radius R and moment of inertia $I = \frac{2}{5}mR^2$ is released without initial velocity from point A over an inclined plane of angle α with the horizontal. Point A is at a height h. Assume that the sphere rolls **without slipping** over the incline AB.

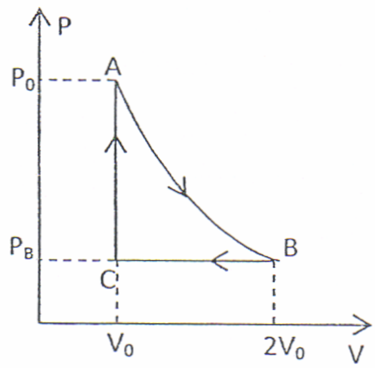


1. a) For what reason does the sphere roll without sliding along AB?
   b) Find an expression for the speed V_B of the sphere at point B in terms of h and the gravitational acceleration g.
2. The sphere hits a block of mass M (M = 3m) with the speed V_B and **sticks to it**. The block, initially at rest, is attached to a spring of stiffness k. Neglect all friction forces along the way from **B to the wall.**
   a) Find the speed V of the system (m, M) just after collision in terms of [illegible] and V_B.
   b) Determine the maximum compression X of the spring as a function of ~~M~~, ~~K~~ and V_B.
   m, K, + V_B

II- [7pts]

One mole of an ideal gas undergoes the cycle with the following transformations:

$A \rightarrow B$: adiabatic expansion, such that $V_B = 2\,V_0$;
$B \rightarrow C$: isobaric compression;
$C \rightarrow A$: isochoric transformation.



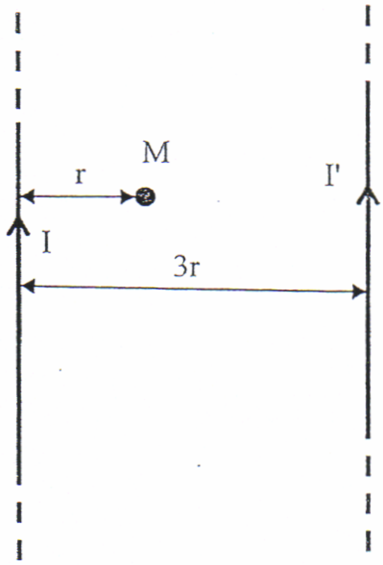
1. Find P_B, T_B and T_C in terms of the adiabatic constant γ, the pressure P_0 and the temperature T_0 of state A.
2. Calculate Q_{CA} given that $|Q_{BC}| = 2000$ J and the efficiency of this cycle is $\eta = 0.3$.
3. Compare the efficiency η of this cycle with that of a Carnot cycle operating between the same extreme temperatures of this cycle. Take $\gamma = 1.4$.

III- [6 pts]

Consider a capacitor of capacitance $C_1 = 5\ \mu F$ initially charged by $q_1 = 60\ \mu C$. A second capacitor of capacitance $C_2 = 1\ \mu F$ initially uncharged is now connected in parallel with the first capacitor. Determine the charge and the potential difference across each capacitor long time after connection.

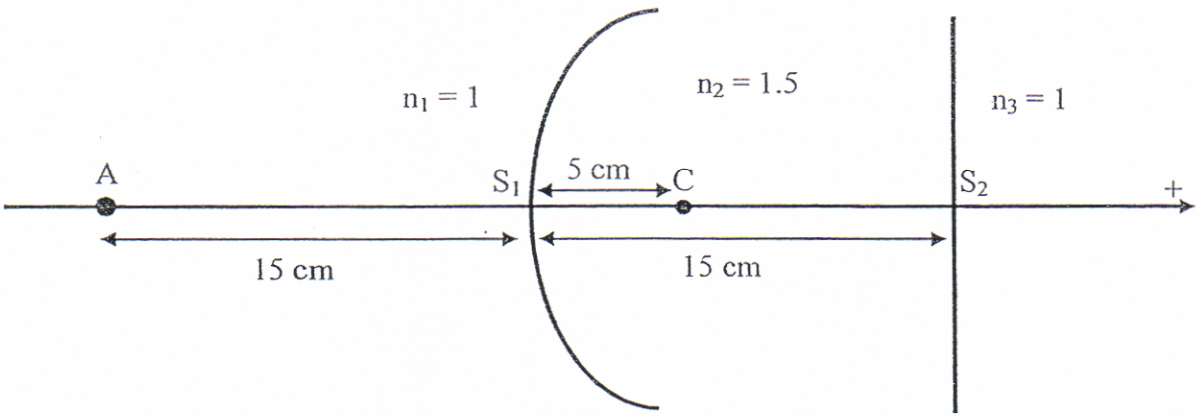
IV- [7 pts]

1. Using Ampere's law, determine the magnetic field $\vec{B}_1$ created by an infinite straight conducting wire traversed by a current I, at a point M situated at a distance r from the wire.
2. A second infinite wire is placed parallel to the first at a distance 3r from it is traversed by a current I′ as shown in the figure. What is the value of I′ such that the resultant magnetic field $\vec{B}$ is null. The point M and the two conductors lie in the same plane.



V- [7 pts]

Consider an optical system formed of a spherical diopter of radius of curvature 5 cm and a plane diopter as shown in the below figure.



Determine the position and nature of the final image given by the spherical-plane system of a real point object A placed 15 cm in front of the spherical surface.

Mécanique

1

12p5

I – 1 – a – à cause des forces de frottement

1

5

b – $E_{MA} = E_{MB} \Rightarrow E_{KA} + E_{PA} = E_{KB} + E_{PB}$ 0,5

2,0 $\Rightarrow 0 + mgR = \frac{1}{2} m v_B^2 + \frac{1}{2} I \omega_B^2 + 0$ (référence $E_{PB} = 0$)

0,5 $v_B = \omega_B . R$ alors $mgR = \frac{1}{2} m v_B^2 + \frac{1}{2} \cdot \frac{2}{5} m R^2 \cdot \frac{v_B^2}{R^2}$

$\Rightarrow gR = \frac{7}{10} v_B^2 \Rightarrow \boxed{v_B = \sqrt{\frac{10}{7} g R}}$ 1

3 2 – a – Csvt de la qt de mvt $\Rightarrow \vec{P}_{juste\ avant} = \vec{P}_{juste\ après}$ 1

1,5 $\Rightarrow m . \vec{v}_B + \vec{0} = (m + M) \vec{V} \Rightarrow V = \frac{m}{m+M} v_B$

$\Rightarrow \boxed{V = \frac{v_B}{4}}$ 0,5

4 b – Csvt de l'Energie mécanique juste après le choc (i) et à la compression maximale (f) 0,5

$E_{Ki} + E_{Pi} = E_{Kf} + E_{Pf} \Rightarrow E_{Ki} + E_{PPi} + E_{Pei} = E_{Kf} + E_{PPf} + E_{Pef}$

$\Rightarrow \frac{1}{2} (m+M) V^2 + 0 + 0 = 0 + 0 + \frac{1}{2} K X^2$ 2,5

$\Rightarrow 2mV^2 = \frac{1}{2} K X^2 \Rightarrow X^2 = \frac{4mV^2}{K} \Rightarrow \boxed{X = 2V\sqrt{\frac{m}{K}}}$

$\Rightarrow \boxed{X = \frac{v_B}{2}\sqrt{\frac{m}{K}}}$

10

5 : 5

Mécanique

2

I – (2ème méthode)

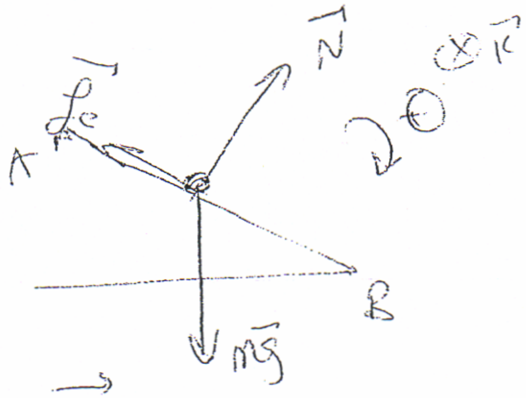
à cause des forces de frottement 1

$\Delta E_c = \sum W_{forces\ extérieures}$

$E_{cB} - E_{cA} = \cancel{W_{\vec N}} + W_{\vec P} + \cancel{W_{\vec f}} = mgh$ 4

$\Rightarrow \frac{1}{2} m v_B^2 + \frac{1}{2} I \omega_B^2 - 0 = mgh \Rightarrow \cdots \Rightarrow v_B = \sqrt{\frac{10}{7}g}$

I – (3ème méthode)



$\sum \vec{\mathcal{M}}_{/(O,\vec k)} = I \ddot{\vec\theta}$

$\vec{\mathcal{M}}_{\vec P} + \vec{\mathcal{M}}_{\vec N} + \vec{\mathcal{M}}_{\vec f} = \frac{2}{5} m R^2 \cdot \ddot{\vec\theta}$

$\Rightarrow f \cdot R = \frac{2}{5} m R^2 \ddot\theta = \frac{2}{5} m R^2 \cdot \frac{a}{R} = \frac{2}{5} m R \cdot a$

$\Rightarrow \boxed{a = \frac{5}{2} \cdot \frac{f}{m}}$ 1

2ème loi de Newton : $\sum \vec F = m\vec a \Rightarrow m\vec g + \vec N + \vec{f_e} = m\vec a$

$\Rightarrow f_e = m(g\sin\alpha - a) \Rightarrow f_e = m(g\sin\alpha - \frac{5}{2}\frac{f}{m}$ 1

$\Rightarrow f(1 + \frac{5}{2}) = mg\sin\alpha \Rightarrow \boxed{f = mg\sin\alpha \frac{2}{7}}$ 1

$\Rightarrow a = \frac{5}{2} mg\sin\alpha \cdot \frac{2}{7} = \frac{5}{7} g\sin\alpha = a$ 1

3

όνα $v_B^2 - v_A^2 = 2a \cdot AB = 2a \cdot \frac{h}{\sin\alpha} = 2 \cdot \frac{5}{7} \cdot g\sin\alpha \cdot \frac{h}{\sin\alpha}$

$\Rightarrow v_B^2 = \frac{10}{7} \cdot g h \Rightarrow \boxed{v_B = \sqrt{\frac{10}{7} \cdot gh}}$ 1

8pts
II - 1 -

•) $P_A \cdot V_A^{\gamma} = P_B \cdot V_B^{\gamma} \Rightarrow P_0 \cdot V_0^{\gamma} = P_B\,(2V_0)^{\gamma}$

$\Rightarrow P_B = \dfrac{P_0}{2^{\gamma}} = \boxed{2^{-\gamma} \cdot P_0 = P_B}$ 1

4

•) $T_A \cdot V_A^{\gamma-1} = T_B \cdot V_B^{\gamma-1} \Rightarrow T_0 \cdot V_0^{\gamma-1} = T_B \cdot (2 \cdot V_0)^{\gamma-1}$

$\Rightarrow T_B = \dfrac{T_0}{2^{\gamma-1}} \Rightarrow \boxed{T_B = 2^{1-\gamma} \cdot T_0}$ 1

ou $\dfrac{P_A V_A}{T_A} = \dfrac{P_B V_B}{T_B} \Rightarrow \dfrac{P_0 V_0}{T_0} = \dfrac{2^{-\gamma} P_0 \cdot 2 \cdot V_0}{T_B} \Rightarrow \boxed{T_B = 2^{1-\gamma} \cdot T_0}$

•) $\dfrac{P_A}{T_A} = \dfrac{P_C}{T_C} \Rightarrow \dfrac{P_0}{T_0} = \dfrac{2^{-\gamma} P_0}{T_C} \Rightarrow \boxed{T_C = T_0 \cdot 2^{-\gamma}}$ 1

2 - 1 $\rho = 1 - \dfrac{Q_{BC}}{Q_{CA}} = 1 - \dfrac{2000}{Q_{CA}} = 0{,}3$

$\Rightarrow \dfrac{2000}{Q_{CA}} = 0{,}7 \Rightarrow \boxed{Q_{CA} = 2857\,J}$ 1

~~$\rho = 1 + \dfrac{Q_{BC}}{Q_{CA}} = 1 + \dfrac{-2000}{Q_{CA}}$~~

~~$\Rightarrow \boxed{Q_{CA} = 4000\,J}$~~

3 - $\rho_{Carnot} = 1 - \dfrac{T_{min}}{T_{max}}$; $T_B = 2^{1-1{,}4} \cdot T_0 = 2^{-0{,}4} \cdot T_0 = 0{,}75\,T_0$

$T_C = 2^{-1{,}4} \cdot T_0 = 0{,}3789\,T_0$

$T_A = T_0$

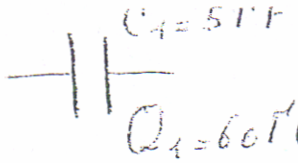
1 $= 1 - \dfrac{0{,}3789}{\cancel{0{,}7581}}$ = ~~0,620~~ [illegible] =

1

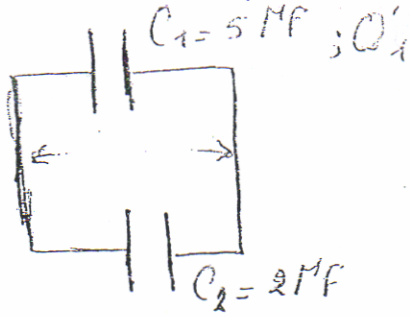
$\rho_{Carnot} > \rho_{cycle}$

ce qui est prévu théoriquement. 1

III -



5



Conservation de charge :

$Q_1 = Q'_1 + Q'_2$

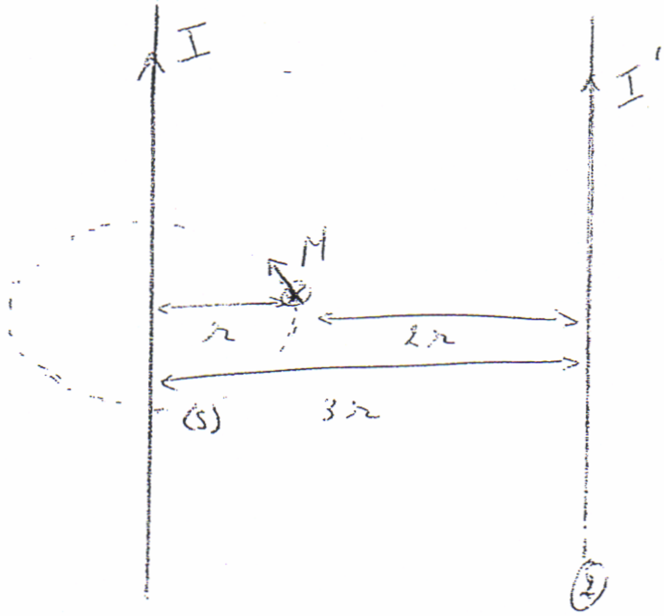
$V_1 = V_2$; $\dfrac{Q'_1}{C_1} = \dfrac{Q'_2}{C_2} \Rightarrow \dfrac{Q'_1 + Q'_2}{C_1 + C_2} = \dfrac{Q_1}{C_1 + C_2}$

$\Rightarrow Q'_1 = \dfrac{C_1 Q_1}{C_1 + C_2} = \dfrac{5}{6} \times 60 = 50\mu C$

$Q'_2 = \dfrac{C_2}{C_1 + C_2} Q_1 = \dfrac{1}{6} \times 60 = 10\mu C$

$V_1 = V_2 = \dfrac{Q'_1}{C_1} = \dfrac{Q'_2}{C_2} = \dfrac{50}{5} = 10V$

IV -



$\int_{(S)} \vec{B}\, d\vec{l} = \mu_0 I$

$\int_{(S)} \vec{B} \cdot d\vec{l} = \int_{(S)} B\, dl \cos 0 = B \int dl$

$\int dl = 2\pi r \Rightarrow B_1 \cdot 2\pi r = \mu_0 I$

$B_1 = \dfrac{\mu_0 I}{2\pi r}$ ⊗

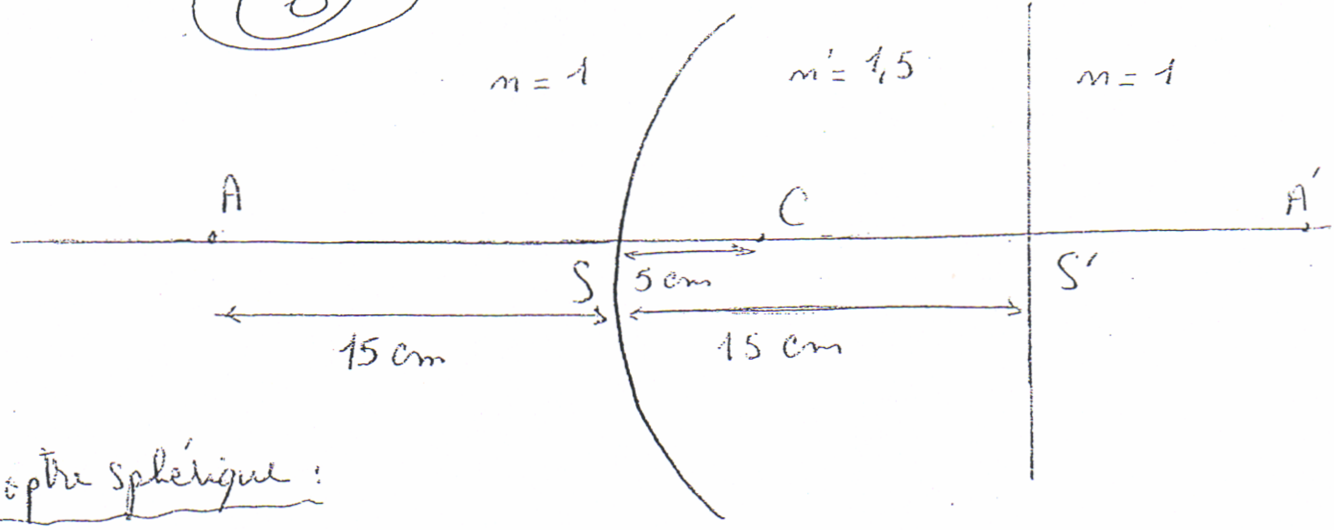
$B_2 = \dfrac{\mu_0 I'}{2\pi (2r)}$ ⊙

$B_{Tot} = B_1 - B_2 = \dfrac{\mu_0}{2\pi} \left(\dfrac{I}{r} - \dfrac{I'}{2r} \right)$

$B_{tot}(M) = 0 \Rightarrow \dfrac{I}{r} = \dfrac{I'}{2r} \Rightarrow I' = 2I$

VI

6



Dioptre sphérique :

$$\frac{1,5}{\overline{SA_1}} + \frac{1}{15} = \frac{1,5-1}{5} = \frac{1}{10}$$

$$\Rightarrow \frac{1,5}{\overline{SA_1}} = \frac{1}{10} - \frac{1}{15} \Rightarrow \overline{SA_1} = 45 \text{ cm}$$

$$S'A_1 = 45 - 15 = 30 \text{ cm}$$

$$\frac{p'}{p} = \frac{n'}{n} \Rightarrow p' = \frac{n'}{n} p = \frac{1,5}{1} \times 30 = 20 \text{ cm}$$

image A' réelle
à 20 cm du dioptre plan

LEBANESE UNIVERSITY
Faculty of Medical Sciences
Faculty of Dentistry
Faculty of Pharmacy

Time : 1 hour
Date : 13/9/2011

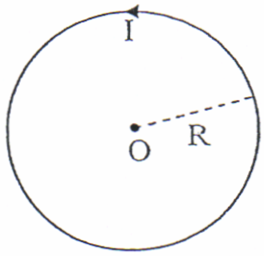
2nd year Entrance Exam
Academic year 2011-2012

Subject : Physics

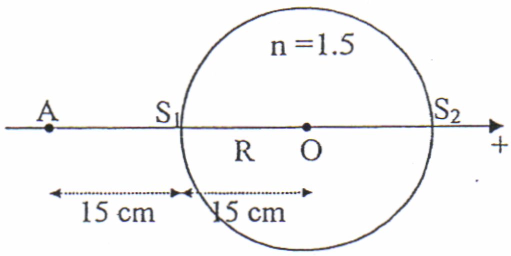
Number of pages = 2

I – [8 pts]
A spherical **conductor** of center O, radius R, is charged positively by a charge Q. Determine the Magnitude, sense and draw figure of the electric field and the electric potential outside and inside the sphere.

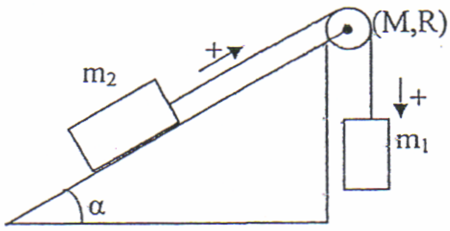
II – [6 pts]
A circular wire (loop) of radius R and center O is traversed by a steady current I as shown in the adjacent figure. Determine the magnetic field (Magnitude and sense) created at the center O of the loop.



III – [6 pts]
A glass sphere of radius R = 15 cm and index of refraction n = 1.5 is placed in air. Determine the position and nature of the final image given by the sphere for a real point object 'A' placed in air 15 cm from S_1.



IV – [13 pts]
Consider two blocks of masses m_1 and m_2 attached by an inextensible massless chord passing around a pulley of mass M, radius R, and of moment of inertia $I = \frac{1}{2} MR^2$. The pulley rotates without friction around its axis. Block m_2 moves with kinetic friction (of coefficient μ) up along a rough inclined plane of angle of inclination $\alpha = 30°$ with the horizontal as shown in the adjacent figure.
Given that $m_1 = m_2 = M$:



1) Express the acceleration of mass m_1 in terms of μ, α and the gravitational acceleration g.
2) Assuming that the motion of m_1 becomes uniform, what must be the value of the coefficient of kinetic friction μ between m_2 and the inclined plane?
3) As m_1 is moving with a constant velocity v_o, the chord holding it is cut. Write down the time equation of motion y(t) of block m_1 before it touches the ground.

V – [7 pts]

One mole of an ideal diatomic gas at initial state A (P_o, V_o, T_o) undergoes the following thermodynamic cycle:

- AB: Isothermal transformation such that $V_B = 2V_o$
- BC: Isobaric transformation
- CA: Adiabatic transformation

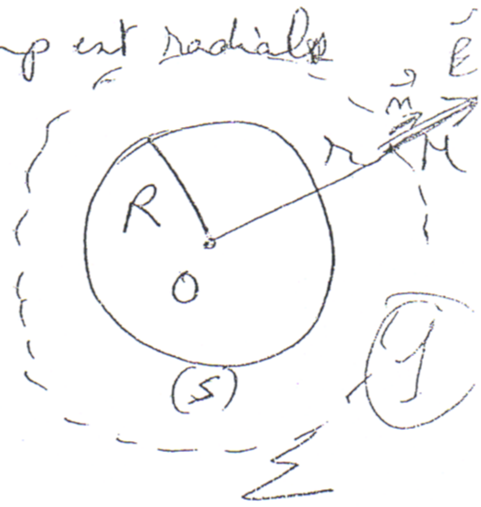
Given $C_V = \frac{5}{2}R$ and $C_P = \frac{7}{2}R$

1) Plot on a (P, V) diagram the above described cycle.
2) Determine in terms of T_o and the adiabatic constant γ the temperature at each state.
3) Find in terms of R, T_o, and γ the quantities of heat exchanged during each transformation stating whether the heat is gained or lost.
4) Determine in terms of γ the efficiency of the cycle.

1) La Surface de ~~Gauss~~ est un Sphère concentrique passant par le Point $M / OM = r$ (1)

Par raison de symétrie sphérique, le champ est radiale

$r>R$ dirigé vers l'extérieur $(Q>0)$ (1)



(1)

$$\phi = \int_\Sigma \vec{E}\,\vec{n}\,dS = \int_\Sigma E\,dS = E\int_\Sigma dS = E\,S_\Sigma$$ (1)

$$= E\,4\pi r^2$$

$$\phi = \frac{1}{\varepsilon_0}\sum_i q_i = \frac{1}{\varepsilon_0}\,Q$$ (1/2)

d'où $$\boxed{E_e = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}}$$ (1/2)

on $\vec{E} = -\overrightarrow{grad}\,V \Rightarrow E = -\frac{dV}{dr}$ (1/2)

$$dV = -E\,dr = -\frac{Q}{4\pi\varepsilon_0}\frac{dr}{r^2} \Rightarrow \boxed{V_e = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r} + cte}$$

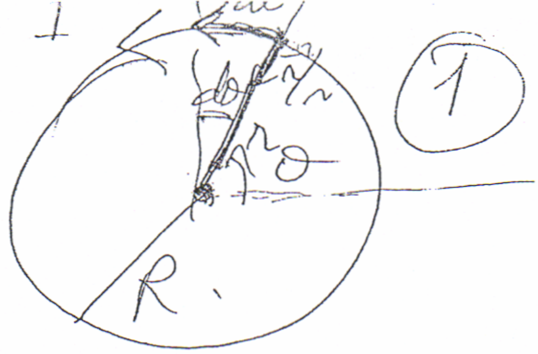
on $V=0$ pour $r \to \infty \Rightarrow cte = 0$ (1/2)

$$\Rightarrow \boxed{V_e = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}}$$ (1/2)

$r<R$ $\quad \phi = \frac{1}{\varepsilon_0}\sum_i q_i = 0 \Rightarrow E_i = 0$ (1/2)

donc $$\boxed{V_i = cte = V_{(S)} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}}$$ (1)

VII $d\vec{B}' = \frac{\mu_0 I}{4\pi r^2} \vec{dl} \wedge \frac{\vec{r}}{r}$ 1



$dB = \frac{\mu_0 I}{4\pi R^2} dl \cdot \sin \pi/2$ 1

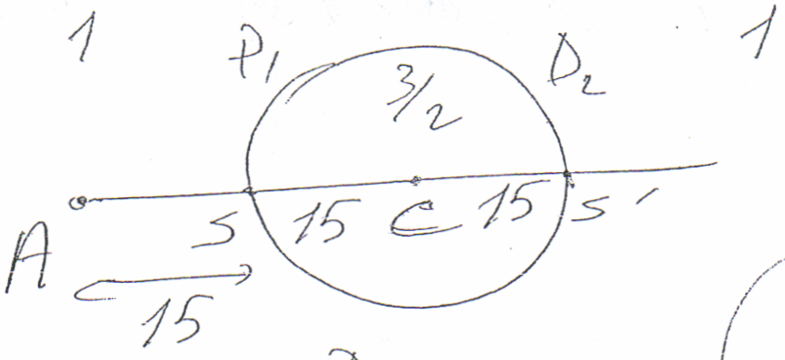
on tg $d\theta \simeq d\theta = \frac{dl}{R} \Rightarrow dl = R\,d\theta$

$dB = \frac{\mu_0 I}{4\pi R^2} R\,d\theta = \frac{\mu_0 I}{4\pi R} d\theta$ 2

$B = \frac{\mu_0 I}{4\pi R}\int_0^{2\pi} d\theta = \frac{\mu_0 I}{2R}$ $\odot$ 1

perpendiculaire dirigé vers l'extérieur

III)



$A \xrightarrow{D_1} A_1 \xrightarrow{D_2} A'$ 2 1/2

1) $\frac{n'}{p'} - \frac{n}{p} = \frac{n'-n}{R} \Rightarrow \frac{3}{2\overline{SA_1}} + \frac{1}{15} = \frac{3/2 - 1}{15} = \frac{1}{30}$

$\frac{3}{2\overline{SA_1}} = \frac{1}{30} - \frac{1}{15} = -\frac{1}{30} \Rightarrow \boxed{\overline{SA_1} = -45\text{ cm}}$

$\Rightarrow \boxed{\overline{S'A_1} = -75\text{ cm}}$

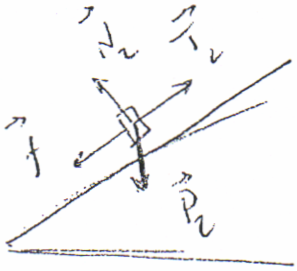
2 1/2

$\frac{1}{\overline{S'A'}} + \frac{3}{150} = \frac{1 - 3/2}{-15} = \frac{1}{30}$

$\frac{1}{\overline{S'A'}} = \frac{1}{30} - \frac{3}{150} = \frac{2}{150} = \frac{1}{75} \Rightarrow \boxed{\overline{S'A'} = 75\text{ cm} \text{ (réelle)}}$

1

I 1) $\vec{P}_2 + \vec{N}_2 + \vec{T}_2 + \vec{f}_2 = m_2 \vec{a}$ (1)



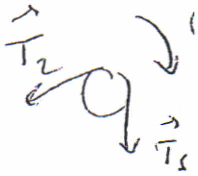
$$\begin{cases} ox: & -m_2 g \sin\alpha + T_2 - f_2 = m_2 a \quad (1) \; 1 \\ oy: & +m_2 g \cos\alpha = N \Rightarrow \; 0{,}5 \end{cases}$$

$$f = \mu N = \mu m_2 g \cos\alpha \quad 0{,}5$$

$$(1): T_2 = m_2 \left(a + g\sin\alpha + \mu g \cos\alpha\right)$$

$\vec{P}_1 + \vec{T}_1 = m_1 \vec{a}$ 1 $\Rightarrow P_1 - T_1 = m_1 a$

$$T_1 = m_1 (g - a) \quad (2) \; 1$$



$$-R T_2 + R T_1 = I \ddot{\theta}$$

2 $$= \frac{1}{2} M R^2 \times \frac{a}{R} \Rightarrow -T_2 + T_1 = \frac{M a}{2} \quad (3)$$

$$\Rightarrow -m_2 a - m_2 g \sin\alpha - \mu m_2 g \cos\alpha + m_1 g - m_1 a = \frac{Ma}{2}$$

$$a\left(m_2 + m_1 + \frac{M}{2}\right) = g\left(m_1 - m_2 \sin\alpha - \mu m_2 \cos\alpha\right)$$

$$\boxed{a = \frac{g\left(m_1 - m_2 \sin\alpha - \mu m_2 \cos\alpha\right)}{m_2 + m_1 + \frac{M}{2}} = \frac{1 - \sin\alpha - \mu\cos\alpha}{\frac{5}{2}} \times g \quad 2}$$

2) $a = 0 \Rightarrow 1 - \sin\alpha = \mu \cos\alpha \Rightarrow \mu = \dfrac{1 - \sin\alpha}{\cos\alpha} = \dfrac{1 - \frac{1}{2}}{\frac{\sqrt{3}}{2}} = 0{,}5$

2,5

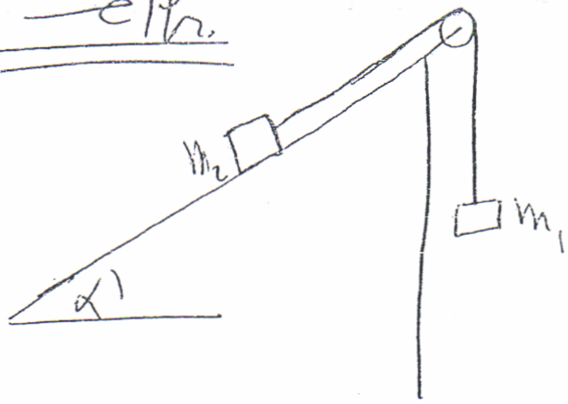
3) v_0

$M.R.U.A$: $a = g$ 0,5

$x = \frac{1}{2} a t^2 + v_0 t + \cancel{x_0}$ 1

$\boxed{x = \frac{1}{2} g t^2 + v_0 t}$ si cas $\downarrow +$ ou $x = -\frac{1}{2} g t^2 - v_0 t$ si cas $\uparrow +$

$$E_{M_{t_f}} - E_{M_{t_i}} = W_{f_{t_i \to t_f}}$$



$$E_{M_t} - E_{M_{t_0}} = W_{f_{t_0 \to t}} \quad 1$$

$$\left(\frac{1}{2} m_1 v^2 - m_1 g x\right) + \frac{1}{2} I W^2 + \left(\frac{1}{2} m_2 v^2 + m_2 g \sin\alpha\, x\right) = -$$

1 1 1 ? 1

avec $f = \mu m_2 g \cos\alpha$.

dérivée /à t :

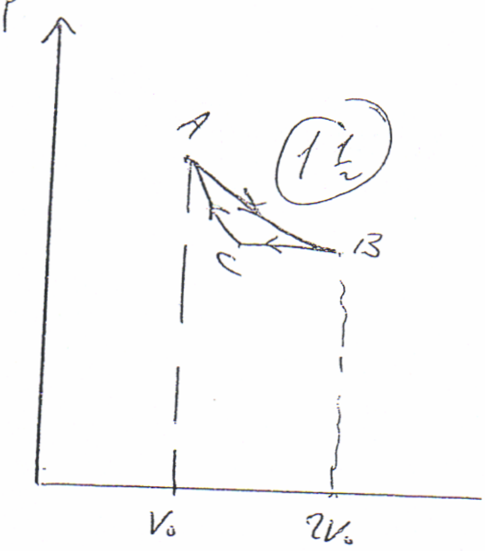
1

$$m_1 v a - m_1 g v + I W \ddot{\theta} + m_2 v a + m_2 g \sin\alpha\, v = -\mu m_2 g \cos\alpha$$

avec $v = RW$ et $a = R\ddot{\theta}$

$$a = \frac{(m_1 - m_2 \sin\alpha - \mu m_2 \cos\alpha)}{m_1 + m_2 + \frac{I}{R^2}}\, g = \frac{1 - \sin\alpha - \mu\cos\alpha}{5/2}\, g \quad 1$$

a)



b) $T_A = T_B = T_0$ (AB isoth.) $\frac{1}{2}$

$P_A V_A = P_B V_B \Rightarrow P_B = \frac{P_0 V_0}{2V_0} = \frac{P_0}{2}$ $\frac{1}{2}$. $P_C = P_B = \frac{P_0}{2}$ (BC isob

CA adiab. $\Rightarrow T_A^{\gamma} P_A^{1-\gamma} = T_C^{\gamma} P_C^{1-\gamma} \Rightarrow T_C = \left(\frac{P_0}{\frac{P_0}{2}}\right)^{\frac{1-\gamma}{\gamma}} T_0 = 2^{\frac{1}{\gamma}-1} T_0$ (

c) $Q_{CA} = 0$ (CA adiab.) $\frac{1}{2}$

AB isoth. $\Rightarrow \Delta U_{AB} = 0$ (gaz parfait) $\Rightarrow Q_{AB} = -W_{AB} = \int$

$\Rightarrow Q_{AB} = \int_{V_A}^{V_B} nRT_A \frac{dV}{V} = nRT_0 \ln \frac{V_B}{V_A} = RT_0 \ln 2 > 0$ 1

$R, T_0, \ln 2 > 0$

BC isob. $\Rightarrow Q_{BC} = nC_p (T_C - T_B) = \frac{7}{2} R T_0 \left(2^{\frac{1}{\gamma}-1} - 1\right)$ 1

$Q_{BC} < 0$ car $\gamma > 1$.

d) $e = \frac{Q_{AB} + Q_{BC}}{Q_{AB}} = 1 + \frac{Q_{BC}}{Q_{AB}} =$ 1

1 $1 + \frac{\frac{7}{2}\left(2^{\frac{1}{\gamma}-1} - 1\right)}{\ln 2}$