This is a Class 1 exam

Lebanon Evangelical School for Boys and Girls

Lebanon Evangelical School

for Boys and Girls — Loucizeh - Baabda

Stage Exam 06

20JUN, 21JUN2022

Do NOT write in this box. Your MARK will be placed here.

Subject :	Physics
Class :	11S
Teacher :	Mr. Ali Moukalled
Duration :	1 hour

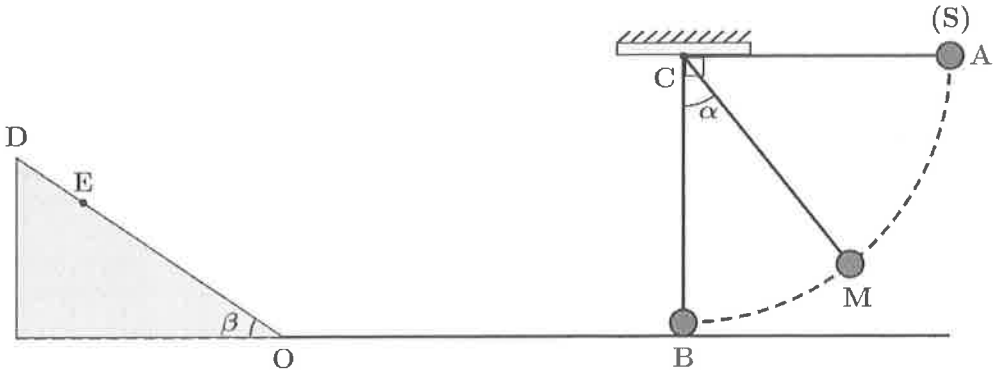
Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

Exercise1 (10 points)

Mechanical Energy

A pendulum is formed of a massless and inextensible string of length $l = 1.8m$, having one of its ends **C** fixed to a support while the other end carries a particle **(S)** of mass $m = 200g$.
The pendulum is stretched horizontally at point **A**. The particle is launched vertically downwards with a velocity $\vec{V}_A$ of magnitude $V_A = 8m/s$.
Take the horizontal plane passing through **BO** as the gravitational potential energy reference and $g = 10m/s^2$.
Neglect air resistance.



A- Motion between A and B

1. Calculate the mechanical energy of the system [pendulum ; Earth] at the instant of launching **(S)** at **A**.
2. (a) Find the expression of the gravitational potential energy in terms of α at **M**.
   (b) Deduce the expression of the kinetic energy in terms of α at **M**.
3. Show that the magnitude V_B of the velocity of **(S)** at **B** is $10m/s$.

B- Motion between B and O

After **(S)** reaches point **B** the pendulum is cut and the particle continues its motion along a horizontal frictional path $BO = 5m$, reaching **O** with a velocity $V_O = 2m/s$..

1. Is the mechanical energy conserved along **BO**? Justify.
2. Calculate the magnitude of the force of friction along **BO**.

C- Motion between O and D

Particle **(S)** climbs the frictionless inclined plane that makes an angle $\beta = 30°$ with the horizontal and stops at point **E** that is between **O** and **D**.

1. Calculate the mechanical energy at **O**. Deduce that at **E**.
2. Determine the distance **OE**.

Turn the page

Exercise2 (10 points)

Charging and Discharging of a Capacitor

A plane capacitor of capacitance C_1, a resistor of resistance $R = 2 \times 10^6 \Omega$, and a switch K are connected in series with a constant voltage source that delivers a voltage $E = 6V$, and of negligible internal resistance (Fig.1)

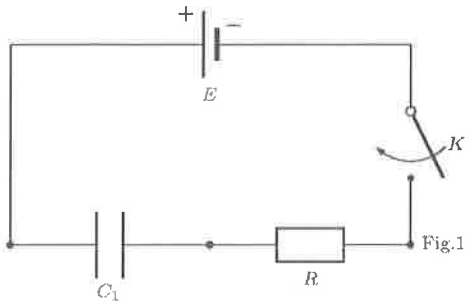


Fig.1

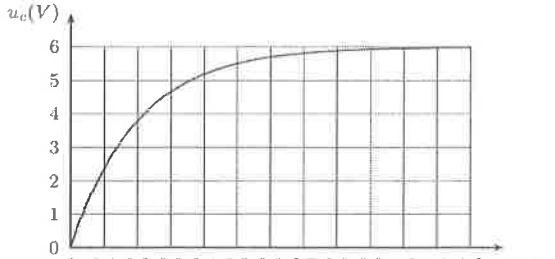


Fig.2

A- Knowing that the armatures of the capacitor are separated by a distance $d = 2mm$, the common surface of the armatures is $S = 36\pi\, cm^2$, and that the relative permittivity of the dielectric is $\epsilon_r = 2$ and $\epsilon_0 = 8.85 \times 10^{-12}\ SI\ unit$, verify that the value of the capacitance of the capacitor is $C_1 = 10^{-10} F$.

B- At $t = 0$, the switch K is closed. The graph of figure (2) represents the variation of the voltage u_C across the capacitor as a function of time.

1. Referring to the graph, determine the value of the voltage u_C at the end of the charging process.
2. Determine at $t = 0$:
   (a) the voltage u_C and the voltage u_R across the resistor.
   (b) the intensity of the electric current.
3. Determine for $t > 1ms$, u_R and i, and then calculate the electric energy stored in the capacitor..
4. At a well determined instant t_1 the value of the voltage across the capacitor is $u_C = 2V$. Find then the value of i.

C- The capacitor of capacitance C_1 is disconnected from the circuit, and it is again connected in series with a resistor of resistance $\mathbf{R = 2000\Omega}$.

1. Sketch without specific measurements the variation of u_C and u_R as a function of time.
2. Define and calculate τ.

GOOD LUCK

Solution "11S"

Exercise 1

$\ell = 1.8m \quad m = 200g = 0.2kg \quad V_A = 8 m/s$

A. Motion between A and B

1) $M.E_A = K.E_A + G.P.E_A$

$= \frac{1}{2} m V_A^2 + mgh_A$

$= \frac{1}{2}(0.2)(8)^2 + (0.2 \times 10 \times 1.8)$

$= 6.4 + 3.6$

$= 10 J$

$M.E_A = 10 J$ (1)

2) a) $G.P.E_M = mgh$

but $h = \ell - \ell\cos\alpha$

$= \ell(1 - \cos\alpha)$

$G.P.E_M = mg\ell(1-\cos\alpha)$

$= 0.2 \times 10 \times 1.8 (1-\cos\alpha)$ (1)

$= 3.6(1-\cos\alpha)$

$= 3.6 - 3.6\cos\alpha$

$G.P.E_M = 3.6 - 3.6\cos\alpha$

b) In the absence of friction, the M.E is conserved

$M.E_A = M.E_M$

$10 = K.E_M + G.P.E_M$

$10 - G.P.E_M = K.E_M$ (1)

$K.E_M = 10 - (3.6 - 3.6\cos\alpha)$

$= 10 - 3.6 + 3.6\cos\alpha$

$= 6.4 + 3.6\cos\alpha$

$\boxed{K.E_M = 6.4 + 3.6\cos\alpha}$ ✓ (1)

3) $M.E_A = M.E_B$

$M.E_A = K.E_B + G.P.E_B$

$\frac{1}{2}mV_B^2 = 10$

$\frac{1}{2}(0.2)V_B^2 = 10$

$V_B^2 = 100 \Rightarrow \boxed{V_B = 10\ m/s}$ ✓ (1)

B. Motion between B and O

BO = 5m (frictional track)

$V_0 = 2\ m/s$

1) No due to the presence of friction ✓ (1)

2) $\Delta M.E = W_{\vec{f_r}}$

$M.E_O - M.E_B = f_r \times OB \times \cos\pi$

$(K.E_O + G.P.E_O) - (M.E_B) = -f_r \times OB$

$\frac{1}{2}mV_O^2 - 10 = -f_r \times 5$ ✓ (1)

$(0.5)(0.2)(2)^2 - 10 = -f_r \times 5$

$0.4 - 10 = -f_r \times 5$ ✓ (1)

$f_r = 1.92\ N$

$\boxed{f_r = 1.92\ N}$

C. Motion between O and D

OD (frictionless)

$\beta = 30^\circ \quad V_E = 0\ m/s$

1) $M.E_O = K.E_O + G.P.E_O$

$= \frac{1}{2} m V_O^2$

$= 0.5(0.2)(2)^2$ ✓ (1)

$= 0.4\ J$

Due to the absence of friction the M.E is conserved

$M.E_E = M.E_O = 0.4\ J$

2) $M.E_E = 0.4\ J$

$K.E_E + G.P.E_E = 0.4\ J$

$mgh_E = 0.4$

but $\sin\beta = \frac{h_E}{EO} \Rightarrow h_E = EO \sin\beta$

$mg\,EO \sin\beta = 0.4$

$$EO = \frac{0.4}{mg\sin\beta} = \frac{0.4}{0.2 \times 10 \times \sin 30} = \frac{0.4}{1} = 0.4\ m$$

$\boxed{EO = 0.4\ m}$ ✓ (1)

Exercise 2

$R = 2 \times 10^6 \Omega$

$E = 6V$

A. $d = 2mm = 2 \times 10^{-3} \Omega$

$S = 36\pi cm^2 = 36\pi \times 10^{-4} m^2$

$\epsilon_r = 2$

$$C_1 = \epsilon_0 \epsilon_r \frac{S}{d} = 8.85 \times 10^{-12} \times 2 \times \frac{36\pi \times 10^{-4}}{2 \times 10^{-3}}$$ ✓ (1)

$$= 1.00091 \times 10^{-10} F \simeq 10^{-10} F$$

$$\boxed{C_1 = 10^{-10} F}$$ ✓ (1)

B. 1) at the end of the charging process ✓ (1)

$U_C = 6V = E$

2) at $t = 0s$

a) $U_C = 0V$

$U_C + U_R = E$

$0 + U_R = E$

$U_R = E = 6V$ ✓ (1)

b) Due to ohm's law

$U_R = Ri$

$$i = \frac{U_R}{R} = \frac{6}{2 \times 10^6}$$

$i = 3 \times 10^{-6} A$

$$\boxed{i = 3 \times 10^{-6} A = 3 \mu A}$$ ✓ (1)

3) $t > 1ms$, $u_R = 0V$,

due to ohm's law

$i = \frac{u_R}{R} = 0A$ $\boxed{i = 0A}$ ✓1

4) $u_c = 2V$.

$u_R + u_c = E$

$u_R = E - u_c$

$= 6 - 2$

$= 4V$

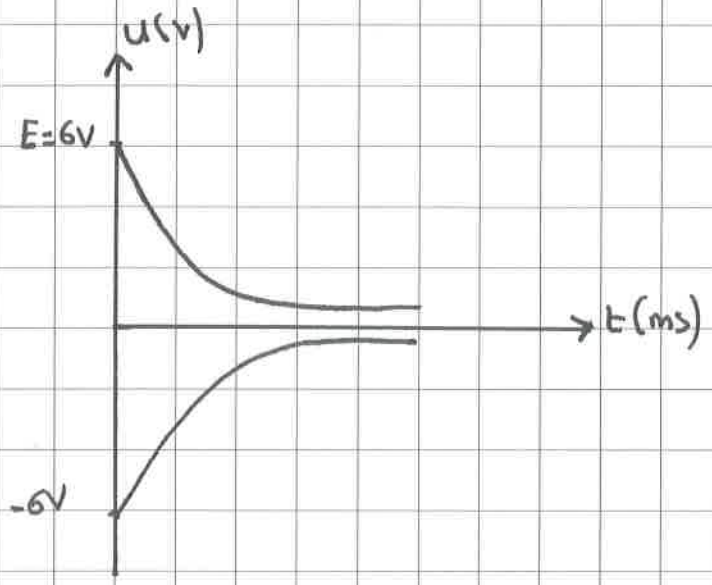
$\boxed{u_R = 4V}$ ✓1

$u_R = Ri$

$i = \frac{u_R}{R} = \frac{4}{2 \times 10^{+6}}$

$i = 2 \times 10^{-6} A = 2\mu A$ ✓1

C. $R = 2000\Omega$



1) $u_c + u_R = 0$

$u_c = -u_R$ ✓1

2) $\tau = RC$

$= 2000 \times 10^{-10}$

$= 2 \times 10^{-7} s$ ✓1