$\boxed{1}$ $\vec{v} = \frac{d\vec{OM}}{dt} \Rightarrow \begin{cases} v_x = R(\omega - \omega\cos(\omega t)) \\ \quad = R\omega(1-\cos(\omega t)) \\ v_y = R\omega\sin(\omega t) \end{cases}$ $\boxed{A}$

$\boxed{2}$ $\|\vec{v}\| = R\omega\left(1 - 2\cos(\omega t) + \cos^2(\omega t) + \sin^2(\omega t)\right)^{1/2}$

$= R\omega\sqrt{2}\left(1 - \cos(\omega t)\right)^{1/2}$ $\boxed{B}$

$\boxed{3}$ $\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \begin{cases} a_x = R\omega^2\sin(\omega t) \\ a_y = R\omega^2\cos(\omega t) \end{cases}$ $\boxed{D}$

$\boxed{4}$ B et D sont exactes

$\boxed{5}$ $\boxed{B}$ la roue fait un tour

$\boxed{6}$ $(\dot{x}^2 + \dot{y}^2) = 2R^2\omega^2(1-\cos(\omega t))$ (d'après la question 2)

$\dot{x}\ddot{y} - \dot{y}\ddot{x} = R^2\omega^3\cos(\omega t)(1-\cos\omega t) - R^2\omega^3\sin(\omega t)\sin(\omega t)$

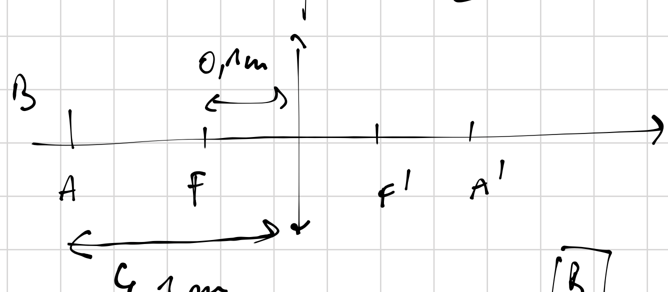
$= R^2\omega^3(\cos(\omega t) - 1)$ (<0)

$\rightarrow \rho(t) = \dfrac{2^{3/2}R^3\omega^3(1-\cos(\omega t))^{3/2}}{R^2\omega^3(1-\cos(\omega t))} = 2^{3/2}R(1-\cos(\omega t))^{1/2}$ $\boxed{D}$

Partie 2

7) $V = 10\ \delta \Rightarrow f' = 10^{-1}$ m $= 10$ cm $\Rightarrow$ réponse $\boxed{A}$

8) Il faut éloigner l'écran.



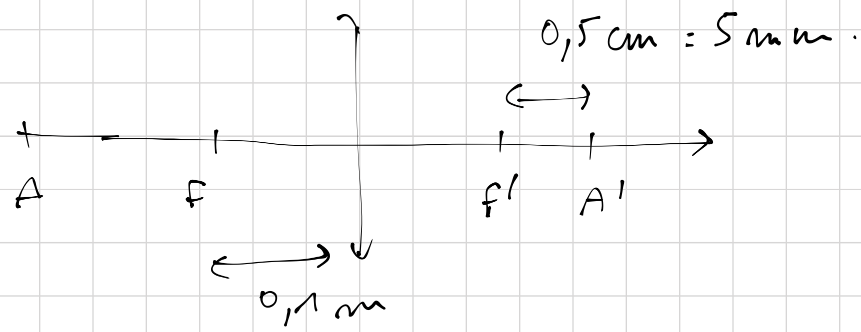
$\boxed{B}$

$\overline{FA}\cdot\overline{F'A'} = -f'^2$

$\Rightarrow \overline{F'A'} = -\dfrac{f'^2}{\overline{FA}}$ A.N : $\overline{F'A'} = \dfrac{10^{-2}}{4} = 2,5\cdot10^{-3}$ m

9)

$$\overline{FA} = -\frac{f'^2}{\overline{F'A'}} \qquad A.N \quad \overline{FA} = -\frac{10^{-2}}{5.10^{-3}} = -2\ m$$



$\Rightarrow \overline{OA} = -2,1\ m$ C

10) On a :

$$\frac{D_0}{OA_i'} = \frac{D_t}{A_iA_i'} \Rightarrow A_iA_i' = \frac{D_t}{D_0} OA_i'$$

$$= \frac{D_t}{D_0}\left(A_iA_i' + \frac{1}{V} + e\right)$$

$$\Rightarrow A_iA_i'\left(\frac{D_0}{D_t} - 1\right) = \frac{1}{V} + e \quad \text{soit} \quad \boxed{A_iA_i' = \frac{D_t}{D_0 - D_t}\left(\frac{1}{V} + e\right)}$$

$\boxed{A}$

11)

$$\frac{1}{OA_i'} + \frac{1}{d_m'} = V$$

$$\frac{1}{OA_i'} = \frac{D_t}{D_0}\frac{1}{A_iA_i'} = \frac{D_0 - D_t}{D_0}\frac{1}{1/V + e}$$ d'après la question précédente

$$\Rightarrow \frac{1}{d_m'} = \frac{D_t - D_0}{D_0}\frac{1}{\frac{1}{V} + e} + V$$

$$= \frac{D_t - D_0 + D_0 + D_0 eV}{D_0\left(\frac{1}{V} + e\right)} = \frac{D_t + D_0 eV}{D_0\left(\frac{1}{V} + e\right)}$$

$\boxed{A}$

$$\rightarrow d_m' = \frac{D_0\left(1/V + e\right)}{D_t + D_0 eV}$$

12

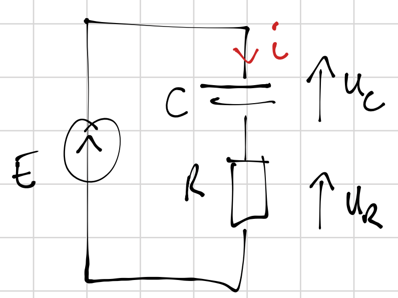
$$\frac{d(d'_m)}{dD_0} = \frac{\left(\frac{1}{V}+e\right)(D_f + D_0 e V) - eV D_0\left(\frac{1}{V}+e\right)}{(D_f + D_0 e V)^2}$$

$$= \frac{1}{(D_f + D_0 e V)^2}\left(\underbrace{\frac{1}{V} D_f + \cancel{D_0 e} + D_f e}_{\frac{D_f}{V} + D_f e > 0} + \cancel{D_0 e^2 V} - \cancel{e D_0} - \cancel{e^2 D_0 V}\right)$$

$\rightarrow$ d'_m fonction croissante de D_0 A

Partie 3

13)



$E = u_C + Ri$ $i = \frac{C du_C}{dt}$

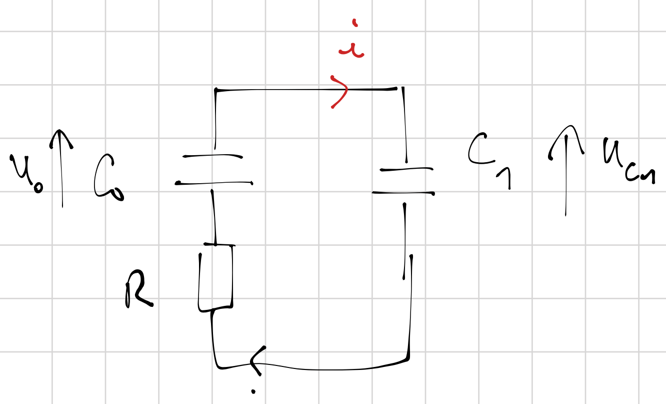
$\rightarrow E = u_C + RC\frac{du_C}{dt}$ $q_0 = C u_C$

$\rightarrow$ $\boxed{E = \frac{q_0}{C_0} + R\frac{dq_0}{dt}}$ B

$q_0 = C_0 E \left(1 - e^{-t/\tau}\right)$ avec $\tau = RC$ (condensateur initialement déchargé + u_C continue)

D

14) $q_0(0) = C_0 E$ cette fois



$u_{C0} = u_{C1} + Ri$

$i = \frac{dq_1}{dt} = -\frac{dq_0}{dt}$

$q_1(t) - 0 = -\left(q_0(t) - C_0 E\right)$

$$\frac{q_0}{C_0} = -\frac{1}{C_1}\left(q_0 - C_0 E\right) - R\frac{dq_0}{dt}$$

Soit

$$R\frac{dq_0}{dt} + \frac{C_0+C_1}{C_0C_1}q_0 = +\frac{C_0}{C_1}E$$

Finalement :

$$\boxed{\frac{dq_0}{dt} + \frac{C_0+C_1}{RC_0C_1}q_0 = \frac{C_0}{C_1R}E} \qquad \boxed{D}$$

15)

$$q_0 = Ae^{-t/\tau} + \frac{C_0^2}{C_0+C_1}E$$

À $t=0$ $\quad q_0 = C_0E = A + \frac{C_0^2E}{C_0+C_1}$

$$\Rightarrow q_0 = \frac{C_0^2E}{C_0+C_1} + \underbrace{\left(C_0E - \frac{C_0^2E}{C_0+C_1}\right)}_{\frac{C_1C_0E}{C_0+C_1}}e^{-t/\tau}$$

$$= \frac{C_0E}{C_0+C_1}\left(C_0 + C_1e^{-t/\tau}\right) \qquad \boxed{C}$$

16)

$$q_1 = -(q_0 - C_0E)$$

$$= \frac{C_0E}{C_0+C_1}\left(\cancel{-C_0} - C_1e^{-t/\tau} \cancel{+C_0} + C_1\right) \qquad \boxed{A}$$

17)

$$q_1(\infty) = \frac{C_0C_1E}{C_0+C_1} \qquad \mathcal{E}_1 = \frac{1}{2}\frac{q_1^2}{C_1} \qquad \mathcal{E}_0 = \frac{1}{2}\frac{q_0^2}{C_0}$$

avec q_1 $\qquad$ avec $q_0 = C_0E$

$$\rightarrow r_\mathcal{E} = \frac{C_0^2C_1E^2}{(C_0+C_1)^2\,C_0E^2} = \frac{C_0C_1}{(C_0+C_1)^2} \qquad \boxed{B}$$

18) $C_1 = n C_0$ $\left(Z_{eq}^{-1} = \sum_i Z_i^{-1} \Rightarrow j C_1 \omega = n j C_0 \omega \right)$

$r_\varepsilon = \dfrac{n C_0^2}{(n+1) C_0^2}$ $\Rightarrow$ $\boxed{B}$

Partie 4

$$\begin{matrix} T_i \\ p_i \\ V_i \end{matrix} \xrightarrow[\text{rev}]{\text{adiab.}} \begin{matrix} T' \\ p_i(1+\varepsilon) \\ V' \end{matrix} \xrightarrow{\text{isobare}} \begin{matrix} T_i \\ p_i(1+\varepsilon) \\ V_f \end{matrix}$$

19) Loi de Laplace : $p_i V_i^\gamma = p_i (1+\varepsilon) V'^\gamma$

$\Rightarrow$ $V' = V_i (1+\varepsilon)^{-1/\gamma}$ $\boxed{A}$

$T_i = T_f$ $\Rightarrow$ $p_i V_i = p_i (1+\varepsilon) V_f$ $\Rightarrow$ $V_f = \dfrac{V_i}{1+\varepsilon}$ $\boxed{D}$

20) $pV^\gamma = cte$ $\Rightarrow$ $p^{1-\gamma} T^\gamma = cte$

$$p_i^{1-\gamma} T_i^\gamma = p_i^{1-\gamma} (1+\varepsilon)^{1-\gamma} T'^\gamma$$

$\Rightarrow$ $T' = T_i (1+\varepsilon)^{\frac{\gamma-1}{\gamma}}$ $\boxed{B}$

21) T_1 adiabatique $W_{E_i E'} = n C_V (T' - T_i)$

$\Rightarrow W_{E_i E'} = \dfrac{nR}{\gamma - 1} T_i \left((1+\varepsilon)^{1-1/\gamma} - 1 \right)$ et $p_i V_i = nRT_i$

$\rightarrow$ $\boxed{C}$

22) T2 isobare : $W_{E' E_f} = -p_f (V_f - V')$

$\Rightarrow$ $W_{E' E} = -p_i (1+\varepsilon) \left(\dfrac{V_i}{1+\varepsilon} - V_i (1+\varepsilon)^{-1/\gamma} \right)$

$$\Rightarrow \quad W_{E'E_f} = p_i V_i \left((1+\varepsilon)^{1-1/\gamma} - 1 \right) \quad \boxed{C}$$

23) $\Delta U = 0$ car $T_f = T_i$ $\boxed{A}$

$$\Rightarrow \quad Q = -W_{EE'} - W_{E'E_f}$$

$$Q = \frac{p_i V_i}{\gamma - 1}\left(1 - (1+\varepsilon)^{1-1/\gamma}\right) + p_i V_i \left(1 - (1+\varepsilon)^{1-1/\gamma}\right)$$

$$= \frac{p_i V_i \gamma}{\gamma - 1}\left(1 - (1+\varepsilon)^{1-1/\gamma}\right)$$

($= \Delta H$ pour T_2 car $Q = 0$ sur T_1).

$\boxed{C}$

24) Si $\varepsilon \ll 1$

$$(1+\varepsilon)^{1-1/\gamma} \simeq 1 + \frac{\gamma - 1}{\gamma}\varepsilon \quad \Rightarrow \quad Q \simeq -\frac{p_i V_i \gamma}{\gamma - 1}\,\frac{\gamma - 1}{\gamma}\,\varepsilon$$

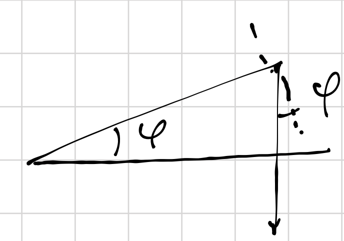
Soit $Q \simeq -p_i V_i \varepsilon$ et $W = -Q$ $\boxed{B}$ et $\boxed{D}$

Partie 5

$$\vec{OA} = r\,\vec{e_\rho} \qquad \vec{v} = r\dot{\varphi}\,\vec{e_\varphi} \qquad \vec{a} = r\ddot{\varphi}\,\vec{e_\varphi} - r\dot{\varphi}^2\,\vec{e_\rho}$$

$$\vec{P} = -mg\sin\varphi\,\vec{e_\rho} - mg\cos\varphi\,\vec{e_\varphi}$$

$$\vec{R} = R_n\,\vec{e_\rho} \quad \text{(pas de frottement)}$$



25)

$$\begin{cases} -mr\dot{\varphi}^2 = -mg\sin\varphi + R_n \\ mr\ddot{\varphi} = -mg\cos\varphi \end{cases} \quad \boxed{A}$$

26) $E_k = \frac{1}{2} m r^2 \dot{\varphi}^2$ $\boxed{B}$

$E_p = mgr\sin\varphi$ $\boxed{C}$

27) Conservation de l'énergie mécanique :

$$\frac{1}{2} m v_0^2 + m g r = \frac{1}{2} m v^2 + m g r \sin\varphi$$

$$\rightarrow \quad v^2 = v_0^2 + 2 g r (1 - \sin\varphi) \qquad \boxed{B}$$

28) $R_n = - m \frac{v^2}{r} + m g \sin\varphi$ d'après 25.

$$= - \frac{m v_0^2}{r} - 2 m g (1 - \sin\varphi) + m g \sin\varphi$$

$$= - \frac{m v_0^2}{r} + 3 m g \sin\varphi - 2 m g \qquad \boxed{A}$$

29) Si $v_0 = 0$ R_n s'annule pour $\sin\varphi = \frac{2}{3}$ $\boxed{C}$

30) Conservation de l'énergie mécanique :

$$\frac{1}{2} m v_{sol}^2 = m g r \rightarrow v_{sol} = \sqrt{2 g r} \qquad \boxed{D}$$

Partie 6

31) Conservation de l'énergie mécanique : $0 = \frac{1}{2} m_e v^2 - e V_a$

$$\rightarrow \quad v = \sqrt{\frac{2 e V_a}{m_e}} \qquad \boxed{B}$$

32) A.N : $v = \left(\frac{2 \times 1{,}6 . 10^{-19} \times 10^2}{9 . 10^{-31}} \right)^{1/2} = \left(\frac{2 \times 16}{9} \right)^{1/2} 10^6$

$$= \frac{4 \times 1{,}5}{3} . 10^6 \ m.s^{-1}$$

$\boxed{C}$

33) $\lambda_{DB} = \frac{h}{mv} = \frac{h}{\sqrt{2 e V_a m_e}}$ $\boxed{A}$

A.N : $\lambda_{DB} = \frac{6.10^{-34}}{9.10^{-31} . 6.10^{6}} = \frac{10^{-9}}{9} \simeq 10^{-10}$ m $\boxed{C}$

34) $m \frac{v^2}{R} = e v B \rightarrow R = \frac{mv}{eB}$ $\boxed{D}$

35) $\boxed{A}$ ($q\vec{v} \wedge \vec{B}$ ne modifie pas $\|\vec{v}\|$)

$\boxed{D}$ Il ne subit alors plus aucune force

36) θ est sans dimension

$R = \frac{mv}{eB}$ rayon $\Rightarrow \left[\frac{m\sqrt{\frac{2eV_a}{m}}}{eB} \right] = [L]$

$\left[\sqrt{\frac{2 V_a m}{e}} \right] = [B][L]$

$\rightarrow \alpha = 1$ $\boxed{C}$