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Name:……
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Section:……

Physics for Engineers I (PHYS 191)
and
General Physics I (PHYS 101)
Fall 2015
Final Exam
January 2, 2016

Please read the following instructions carefully before you start answering:

1. Make sure that you have 9 pages including two parts, A and B. Part A consists of 15 multiple choice questions, while Part B consists of 4 problems.
2. Answer all the questions and show all the steps of your work in part B in a clear tidy way.
3. Calculators are permitted but no electronic dictionaries.
4. Include units in all calculations and answers.
5. All your work must be done on your exam paper; no loose papers are allowed. If additional space is required use the last page and indicate that this has been done.
6. This is a timed exam (120 minutes). Do not spend too much time in any particular question.

Best Wishes

Part A: *Please choose the correct answer for each question*

Question 1: (1 pt) What is the value of $\pi(8.104)^2$, written with the correct number of significant figures?

A) 206.324
B) 206.323
C) 206.3
D) 206
E) 200

Question 2: (1 pt) Suppose that an object is moving with constant nonzero acceleration. Which of the following is an accurate statement concerning its motion?

A) In equal times its speed changes by equal amounts.
B) In equal times its velocity changes by equal amounts.
C) In equal times it moves equal distances.
D) A graph of its position as a function of time has a constant slope.
E) A graph of its velocity as a function of time is a horizontal line.

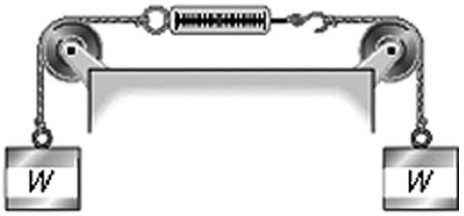
Question 3: (1 pt) An object has a position given by $\vec{r}$ = [2.0 m + (3.00 m/s)t]$\hat{\boldsymbol{\imath}}$ + [3.0 m - (2.00 m/s^2)t^2]$\hat{\boldsymbol{\jmath}}$, where all quantities are in SI units. What is the magnitude of the acceleration of the object at time t = 2.00 s?

A) 1.00 m/s^2
B) 0.00 m/s^2
C) 0.522 m/s^2
D) 4.00 m/s^2
E) 2.00 m/s^2

Question 4: (1 pt) A ball is tied to the end of a cable of negligible mass. The ball is spun in a circle with a radius 2.00 m making 7.00 revolutions every 10.0 seconds. What is the magnitude of the acceleration of the ball?

A) 67.9 m/s^2
B) 38.7 m/s^2
C) 29.3 m/s^2
D) 14.8 m/s^2
E) 74.2 m/s^2

Question 5: **(1 pt)** Two objects, each of weight *W*, hang vertically by spring scales as shown in the figure. The pulleys and the strings attached to the objects have negligible weight, and there is no appreciable friction in the pulleys. The reading in each scale is



A) *W*.
B) more than *W*, but not quite twice as much.
C) less than *W*.
D) 2*W*.
E) more than 2*W*.

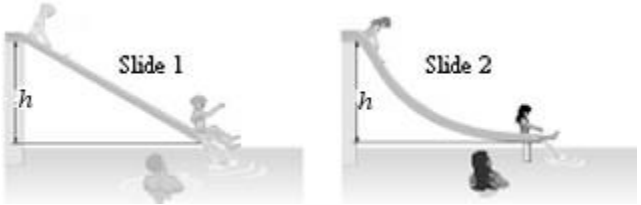
Question 6: **(1 pt)** You push downward on a box at an angle 25° below the horizontal with a force of 750 N. If the box is on a flat horizontal surface for which the coefficient of static friction with the box is 0.76, what is the mass of the heaviest box you will be able to move?

A) 59 kg
B) 68 kg
C) 54 kg
D) 82 kg
E) 97 kg

Question 7: **(1 pt)** A traveler pulls on a suitcase strap at an angle 36° above the horizontal. If 908 J of work are done by the strap while moving the suitcase a horizontal distance of 15 m, what is the tension in the strap?

A) 43 N
B) 75 N
C) 61 N
D) 85 N
E) 92 N

Question 8: **(1 pt)** Swimmers at a water park have a choice of two frictionless water slides as shown in the figure. Although both slides drop over the same height, *h*, slide 1 is straight while slide 2 is curved, dropping quickly at first and then leveling out. How does the speed v_1 of a swimmer reaching the end of slide 1 compares with v_2, the speed of a swimmer reaching the end of slide 2?



A) $v_1 > v_2$
B) $v_1 < v_2$
C) $v_1 = v_2$
D) No simple relationship exists between v_1 and v_2 because we do not know the curvature of slide 2.
E) None of the above.

Question 9: **(1 pt)** A 2.3-kg object traveling at 6.1 m/s collides head-on with a 3.5-kg object traveling in the opposite direction at 4.8 m/s. If the collision is perfectly elastic, what is the final speed of the 2.3-kg object?

A) 0.48 m/s
B) 7.1 m/s
C) 3.8 m/s
D) 4.3 m/s
E) 6.6 m/s

Question 10: **(1pt)** While spinning down from 500.0 rpm to rest, a solid uniform flywheel does 5.1 kJ of work. If the radius of the disk is 1.2 m, what is its mass?

A) 5.2 kg
B) 4.4 kg
C) 6.0 kg
D) 6.8 kg
E) 8.2 kg

Question 11: **(1 pt)** A solid uniform sphere of mass 1.85 kg and diameter 45.0 cm spins about an axle through its center. Starting with an angular velocity of 2.40 rev/s, it stops after turning through 18.2 rev with uniform acceleration. The net torque acting on this sphere as it is slowing down is closest to

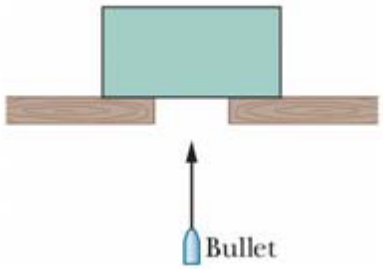
A) 0.00593 N.m.
B) 0.0372 N.m.
C) 0.0466 N.m.
D) 0.0620 N.m.
E) 0.149 N.m.

Question 12: **(1 pt)** A 0.600-mm diameter wire stretches 0.500% of its length when it is stretched with a tension of 20.0 N. What is the Young's modulus of this wire?

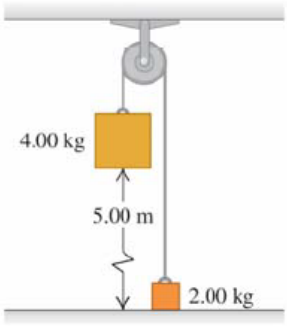
A) 5.66×10^{10} N/m^2
B) 3.54×10^{9} N/m^2
C) 1.41×10^{10} N/m^2
D) 6.43×10^{9} N/m^2
E) 2.78×10^{9} N/m^2

Part B: *Please solve the following problems showing all the steps of your solutions.*

Problem 1: (4 pts) In the figure beside, a 10 g bullet moving strikes and passes through the center of mass of a 5.0 kg block initially at rest. The bullet emerges from the block moving directly upward at 300 m/s. To what maximum height does the block then rise above its initial position?

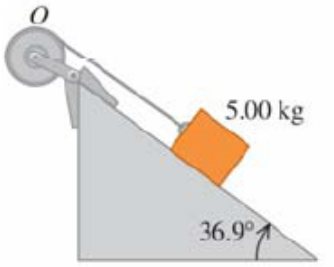


Problem 2: **(4 pts)** The pulley in the figure below has radius 0.160 m and moment of inertia 0.560 kg.m^2. The rope does not slip on the pulley rim. Use energy methods to calculate the speed of the 4.00-kg block just before it strikes the floor.



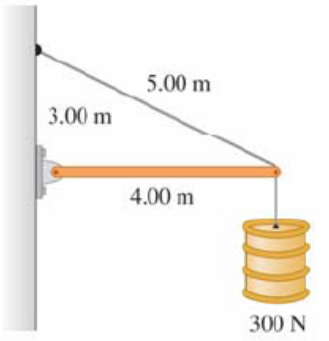
Problem 3: **(4 pts)** A block with mass m = 5.00 kg slides down a surface inclined 36.9° to the horizontal (see figure below). The coefficient of kinetic friction is 0.25. A string attached to the block is wrapped around a flywheel on a fixed axis at O. The flywheel has mass 25.0 kg and moment of inertia 0.500 kg.m2 with respect to the axis of rotation. The string pulls without slipping at a perpendicular distance of 0.200 m from that axis.

(a) What is the acceleration of the block down the plane?
(b) What is the tension in the string?



Problem 4: (4 pts) The horizontal beam in the figure below weighs 150 N, and its center of gravity is at its center.

(a) Find the tension in the cable and
(b) Find the horizontal and vertical components of the force exerted on the beam at the wall.



End of Exam

Useful Information

$\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$, $\vec{v}_{av} = \frac{\Delta\vec{r}}{\Delta t}$, $\vec{v} = \lim_{\Delta t\to 0}\frac{\Delta\vec{r}}{\Delta t} = \frac{d\vec{r}}{dt}$, $\vec{a}_{av} = \frac{\Delta\vec{v}}{\Delta t}$, $\vec{a} = \lim_{\Delta t\to 0}\frac{\Delta\vec{v}}{\Delta t} = \frac{d\vec{v}}{dt}$

$v_x = v_{0x} + a_x t$, $x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$, $v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$, $x - x_0 = \left(\frac{v_{0x}+v_x}{2}\right)t$

$v_x = v_{0x} + \int_0^t a_x \ dt$, $x = x_0 + \int_0^t v_x \ dt$,

$\sum \vec{F} = m\vec{a}$, $w = mg$, $f_s \le \mu_s n$, $f_k = \mu_k n$,

$W = \vec{F}\cdot\vec{s}$, $W = Fscos\emptyset$, $W = \int_{P_1}^{P_2} Fcos\emptyset dl = \int_{P_1}^{P_2} F_{\parallel} dl = \int_{P_1}^{P_2} \vec{F}.d\vec{l}$,

$W_{tot} = \Delta K$, $K = \frac{1}{2}mv^2$, $U_{grav} = mgy$, $U_{el} = \frac{1}{2}kx^2$, $K_1 + U_1 + W_{other} = K_2 + U_2$

$W_{grav} = -\Delta U_{grav}$, $W_{el} = -\Delta U_{el}$, $F_x(x) = -\frac{dU(x)}{dx}$, $\vec{F} = -\left(\frac{dU}{dx}\hat{\imath} + \frac{\partial U}{\partial y}\hat{\jmath} + \frac{\partial U}{\partial z}\hat{k}\right)$,

$P_{av} = \frac{\Delta W}{\Delta t}$, $P = \vec{F}.\vec{v}$, $\vec{p} = m\vec{v}$, $\sum \vec{F} = \frac{d\vec{p}}{dt}$, $\vec{J} = \sum \vec{F}\,\Delta t$, $\vec{J} = \int_{t_1}^{t_2}\sum \vec{F}\,dt$, $\vec{J} = \vec{p}_2 - \vec{p}_1$

$\omega = \frac{d\theta}{dt}$, $\alpha = \frac{d\omega}{dt}$, $\omega = \omega_0 + \alpha t$, $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$, $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$,

$v = r\ \omega$, $a_{tan} = r\ \alpha$, $a_{rad} = \frac{v^2}{r} = \omega^2\ r$, $\tau = F\ l\ sin\ \theta$, $\vec{\tau} = \vec{r}\times\vec{F}$, $\sum \tau = I\ \alpha$,

$I = mr^2$, $W = \tau\ \Delta\theta$, $W = \int_{\theta_1}^{\theta_2}\tau\ d\theta$, $W_{tot} = \Delta K$, $K = \frac{1}{2}I\omega^2$, $P = \frac{dW}{dt}$, $P = \tau\ \omega$,

$\vec{L} = I\vec{\omega}$, $\vec{L} = \vec{r}\times\vec{p} = \vec{r}\times m\vec{v}$, $\sum \vec{\tau} = \frac{d\vec{L}}{dt}$, $\vec{r}_{cm} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3 + \cdots}{m_1 + m_2 + m_3 + \cdots}$,

Elastic modulus= $\frac{\text{Stress}}{\text{Strain}}$, $Y = \frac{F_{\perp}/A}{\Delta l/l_0}$, $B = -\frac{\Delta p}{\Delta V/V_0}$, $p = \frac{F_{\perp}}{A}$, $S = \frac{F_{\parallel}/A}{x/h}$, g = 9.80 m/s^2