Physics 200 Name KEY

Exam 2 – Friction and Energy

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October 25, 2007

This is a closed book examination. There is extra scratch paper available. Explanations must be included with all answers – even multiple-choice questions where the explanation is worth 75% of the possible points.

A general reminder about problem solving:

1. Draw a picture then create a simplified free body diagram with all forces
2. Write down what you know including coordinate frame
3. Write down what you don't know and/or want to know
4. List mathematical relationships
5. Simplify and solve
6. Check your answer – Is it reasonable? Are units correct?

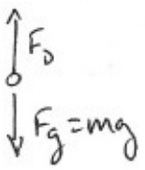
- Show all work! Use extra paper if needed.

The next two questions concern a large stone elephant statue and a small stuffed toy mouse that you drop from a great height. Do not neglect any effects due to air drag.

1. [4 PTS] When both objects have reached terminal velocity the acceleration
   A. of the large stone elephant is greater.
   ~~B.~~ of both objects is the same and zero.
   C. of both objects is the same and non-zero.
   D. of the small stuffed toy mouse is greater.

$V_{terminal}$ = constant so $\Delta V = 0$ and $a = 0$

2. [4 PTS] Which object has a greater drag force on it?
   ~~A.~~ The large stone elephant has the largest drag force.
   B. Both objects have the same drag force.
   C. The small stuffed toy mouse has the largest drag force.
   D. Not enough information is given.



② V_{term} $\Delta V = 0$ $a = 0$ so $\Sigma F = 0$

$\therefore F_D = F_g$

$m_{ele} > m_{mouse} \rightarrow F_{De} > F_{Dm}$

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4. [4 PTS] Two identical apples are thrown with the same initial speed from the roof of Hagen Hall. One apple is thrown at 45 degrees above the horizon while the other apple is thrown at 45 degrees below the horizon. Neglect any effects due to air drag. Indicate which statement below is true.
   a) The apples strike the ground at the same time and with the same speed.
   ~~b)~~ The apples strike the ground at different times and with the same speed.
   c) The apples strike the ground at the same time and with different speeds.
   d) The apples strike the ground at different times and with different speeds.

$E_i = PE_i + KE_i$ is the same for both apples. Energy is conserved $E_f = E_i$ so KE_f is the same for both apples — hence they have the same speed $v = \sqrt{\frac{2KE}{m}}$. The apple with an initial velocity down will take less time to hit the ground

The next three questions involve two carts that are identical except they have different masses. The mass of cart 1 is twice the mass of cart 2 ($m_1 = 2m_2$).

5. [8 PTS] The two carts are pushed with the same force for the same amount of distance. Which cart has a greater kinetic energy after being pushed? Neglect any effects due to friction.
   a) Cart 1 has the greatest kinetic energy.
   ~~b)~~ Both carts have the same kinetic energy.
   c) Cart 2 has the greatest kinetic energy.
   d) Not enough information is given.

$W = \Delta KE$

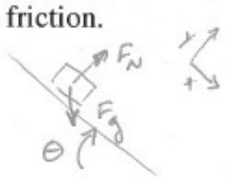
$\theta = 0°$ and F is constant

$W = \int \vec{F} \cdot d\vec{x} = \int F\cos\theta\, dx$

$W = F\Delta x$

Work is the same for both carts hence ΔKE is the same and since $KE_i = 0$ for both KE_f is the same.

6. [8 PTS] The two carts roll down the same incline. Which cart has a greater kinetic energy at the bottom of the incline? Neglect any effects due to friction.
   ~~a)~~ Cart 1 has the greatest kinetic energy.
   b) Both carts have the same kinetic energy.
   c) Cart 2 has the greatest kinetic energy.
   d) Not enough information is given.



$F_g \sin\theta = ma_x$

$mg\sin\theta = ma_x$

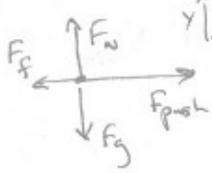
$g\sin\theta = a_x$

Both carts travel the same distance - but have different forces acting on them $F = mg\sin\theta$

$\therefore F_1 > F_2$ $(m_1 > m_2)$

Acceleration is the same for both carts so they have the same velocity $\therefore$ more massive cart has more KE

7. [8 PTS] The two carts are pushed with the same force for the same distance. Which cart has a greater kinetic energy after being pushed? Assume the coefficient of friction is the same for both carts.
   a) Cart 1 has the greatest kinetic energy.
   b) Both carts have the same kinetic energy.
   ~~c)~~ Cart 2 has the greatest kinetic energy.
   d) Not enough information is given.



$F_N - F_g = 0 \quad \therefore F_N = F_g = mg$

$F_{net} = F_p - F_f = F_p - \mu mg$

$m_1 > m_2$ so $F_{Net_1} < F_{Net_2}$

$W = \Delta KE = \int \vec{F} \cdot d\vec{x}$ so $W_1 < W_2$ and $\Delta KE_1 < \Delta KE_2$

Cart 2 will have a greater kinetic energy.

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The next two questions involve two balls that are identical except they have different masses. Ball one is more massive than ball two ($m_1 > m_2$). Neglect any effects due to air drag.

8. [4 PTS] The balls are thrown with the same initial velocity straight up into the air. Which ball has more energy at the top of their trajectory?
   a) Ball one has more energy.
   b) Ball one and two have the same energy at the top.
   c) Ball two has more energy.

$KE_1 > KE_2$ since $m_1 > m_2$ $(KE = \frac{1}{2}mv^2)$

Ball one starts off with more energy so it will always have more energy - The energy is PE_g at the top of the trajectory

9. [4 PTS] The balls are dropped from the same height. Which ball has the greater velocity right before hitting the ground?
   a) Ball one has a greater velocity.
   b) Ball one and two have the same velocity.
   c) Ball two has a greater velocity.

$E_i = E_f$

$PE_i + KE_i = PE_f + KE_f$ Define $PE = 0$ on ground

$mgh = \frac{1}{2}mv^2$

$(2gh)^{1/2} = v$ Same height $\therefore$ Same velocity

$F_g = mg$ $F_g = ma$ $a = g$

acceleration is the same (g) for both objects...

10. [12 PTS] You need to move a 75 kg box that is resting on a level floor in your apartment. The coefficient of state friction between the box and the floor is 0.8. You can either push or pull the box. Assume you will apply your push or pull at the same angle so the force is either applied at an angle, θ, above or below the horizontal.
    a) Does one method require less force that the other? Explain.
    b) Calculate the minimum force needed to move the box by each method if $\theta = 40°$. Compare these forces to the force required when $\theta = 0°$

11. [12 PTS] You are watching a "flying pig" (spherical pendulum) move in a circle in front of your physics class. You estimate the pig has a mass of 0.25 kg, is suspended from a string that is 0.7 m long and that it takes 1.7 seconds to make one revolution.
    a) What is the kinetic energy of the pig when flying?
    b) What is the change in potential energy of the pig when flying compared to when it is not flying.

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