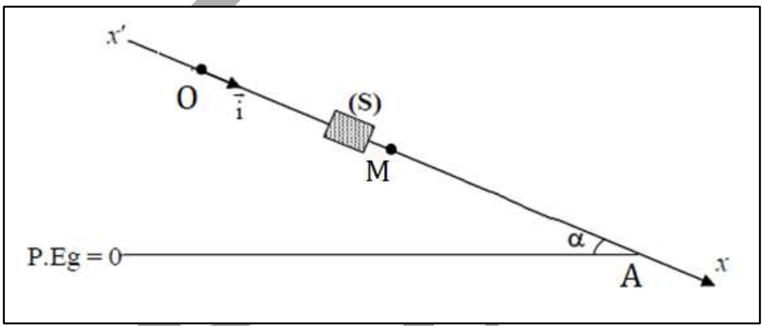
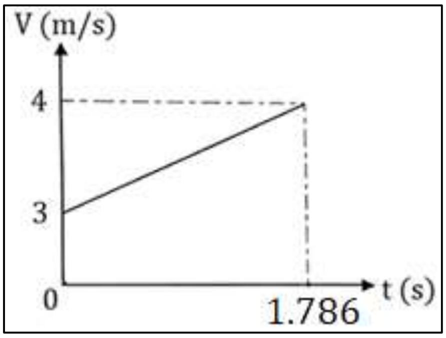
<u>Exercise 1</u> Motion along an inclined plane

A solid (S), of mass 500 g considered as a particle, is released at t = 0 with an initial velocity $\vec{V}_0 = V_0\vec{\imath}$ from the top point O of an inclined plane (OA) that makes angle $\alpha = 30^0$ with the horizontal. The inclined plane is rough and exerts a constant force of friction $\vec{f}$ on (S). The horizontal level passing through A chosen as a reference level of GPE as shown in document (Doc 1). Document (Doc 2) shows the variation of the velocity V of (S) as function of time as it moves from O to A.
Given $g = 10$ m/s^2.



Doc.1



Doc.2

Part 1: Dynamical Study

1-1) Name the external forces acting on (S) along the path OA. Draw, not to scale, a diagram of these forces.

1-2) Determine the variation of linear momentum $\Delta\vec{P}$ of (S) between O and A.

1-3) We can consider that $\frac{\Delta\vec{P}}{\Delta t} \approx \frac{d\vec{P}}{dt}$. Applying Newton's second law $\Sigma\vec{F}_{ext} = \frac{d\vec{P}}{dt}$ on the solid (S), determine the sum of the external forces ($\sum\vec{F}_{ex}$) acting on (S).

1-4) Verify that the force of friction $\vec{f} = -2.22\,\vec{\imath}$ (N).

Part 2: Energetic Study

Consider the distance OA= 6.25 m and a point M at instant t between O and A such that OM = x.

2-1) Calculate the mechanical energy ME_o of system [(S), Earth] at point O.

2-2) Determine, by applying the variation of mechanical energy $\Delta ME = W_{\vec{f}}$ between the two points O and M, the mechanical energy ME of system [(S), Earth] at point M as function of x.

2-3) Determine the gravitational potential energy GPE of system [(S), Earth] at point M as function of x.

2-4) Determine the kinetic energy KE of (S) at point M as function of x.

2-5) Represent on the same graph, using a convenient scale, the graphs of KE, GPE and ME as function of x between A and O.

Part of the Q	Physika LB physika-lb.blogspot.com **SE3 LS** **PHYSICS** **Answer key** **2021/2022** **Date: /03/2022**	**Mark**
	Exercise 1	
1-1	The external forces acting on (S): $M\vec{g}$: weight of (S) $\vec{N}$: Normal Reaction on (S) $\vec{f}$: friction force Diagram	
1-2	$\vec{P} = M\vec{V}$ $\vec{P}_O = M\vec{V}_O = 0.5\text{x}3\vec{i} = 1.5\,\vec{i}$ (kg.m/s) $\vec{P}_A = M\vec{V}_A = 0.5\text{x}4\,\vec{i} = 2\,\vec{i}$ (kg.m/s) $\Delta\vec{P} = \vec{P}_A - \vec{P}_O = 2\,\vec{i} - 1.5\,\vec{i} = 0.5\,\vec{i}$ (kg.m/s)	
1-3	Apply Newton's 2nd law $\sum \vec{F}\text{ ext} = \frac{d\vec{P}}{dt} = \frac{\Delta\vec{P}}{\Delta t} = \frac{0.5\,\vec{i}}{1.786} = 0.28\,\vec{i}$ (N)	
1-4	$\sum \vec{F}\text{ ext} = 0.28\,\vec{i}$ $M\vec{g} + \vec{N} + \vec{f} = 0.28\,\vec{i}$ $Mg\sin\alpha\,\vec{i} + Mg\cos\alpha\,\vec{j} + \vec{N} + \vec{f} = 0.28\,\vec{i}$ Where $Mg\cos\alpha\,\vec{j} + \vec{N} = \vec{0}$ $Mg\sin\alpha\,\vec{i} + \vec{f} = 0.28\,\vec{i}$ $0.5\text{x}10\sin 30\,\vec{i} + \vec{f} = 0.28\,\vec{i}$ $\vec{f} = -2.22\,\vec{i}$	
2-1	$ME_O = \frac{1}{2}MV_O^2 + Mgz_O = = \frac{1}{2}MV_O^2 + MgAO\sin\alpha = \frac{1}{2}(0.5)(3)^2 + 0.5\text{x}10\text{x}6.25\sin 30 = 17.875\text{J}$	
2-2	$\Delta ME = W_f$ $ME - ME_O = -f\,x$ $ME - 17.875 = -2.22\,x$ $ME = -2.22\,x + 17.875$	
2-3	$GPE = Mgz = Mg(MA)\sin\alpha = Mg(OA-OM)\sin\alpha = Mg(OA-x)\sin\alpha = 0.5\text{ x}10\,(6.25 - x)\sin 30 = 15.625 - 2.5x$	
2-4	$ME = KE + GPE$ $-2.22\,x + 17.875 = KE + 15.625 - 2.5x$ $KE = 0.28\,x + 2.25$	
2-5	Graph	