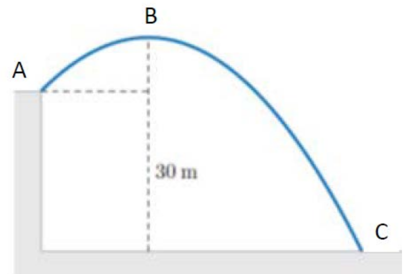
Physics 1100, SP17, Final Exam-a (2 hours), Name______________________, ID#______________, Score_100/100

1. (**2D kinematics - projectile, 4/ea.**) A ball at the point of A is launched on the top of a 30-m hill in a direction 30^o above horizontal and reaches the point B, 10 m higher above the hill, and then arrives at the point C.



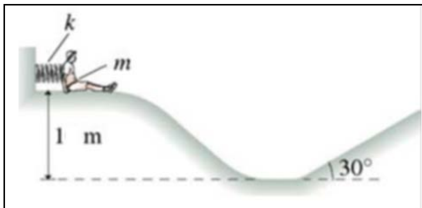
Ignore air resistance and use g = 10 m/s^2. Find:

(a) Launching velocity (magnitude only)? **Ans.**________31 m/s
(b) Time it takes to reach the top point B? **Ans.** ________1.55 s
(c) Time it takes to reach the ground after passing the B point? **Ans.**______2.9 s
(d) The maximum horizontal distance it can travel from A to C? **Ans.** ______119 m
(e) The ball's impact velocity at C (magnitude only)? **Ans.** _________39.5 m/s

2. (**Newton's laws/gravitation force/normal force/friction force, 4/ea.**) A 60-N horizontal force, **P**, pushes three objects next to each other with masses as indicated, across a horizontal solid surface, as shown below. There are no friction forces on the objects except the 5-kg object. The coefficient of kinetic friction is 0.10. Use g = 10 m/s^2.

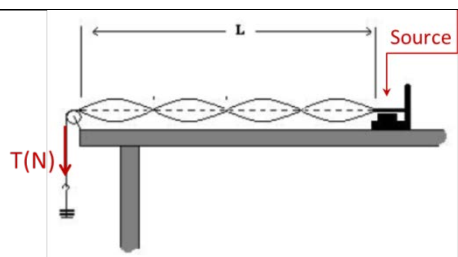
(a) What is the normal force on the 2-kg object? **Ans.** _________20 N
(b) What is the acceleration of the three-mass system? **Ans.** ____5.5 m/s^2
(c) What is the force the 2-kg object exerts on the 3-kg object? **Ans.**_______49 N
(d) What is the force the 3-kg object exerts on the 2-kg object? **Ans.**_______- 49 N
(e) What is the force the 5-kg object exerts on the 3-kg object? **Ans.**_______ -32.5 N

3. (**Work/kinetic energy/potential energy, 4/ea.**) A spring with a force constant of 20,000 N/m is compressed by X = 0.1 m to launch a student with a mass of 50 kg at the maximum speed attainable. The track shown below is frictionless except for the final 30^o incline, where the coefficient of kinetic friction is 0.10. Find:



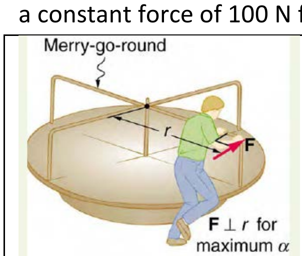
(a) The student's speed right after losing contact with spring (x = X)? **Ans.** __2 m/s
(b) The student's linear momentum in the valley? **Ans.**____245 Kg.m/s
(c) How far the student can go along the incline? **Ans.** ____2.05 m
(d) What is the work done by the friction force? **Ans.** _____89 J
(e) What is the work done by the gravitation force? **Ans.**___512.5 J

4. (**Waves – standing wave, 5/ea.**) At Brooklyn College general physics lab, a string with a line mass density of 0.003 kg/m and a string tension of 12 N is excited by a source with a frequency of 120 Hz resulting in a standing wave pattern as shown below. Find:



(a) The wave traveling velocity (or speed). **Ans.** ______63.25 m/s
(b) The wavelength of the wave. **Ans.** ______0.53 m
(c) The length of L. **Ans.** _______1.05 m
(d) What will be the number of anti-node when the tension is reduced to 7.62 N by reducing the suspended mass? **Ans.______5**

5. (**Torque/rotational motion, 4/ea.**) A 400-kg merry-go-around with a radius of 3 m is considered as a uniform disk. Peter exerts a constant force of 100 N for 1 second to speed up the spinning, reaching a faster angular velocity of 3.14 rad/s.



(a) What is the torque Peter applied to the merry-go-around? **Ans.** __________300 N.m
(b) What is the angular acceleration of the merry-go-around obtained? **Ans.** ___0.17 rad./s
(c) What is the initial angular velocity before the Peter's 1-second force? **Ans.**__2.97 rad./s
(d) What is the work done by the Peter's force? **Ans.** _____________916.5 J
(e) What is the increase in the merry-go-around's rotational kinetic energy due to Peter's work? **Ans.**___________916.5 J

<<Equations given below are for your reference only. >>

Kinematics	$v = v_0 + at$	$x = x_0 + v_0 t + (1/2)at^2$	$v^2 = v_0^2 + 2a(x - x_0)$	$v = \mathrm{sqrt}(v_x^2 + v_y^2)$
Newton's Laws	$\mathbf{V_0}$ remains with $\mathbf{F}_{net} = \mathbf{0}$	$\mathbf{F}_{\mathbf{net}} = m\boldsymbol{a}$	$\mathbf{F_1} = -\mathbf{F_2}$	
Uniform circular motion for a point-mass	$a_c = v^2/r$; $a_c = r\omega^2$	$F_c = ma_c$	$v = r\omega$	
Work, energy for a point mass	$w = F*d*\cos\theta$	$KE = (1/2)mv^2$	$PE = m*g*h$	
Momentum, collisions	$\mathbf{p} = m\mathbf{v}$	Momentum conservation: $\Delta p = 0$ for an isolated system		
Statics, torque	Condition-1: $\mathbf{F}_{net} = 0$	Condition-2: $\boldsymbol{\tau}_{net} = 0$	$\tau = F*r$	
Rotational motion for a uniform disk	$\theta = \theta_0 + \omega_0\Delta t + (1/2)\alpha\Delta t^2$	$I = (1/2)mr^2$; $\tau = Fr$; $L = I\omega$	$\tau = I\alpha$; $W = \tau\Delta\theta$	$KE_{rot} = (1/2)I\omega^2$
Oscillatory motion for a system with a spring and a point-mass	$F = -k \lvert \Delta x \rvert$	$KE = (1/2)mv^2$, for a point-mass $PE_{sp} = (1/2)kx^2$	$\omega = (k/m)^{1/2}$	$KE_m = (1/2)mv_m^2$; $PE_{sp} = (1/2)kX^2$ $KE_m = PE_m$
Waves	$y(x, t) = y_m \sin(\omega t - kx)$. $k = 2\pi/\lambda$; $w = 2\pi f$; $f = 1/T$; $v = \lambda/T$			
Standing wave (in a string)	$y(x, t) = 2 y_m \cos(\omega t) \sin(kx)$. $v = \mathrm{sqrt}(T/\mu)$, where T is the string tension and μ is the line mass density. $L = n(\lambda/2)$, where n is the number of anti-node			