PH201 U2022 Q2 Solutions

Monday, July 4, 2022 5:02 PM

Name:_____ ID:_____

Physics 201

Quiz 2

7/5/2022

Collaboration is not allowed. Allowed on your desk are: one 8.5 x 11 inch doubled sided sheet of notes, non-communicating graphing scientific calculator, 2 pages of scratch paper, writing utensils, and the exam. You will have 50 minutes to complete this exam.

You may need this:

if $0 = Ax^2 + Bx + C$

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

For question 1 **fill in the square** next to all correct answers. A given problem may have more than one correct answer. Each correctly bubbled answer will receive two points. There are **6** correct answers in this section and only the first **6** filled in answers will be graded. There is no partial credit.

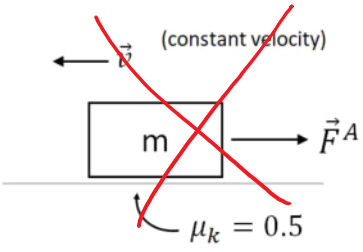
1. Which of the following statements MUST be true?

$f^f = \mu f^N$

- ☐ (a) The kinetic frictional force on a sliding object is dependent on its weight
- ☑ (b) The kinetic frictional force on a sliding object is dependent on the normal force acting on it
- ☐ (c) The weight of an object is equal to the normal force acting on it
- ☑ (d) The net force on an object is equal to its own mass times the acceleration of the object $\vec{F}_{net} = m\vec{a}$
- ☐ (e) The coefficient of kinetic friction depends on the normal force acting on the object
- ☐ (f) The coefficient of static friction has units of Newtons
- ☑ (g) The coefficient of static friction is unitless (has no units)
- ☑ (h) An object with non-zero net force acting on it is accelerating $\vec{F}_{net} = m\vec{a}$
- ☐ (i) Your instructor jumps really high. While Evan is moving upwards, the net force acting on him is pointed UPWARDS
- ☑ (j) Your instructor jumps really high. While Evan is moving upwards, the net force acting on him is pointed DOWNWARDS
- ☐ (k) Your instructor jumps really high. While Evan is moving upwards, the net force acting on him is ZERO
- ☐ (l) Benny is driving East in his car on a flat highway at a constant speed. The net force on Benny is pointed EAST
- ☐ (m) Benny is driving East in his car on a flat highway at a constant speed. The net force on Benny is pointed WEST
- ☑ (n) Benny is driving East in his car on a flat highway at a constant speed. The net force on Benny is ZERO.

2. (9 points) Carefully draw a free body diagram for each of the following scenarios. Make sure that forces on the free body diagrams are appropriately scaled relative to each other (bigger forces should be represented with larger vectors, forces that are equal in strength should have equally sized vectors). Make sure to label each vector. Assume each situation happens on Earth.

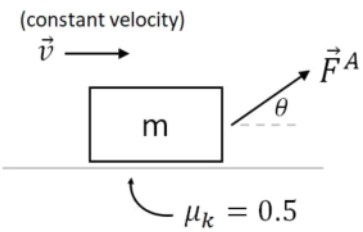
(a)

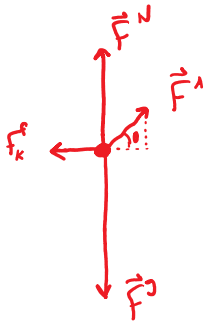


+ 3 pts

It's not possible to have const velocity with the $\vec{v}$ & $\vec{F}^A$ pointed opposite directions ⇒ everybody gets 3 pts

(b)





force sizes determined by:

$f_x^A = |f_k^f|$

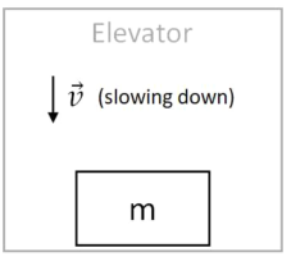
⇓

$|f_k^f| = \frac{1}{2}|F^N|$

⇓

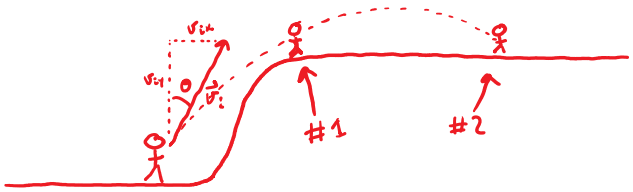
$|F^N| + |F_y^A| = |F^g|$

(c)



$\vec{v}\downarrow$ + slowing down ⇒ $\vec{a}\uparrow = \vec{f}_{net}\uparrow$ ⇒ $F^N > F^g$ ⇛

3. (7 points) Benny throws a baseball to Bernice, who is on a sand dune at the Oregon coast. Bernice catches the ball 5.2 meters above the point at which Benny releases the ball. Benny releases the ball with an initial velocity of 36 m/s at an angle of 30 degrees with respect to vertical. How far away from Benny is Bernice when she catches the ball?



$\cos\theta = \frac{v_{iy}}{|\vec{v}_i|}$

$\Rightarrow v_{iy} = |\vec{v}_i| \cos\theta$

$v_{ix} = |\vec{v}_i| \sin\theta$

$\Rightarrow v_{ix} = 18 \text{ m/s}$

$v_{iy} = 31.17 \text{ m/s}$

Y

$\Delta y = v_{iy}\Delta t + \frac{1}{2} a_y \Delta t^2$

$0 = (31.17 \text{ m/s})\Delta t + (-4.9 \text{ m/s}^2)\Delta t^2 - (5.2 \text{ m})$

$\Rightarrow$ quadratic formula $\Rightarrow$ $\Delta t = \frac{-31.17 \pm \sqrt{31.17^2 - 4(-4.9)(-5.2)}}{2(-4.9)}$

$\Delta t = 0.171 \text{ s}$ or 6.19 s

X

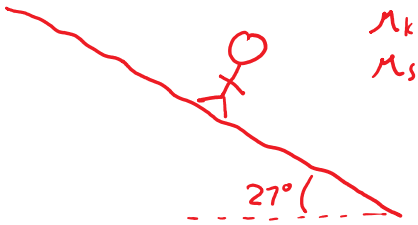
$\Delta x = v_{ix}\Delta t + \frac{1}{2} g_x^{\,0} \Delta t^2$

$\Rightarrow \Delta x = 3.07 \text{ m}$ or 111 m

there are two potential answers to this problem! the two solutions are illustrated by the two locations where Bernice is drawn (#1 & #2) in the problem setup figure.

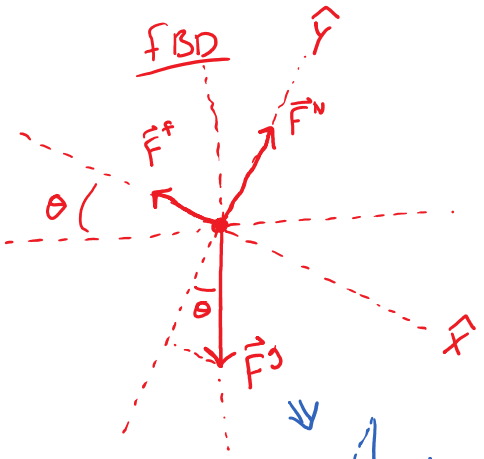
4. (8 points) Benny again finds himself potentially sliding on a slope. The slope makes an angle of 27 degrees with respect to the horizontal. Benny and the slope have coefficients of friction of $\mu_k = 0.2$ and $\mu_s = 0.45$. Benny has a mass of 25 kg and is at rest at $t = 0$ s.

(a) Does Benny slide down the slope? Prove that he does or does not using any combination of words, figures, algebra, graphs, etc.



$\mu_k = 0.2$

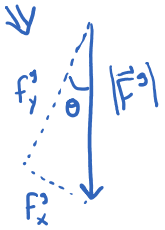
$\mu_s = 0.45$



$+\uparrow |\vec{F}^N| - mg\cos\theta = ma_y^{\,0}$

$\Rightarrow |F^N| = mg\cos\theta$

because the x-component of gravity is larger than the maximum static friction force, Benny will begin to slide !!



$f_x^g = |f^g| \sin\theta$

$f_y^g = |f^g| \cos\theta$

$+\rightarrow |f_x^g| - |f^f| = ma_x$

$|f_{s,max}^f| = \mu_s |F^N| = \mu_s mg\cos\theta = (0.45)(25\,kg)(9.8\,m/s^2)\cos(27°)$

$= 98.2$ N

($|f_{s,max}^f|$: ↑ max value)

$f_x^g = mg\sin\theta = 111$ N

$|f_x^g| > |f_{s,max}^f|$

(b) If Benny's mass were to double to 50 kg, how would that affect your solution? Explain using any combination of words, figures, algebra, graphs, etc.

We need to compare f_x^g with $f_{s,max}^f$

$\Rightarrow \quad f_x^g \gtrless^{?} f_{s,max}^f$

$\Rightarrow \quad mg\sin\theta \gtrless^{?} \mu mg\cos\theta$

the masses will cancel !! ⇒ our comparison does not depend on Benny's mass.