Name _____ Section _____

Physics 1210 Exam #2
October 25, 2018

This test is closed-note and closed-book. No written, printed, or recorded material is permitted. Calculators are permitted but computers are not. No collaboration, consultation, or communication with other people (other than the administrator) is allowed by any means, including but not limited to verbal, written, or electronic methods. Sharing of calculators is prohibited. If you have a question about the test, please raise your hand. For multiple choice, you may choose two answers, and if one is correct, receive half credit, etc. For full credit on written problems, show the full thought process from basic equations to final results.

$$V_{avg}=\frac{x_2-x_1}{t_2-t_1}=\frac{\Delta x}{\Delta t} \quad a_{avg}=\frac{v_2-v_1}{t_2-t_1}=\frac{\Delta v}{\Delta t} \quad a_{centrip}=\frac{v^2}{R}=\frac{4\pi^2 R}{T^2}$$

$$V_{sphere}=\frac{4}{3}\pi R^3$$

$$x_1=x_0+v_0 t+\frac{1}{2}at^2 \quad v_1=v_0+at \quad v_1^2=v_0^2+2a(x_1-x_0)$$

$2.2\,lbs=1\,kg$ $1\,mi=5280\,ft=1609\,m$ $1\,Calorie=4200\,J$

$$x_{quadratic}=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

Work/Energy $\Sigma \bar{F}=m\bar{a}$ $F_{spring}=-kx$ $F_f=\mu F_n$

$$W=\bar{F}\cdot\bar{s} \quad W=\Delta K \quad K=\frac{1}{2}mv^2 \quad U_s=\frac{1}{2}kx^2 \quad U_g=mgy \quad P=\frac{\Delta W}{\Delta t}=Fv \quad W_{grav}=-\Delta U$$

$$F=-\frac{dU}{dx}$$

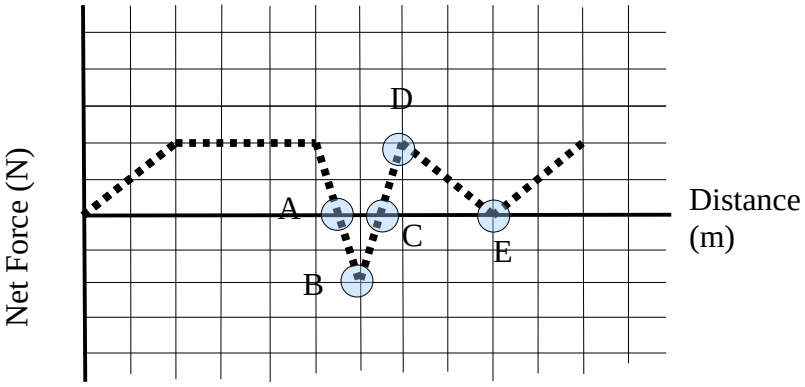
Momentum/Impulse $p=mv$ $J=\Delta(mv)=Ft$ $X_{cm}=\frac{\Sigma m_i x_i}{\Sigma m_i}$

1. (10 pts) You are working with a team to help design cars to stop in shorter distances on level wet roadways without skidding once the driver steps on the brakes. Which of the following things can you do to decrease the stopping distance (circle one or more).
A. decrease μ_k B. decrease μ_s C. increase μ_s D. increase μ_k E. increase car's mass F. decrease car's mass

or but not mass

2. (10 pts) A box rests on an inclined surface. The force that keeps the box from sliding downhill is
A. equal to its weight B. less than its weight C. greater than its weight
D. equal to its weight times μ E. equal to its weight times μ times g

3. (10 pts) From this graph of force versus distance on a particle, from points B to E you can conclude that
A. the velocity goes from negative to positive
B. the position goes from negative to positive
C. the potential energy is zero at both places
D. the change in kinetic energy is positive
E. the change in potential energy is zero



4. (10 pts) Write a few lines of Matlab code that would plot the potential energy stored in a Hooke's Law spring with k=10 N/m every 0.5 meters from x=-2 to 2 meters.

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k = 10
x = -2:0.5:2
U = 0.5*k*x.^2
plot(x,U)
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5. (10 pts) Protons and neutrons are subatomic particles, both of which are examples of
A. crutons B. pions C. bosons D. hadrons E. klingons

6. (10 pts) A truck of mass M moving at speed V locks its brakes and skids to a stop in time t. The coefficient of friction is μ between the tires and road. If you double the truck's initial speed and double μ, the new stopping time is A. unchanged B. 1/2 t C. 1/4 t D. 2t E. 4t

7. (20 pts) Describe an activity that a 100 kg human could (briefly!) do that would require 600 Watts of power. Show a short calculation to back up your claim.

$600\,w = \frac{600\,J}{s}$ $\quad w = F \cdot D = 600\,J = mgD$

$\frac{600}{100 \cdot 10} = D$

$0.6 = D$

climb 0.6 m every second

8. (10 pts) An ice skater of mass M moving at speed 2V collides with a stationary skater of mass 2M. Afterward the first skater is motionless and the second skater moves off with speed V. From this you can conclude that
A. The collision is inelastic B. The collision is elastic C. The collision is both elastic and inelastic
D. The collision is cataclysmic E. Not enough information is given to know

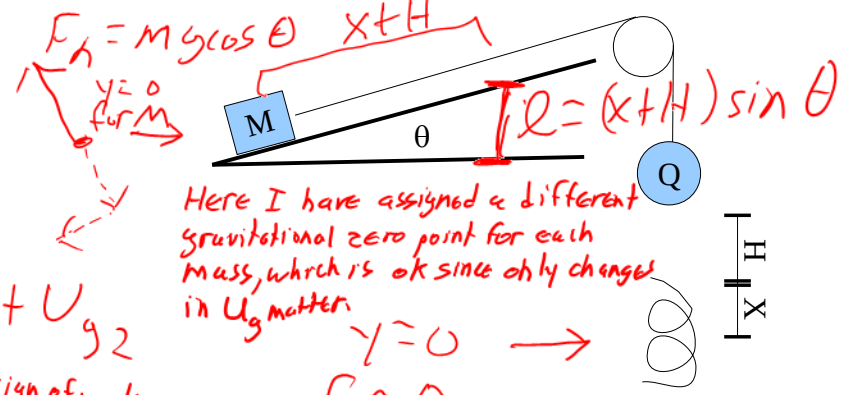
9. (10 pts) As you bike from your dorm or apartment to campus, make a list of the things that do work on you and tell whether the work is positive or negative. Give at least three for full credit.

friction -
you +
air resistance -
gravity + or -

10. (10 pts) An object acted upon by a conservative force
A. increases its kinetic energy but decreases its potential energy
B. increases its potential energy but decreases its kinetic energy
C. does not change kinetic energy
D. does not change potential energy
E. does not change total mechanical energy

work it all in one step!

11. (50 pts) A box of mass M on a slope of angle θ and friction coefficients μ_k and μ_s and is pulled uphill by a massless cord attached over a massless pulley to a hanging mass Q which falls a distance H before hitting and compressing a spring of constant K some distance X before coming to rest. Give an expression for X in terms of other variables, and possibly g.



Here I have assigned a different gravitational zero point for each mass, which is ok since only changes in U_g matter.

$E_1 = E_2$

use energy conservation

$K_1 + U_{sp_1} + U_{g_1} + W_o = K_2 + U_{sp_2} + U_{g_2}$

$Mgy_{M_1} + Qgy_{Q_1} + \mu Mg\cos\theta(x+H)(-1) = \frac{1}{2}kx^2 + Mgy_{M_2} + Qgy_{Q_2}$

sign of work

$(x+H)$

$Qg(x+H) - \mu Mg\cos\theta(x+H) = \frac{1}{2}kx^2 + Mg(x+H)\sin\theta$

$Qgx + QgH - \mu Mg\cos\theta x - \mu Mg\cos\theta H = \frac{1}{2}kx^2 + Mgx\sin\theta + MgH\sin\theta$

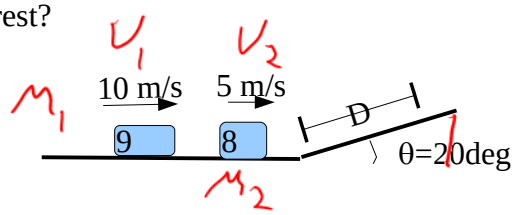
$0 = \frac{1}{2}kx^2 + (Mg\sin\theta - Qg + \mu Mg\cos\theta)x + (Mg\sin\theta - Qg + \mu Mg\cos\theta)H$

$0 = \underbrace{\frac{1}{2}k}_{a}x^2 + \underbrace{g(M\sin\theta - Q + \mu M\cos\theta)}_{b}x + \underbrace{g(M\sin\theta - Q + \mu M\cos\theta)}_{c}H$

12. (40 pts) A 9 sled moving 10 m/s east collides with another 8 kg sled moving east at 5 m/s. Assume frictionless ice and level ground. They then stick together before coasting up a 20 degree frictionless incline.

A. What is their speed immediately after the collision?

B. What distance D do they travel along the incline before coming to rest?



A) conserve momentum

$P_1 = P_2$

y=0 →

$m_1 v_1 + m_2 v_2 = m_{12} v_{12}$

$m_{12} = m_1 + m_2$

$\frac{m_1 v_1 + m_2 v_2}{m_{12}} = v_{12} = \frac{9 \cdot 10 + 8 \cdot 5}{17} = \frac{130}{17}$

$= 7.6 \text{ m/s}$

B) conserve Energy

$E_1 = E_2$

$K_1 + U_{g_1} = K_2 + U_{g_2}$

$\frac{1}{2} m_{12} v_{12}^2 + m_{12} g y_1^{\,0} = \frac{1}{2} m_{12} v_{12}^{\,2\,0} + m_{12} g y_2$

$y_2 = D \sin\theta$

$\frac{1}{2} m_{12} v_{12}^2 = m_{12} g D \sin\theta$

$\frac{1}{2} \frac{v_{12}^2}{g \sin\theta} = D = 8.7 \text{ m}$