APPC, Mechanics: Unit β HW 2

Name: ______________________________

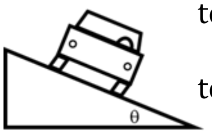
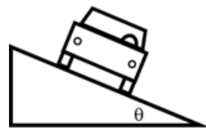
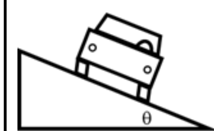
Hr: ___ Due at beg of hr on: ___________

Uβ, HW2, P1

Reference Video: "Physics of Banked Turns"
YouTube, lasseviren1, NEWTON'S LAWS OF MOTION playlist

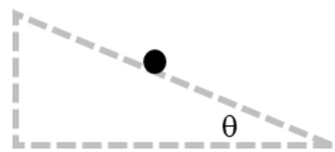
Below are three figures in which a car is going in a horizontal circle on a banked curve of slope θ. At each instant shown, the car is moving toward you (i.e., out of the page). The car has a mass *m*, the coefficient of static friction is μ_s, and the center of the circle is a distance *R* away, directly to your right.

A. Circle the correct answer, for each picture. "In this figure, the car is moving…"

	too fast too slowly at perfect speed		too fast too slowly at perfect speed		too fast too slowly at perfect speed

B. Inside the banked curves above, either (1) write "$F_s = 0$" <OR> (2) draw and label an arrow in the correct direction, to indicate EXACTLY which way the friction force F_s is pointing.

C. We will now consider ONLY the case of the car moving "at perfect speed." The dot in the figure represents the car. (I have included the banked curve so you can be sure to get your vectors pointed correctly. You're welcome. ☺)



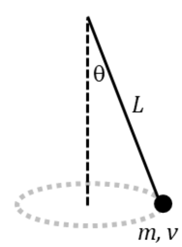
i. Draw a correct FBD for the situation described above. Use SOLID arrows for these vectors. Do NOT draw components, at this time.

ii. Above and to the right of the figure, sketch a coordinate-axis "legend" that applies here. HINT: It might be helpful to refer back to HW1, P1, Part Aiii to make sure you get this exactly right.

iii. One of your Part Ci vectors needs to be resolved for its components to lie along the axes of Part Cii. Resolve that vector now, in the figure, using DASHED arrows. Label the components meaningfully.

D. Here, write two equations: One with a trig function relating your Part Ciii components, and the other (easily) expressing one of those Part Ciii components in terms of other given variables.

E. Write a Newton's 2nd law equation. Then substitute your Part D answers into it and derive an expression for the "perfect" speed of the car on this banked curve.



Next, we deal with a battery-powered toy plane of mass *m* attached to a string of length *L*. The plane circles horizontally at a constant speed *v* and makes a constant angle θ with the vertical.

F. Down and to the right, draw an FBD of the plane. Use SOLID arrows.

G. Add to your FBD by resolving one of your Part F vectors. Use DASHED arrows and label the components meaningfully. HINT: HW1, P1, Part Aiii.

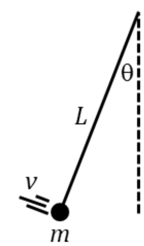
H. Repeat here what you did above in Part D.

I. Write a Newton's 2nd law equation, substitute your Part H answer into it and, finally, derive an expression for the speed *v* in terms of given quantities.

Uβ, HW2, P2
Reference Video: “Non-Uniform Circular Motion: Centripetal and Tangential Acceleration” YouTube, lasseviren1

A. To review: Uniform circular motion (UCM) is circular motion at a ______________ speed. In such a case, the entire (or total) acceleration of the object is in the form of ________________________ acceleration, which conforms to the easy equation _________ and is always is directed…

B. In non-UCM, the object is turning AND, at the same time, its speed is either ______________________ or ______________________. There continues to be a ________________________ acceleration (or ______________ acceleration) and it is sometimes written as $\vec{a}_{\perp}$ because this acceleration is perpendicular to the ________________. The equation of this component – and its direction – is in accord with your Part A answer. However, for non-UCM, there is an additional acceleration component, called the ________________________ acceleration, symbolized _____, which is along the line of motion. Another symbol for this component is $\vec{a}_{//}$ because this acceleration is parallel to the ________________.



A pendulum has a mass m attached to a rope of length L. At the instant depicted, we also know the angle θ that the rope makes with the vertical and the mass’s speed v.

C. On the big dot, draw an FBD of the mass. Use SOLID arrows. Do NOT draw components.

D. Sketch a coordinate-axis “legend” that applies here. HINT: HW1, P1, Part Aiii.

E. Add to your FBD by resolving one of your Part C vectors, in accordance with your Part D answer. Use DASHED arrows, and label your new components.

This is one of the rare cases we will meet in which the acceleration in NEITHER direction equals zero (“Ahem…” This is the whole deal with non-UCM ☺).

F. In the space below, write TWO Newton’s 2nd law equations for this situation. Then derive expressions for (1) a_c, (2) a_t, and (3) the tension in the rope, in terms of the given quantities.

G. Whenever we know the two ⊥ components of any quantity, we can always find the magnitude of the overall (or total, or resultant) vector by using the ________________________ ______________.

H. Write out the expression a_{total} = ? that would result if you applied your Part G answer to two of your three Part F answers. DO NOT SIMPLIFY the expression; just show me what it looks like.

I. If we now wanted to find the mass’s speed at a later instant, we would want to use conservation of energy, and NOT Kinematics Equations I-IV. WHY? (HINT: What condition must be satisfied to use those equations, and how does that compare to what do you see in your Part H answer?)

Uβ, HW2, P3
Reference Video: "Physics of Elevators"
YouTube, lasseviren1, NEWTON'S LAWS OF MOTION playlist

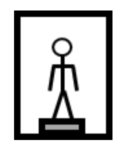
A. Bathroom scales don't tell us our weight; they tell us the ________________ force that is holding us up.

B. Suppose you have a scale in the bathroom right next to the sink. How will the scale read, compared to your actual weight, for each case? (CIRCLE)

i. you stand normally on the scale	EQUAL	MORE THAN	LESS THAN
ii. you stand while pushing downward on the sink	EQUAL	MORE THAN	LESS THAN
iii. during the time you're jumping upward off the scale	EQUAL	MORE THAN	LESS THAN
iv. during the time you're landing back down on the scale	EQUAL	MORE THAN	LESS THAN
v. you stand while lifting upward on the sink	EQUAL	MORE THAN	LESS THAN
vi. you stand on the scale with only one foot	EQUAL	MORE THAN	LESS THAN

C. Explain briefly how Newton's 3rd law comes into play (and relates to your answers) in Parts Bii and Bv.

D. Explain how Newton's 2nd law comes into play (and relates to your answers) in Parts Biii and Biv.



The figure shows an 80 kg person standing *on a scale in an elevator*. ☺ For the next few problems, (1) label FBDs using variables only, and (2) draw vectors to an appropriate length, i.e., the length should mean something. Also, for any calculations, use g = 10 m/s^2.

E. Suppose, at some point, the scale reads 800 N. Draw an FBD for this case.

F. For the case of Part E, determine the acceleration of the person/elevator.

G. List at least two possible things (depending how you word it, there could be three) that the elevator might be doing, for the case of Part E.

H. Suppose, at some point, the scale reads 680 N. Draw an FBD for this case.

I. For the case of Part H, determine the acceleration (mag. and dir.) of the person/elevator.

J. List the two possible, <u>specific</u> things that the elevator might be doing, for the case of Part H.

K. Suppose, at some point, the scale reads 1040 N. Draw an FBD for this case.

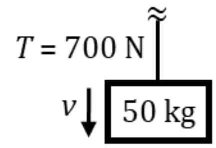
L. For the case of Part K, determine the acceleration (mag. and dir.) of the person/elevator.

M. List the two possible, <u>specific</u> things that the elevator might be doing, for the case of Part K.

Uβ, HW2, P4
Reference Videos: (1) "Physics of Elevators"
(2) "Newton's Law of Motion Review (Part I)"
YouTube, lasseviren1, NEWTON'S LAWS OF MOTION playlist

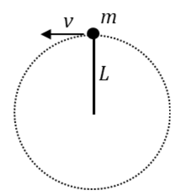
NOTE: As always, you are advised to use $g = 10\ \text{m/s}^2$, to essentially eliminate any need for a calculator.

A 50 kg metal crate is moving downward. It is attached to a heavy cable that, at the moment in question, has a tension of 700 N.



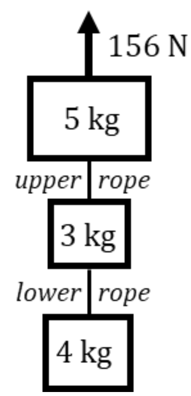
A. Draw an FBD and determine the magnitude and direction of the crate's acceleration.

B. As the crate descends, is it speeding up or slowing down? Briefly explain your answer.



C. A 2 kg stone attached to a 4-m rope is being whirled in a vertical circle. At the top, the speed of the stone is 8 m/s. Draw an FBD and determine the tension in the rope. See the figure.

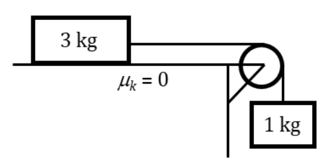
D. Suppose the stone in Part C is still moving at 8 m/s when it reaches the bottom of its path. Again, draw an FBD and determine the tension in the rope.



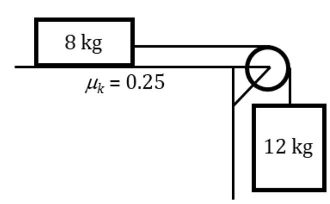
A three-block system is being raised upward, against gravity. See the figure at right.

E. Determine the tension in the upper rope AND the lower rope.

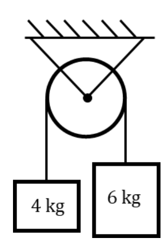
F. For the system shown, find the acceleration of the system and the string's tension.



G. For the system shown, find the acceleration of the system and the string's tension.

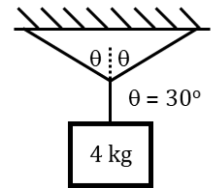


H. For the system shown, find the acceleration of the system and the string's tension.



Uβ, HW2, P5
Reference Videos: (1) "Review of Newton's Laws of Motion (Part II)"
(2) "Review of Newton's Laws of Motion (Part III)"
YouTube, lasseviren1, NEWTON'S LAWS OF MOTION playlist

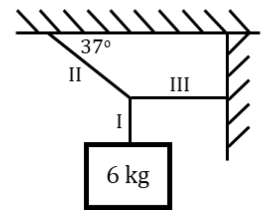
A. With reference to the figure at right...



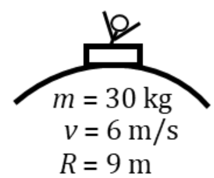
i. What is the VERTICAL component of the tension in each angled rope?

ii. What is the overall tension in each slanted rope? (NOTE the 30-60-90 right triangles...)

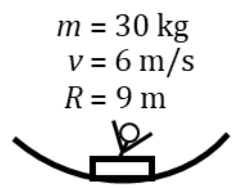
B. Use the diagram at right to determine the tension in Ropes I, II, and III.



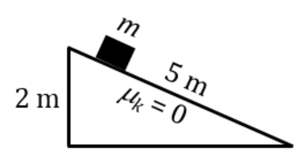
C. A child in a sled slides over the top of a snowy hill. Draw an FBD and determine the normal force of the hill on the sled.



D. Now, the child is at the bottom of the next valley. Draw an FBD and determine the normal force of the hill on the sled.



E. Determine the acceleration of the mass down the frictionless plane. Draw an FBD, and then report your final answer in terms of some fraction of g.



F. Determine the mass's acceleration in this last figure. Note that there IS friction, this time. Draw an FBD and report your answer in terms of some fraction of g.