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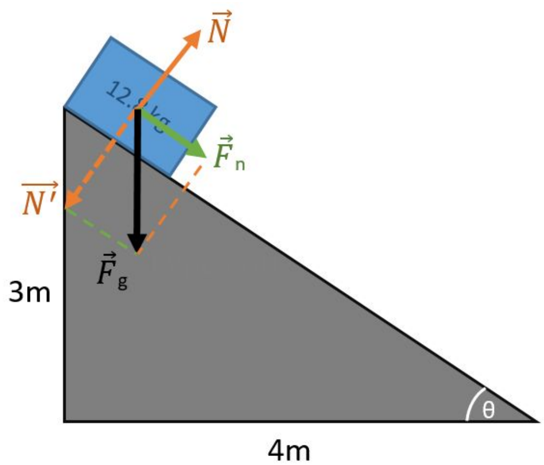
Physics Assignment 2

1. Consider a metal loot crate, at the top of a frictionless ramp. If the mass of the loot crate is 12.8kg and the ramp has a rise of 3m and a run of 4m, then compute the following.

a) Compute the free body diagram of the loot crate a time 0. (i.e. when the loot crate is at the top of the ramp.) (5 Marks)



b) Compute the net force and the acceleration of the loot crate at time 0. Given the frictionless surface what do we know about the acceleration as the object moves down the ramp? (5 Marks)

m = 12.8kg
H = 3m
X = 4m
$\theta = ?$
Fnet = ?

Assuming frictionless ramp, $\mu k = 0$
$tan\theta = H/X$
$\theta = tan^{-1}(3/4)$
$= 36.87^\circ$

Force of Friction is 0 since frictionless surface, therefore $F_f = 0$.

Net force = mgsin θ
= (12.8)(9.8) sin(36.87))
= 75.264 N

Acceleration = gsin θ
= (9.8)(sin(36.87))
= 5.88 m/s^2

Given that the surface of the ramp is frictionless, the acceleration is constant.

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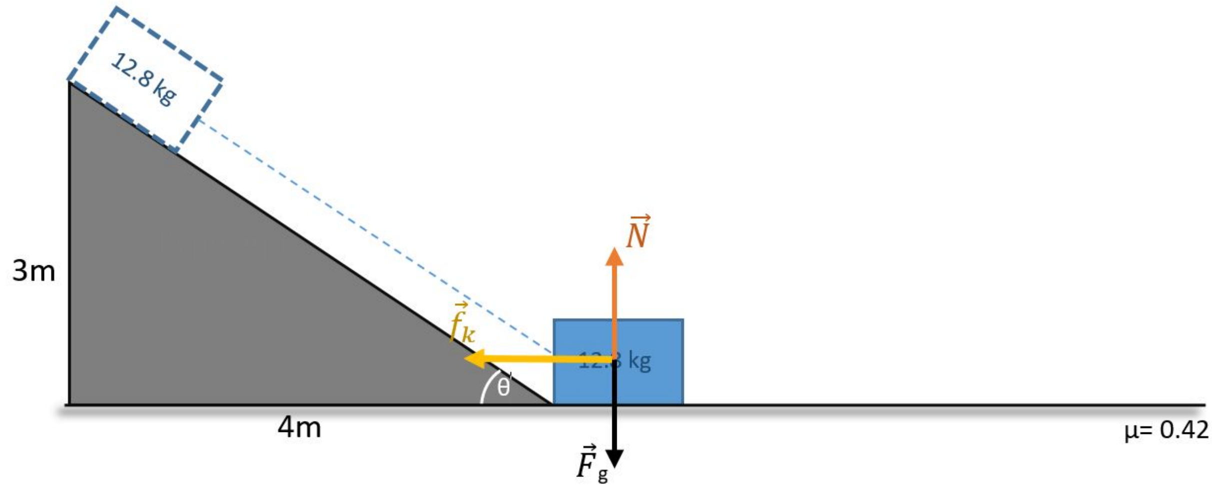
c) Consider the loot crate as it leaves the ramp and moves onto a surface that now has some friction. Compute the free body diagram for this situation. If the coefficient of kinetic friction is 0.42 (steel on steel), calculate the new net force and acceleration. (5 Marks)



- As the crate leaves the ramp, force of gravity and normal force are going to be the acting against each other in equilibrium
  The only other force that's going to act upon the crate is the force of friction.
- As such, the acceleration is going to be facing the other way

Let f_k be the force of friction
$f_k = \mu F_g = \mu mg$
$= (0.42)(12.8)(9.8)$
$= 52.6848$

Since there is no other force acting upon the object, the friction force becomes our net force. Therefore the new Net Force is 52.6848 Newton's going against the direction of motion.

- To find acceleration, we have to take into account the function $F_{net} = ma$
- Another way to figure out the net force is $F_{net} = F_{applied} - F_k$
- However only the force of friction is acting upon the crate as it hits the surface, so $F_{applied} = 0$, therefore $F_{net} = -F_k$
- Substitute these two terms together and we arrive at this equation

ma = $-\mu k F n$
- To find the acceleration, we can factor out the mass so we get acceleration

A = $-\mu k g$
$= -(0.42)(9.8)$
$= -4.116\ m/s^2$

- Therefore the acceleration of the crate is $4.116\ m/s^2$ going against the direction of motion

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(d) If we assume that the force of friction is constant after this point, how long will it take for the loot crate to stop moving? At what distance in meters will the loot crate stop? (5 Marks)

- Break it down to parts
- We want to find out the initial velocity of the crate as it leaves the ramp.

$Vf^2 = vi^2 + 2a\Delta d$

- Let Δd be the length of the ramp as it goes down
- Since the ramp's length is 4 and the height is 3, we can use the 3-4-5 triangle rule to denote the ramp's length as 5 m
- We will then substitute the values obtained from the previous questions to find the final velocity as the crate leaves the ramp

Vi = 0
A = 5.88 m/s^2
D = 5m

Vf = $\sqrt{2ad}$
= $\sqrt{(2)(5.88)(5)}$
= $\sqrt{58.8}$

= 7.6681 m/s as it leaves the ramp

- This final velocity will now become our initial velocity to find the time it takes to stop and the distance it will go before it stops completely.
- To find the time we will use the formula: $v_f = v_i + a(t)$, where our acceleration is derived from part C.
- To find the distance traveled we will use the formula $v_f^2 = v_i^2 + 2a(\Delta d)$. Again, acceleration is derived from part C
- Since at the end the crate will stop, v_f will equal 0

T = ?
0 = (7.6681) + (- 4.116 m/s^2)(t)
T = 7.6681/4.116
= 1.8630 s

Δd = ?
0 = (7.6681)^2 + 2(-4.116)(Δd)
Δd = 58.7997/(8.232)
= 7.1428 m

- Therefore,the time it takes for it to stop is 1.863 seconds, and the distance it will travel is before it goes to a complete stop is 7.1428 meters.

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e) Include a short document (report) that includes a diagram that illustrates the problem and your solution. Ensure you include appropriate labels and show your work (10 Marks)

All diagrams and calculations shown above in the document.