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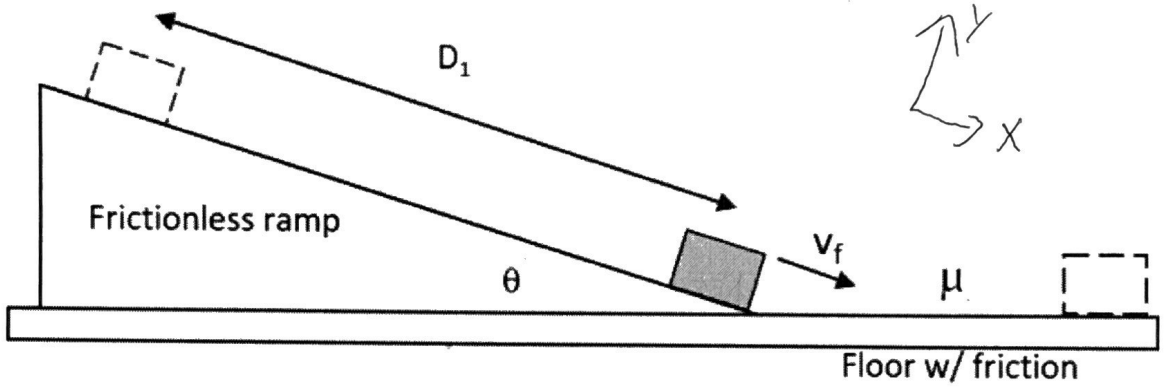
Physics 211 – Exam 1 Free Response

- Show your work and thinking clearly. Points will not be given if you just give the final answers without showing your work.
- **For this problem, you are only allowed to use the formulas on the formula sheet. If your solution uses other formulas that you may have memorized, points will be deducted.**



A 7 kg block starts at rest and slides down a frictionless ramp that makes an angle θ=26 degrees with respect to the horizontal floor below. There is friction between the floor and the block. The length of the ramp is D_1 = 3 meters.

(a) Draw a free body diagram for the block when it is on the ramp. Clearly label all forces (2 points)

Gravity = mg

Normal from ramp = N

(b) Calculate the speed of the block when it reaches the bottom of the ramp. (5 points)

$\Sigma F_x = ma_x$

$mg\sin\theta = ma_x$

$a_x = g\sin\theta$

$V_f^2 = V_0^2 + 2a(x - x_0)$

$V_f^2 = 0 + 2g\sin\theta D_1$

$V_f^2 = 25.7$ $\quad V_f = 5.1 m/s$

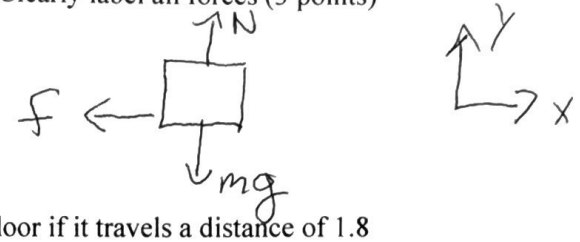
(c) Calculate the time it takes for the box to reach the floor (3 points)

$V = V_0 + at$

$t = \frac{V_f - V_0}{a} = \frac{5.1}{g\sin\theta} = 1.18 \text{ seconds}$

More questions on the back side of this sheet

(c) Draw a free-body diagram for the block when it is on the floor. Clearly label all forces (3 points)



(d) Calculate the coefficient of friction between the block and the floor if it travels a distance of 1.8 meters on the floor before coming to a stop. (4 points)

$\Sigma F_y = ma_y$

$N - mg = 0$

$N = mg$

$\Sigma F_x = ma_x$

$-f_k = ma_x$

$-\mu_k N = ma_x$

$-\mu_k mg = ma_x$

$a_x = -\mu_k g$

$V_f^2 = V_0^2 + 2a(x_f - x_i)$

$0 = V_0^2 + 2a_x \Delta x$

$a_x = -\frac{V_0^2}{2\Delta x}$

$-\mu_k g = -\frac{V_0^2}{2\Delta x}$

$\mu_k = V_0^2 / 2g\Delta x$

$\mu_k = \frac{5.1^2}{(2)(9.8)(1.8)}$

$\mu_k = 0.728$

(e) Using the result you obtained above, sketch a plot of the speed and acceleration of the block parallel to its direction of motion as a function of time, starting from when the block is released from rest. Label the point where the block reaches the end of the ramp. (3 points)