College of Arts and Sciences
Department of Mathematics, Statistics, and Physics
Physics Program

General Physics for Engineering I
PHYS 191
Fall 2013

January 7th 2014

Final Exam

Instructor: Dr. A. Shalaby, Dr. Khalid Al-Qadi,
Dr, Maitha Al-Murikhi and Dr. Leena Al-Sulaiti

Student Name:

Student ID:

Section number:

30

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 10 multiple choices and section B contains 4 problems.
2. Calculators are permitted but no electronic dictionaries or mobile phones.
3. All your work must be done on your exam paper; no loose papers are allowed.
4. This is a timed exam (120 min). Do not spend too much time on any particular question.

Best Wishes

Useful Information:

$\vec{P} = m\vec{v}$

$\Delta K + \Delta U + \Delta(\text{other energy types}) = 0$

$\vec{\mathbf{p}}_A + \vec{\mathbf{p}}_B = \vec{\mathbf{p}}'_A + \vec{\mathbf{p}}'_B$

$E = K + U = constant$

$\Delta\vec{P} = \vec{P}_f - \vec{P}_i$

$\frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2 = \frac{1}{2}m_A v_A'^2 + \frac{1}{2}m_B v_B'^2$

$K_{rotational} = \frac{1}{2}I\omega^2$

$I_{cylinder} = \frac{1}{2}MR^2, \quad I_{sphere} = \frac{2}{5}MR^2$

$L = I\omega = \;, \quad \vec{L} = \vec{r} \times \vec{p},$

$\vec{\tau} = I\vec{\alpha} = \vec{r} \times \vec{F} = \frac{d\vec{L}}{dt}$

$v^2 = v_0^2 + 2ad$

Part A (1 mark each). Please choose the correct answer.

10

1. A box is sliding down an incline tilted at an angle 14.0° above horizontal. The box is sliding down the incline at a speed of 1.70 m/s. The coefficient of kinetic friction between the box and the incline is 0.380. How far does the box slide down the incline before coming to rest?
   a) 2.33 m
   b) 1.16 m
   c) 0.720 m
   d) 1.78 m
   e) The box does not stop. It accelerates down to the plane.

2. A light weight object and a heavy object are sliding with equal speeds along a level frictionless surface. They both slide up the same frictionless hill. Which rises to a greater height? Ignore air resistance.
   a) The heavy object, because it has greater kinetic energy.
   b) They both slide up to the same height.
   c) The lightweight object, because it weighs less.
   d) The heavy object, because it weighs more.
   e) The light object, because it has smaller kinetic energy.

3. An inelastic collision of two objects is characterized by the following?
   a) Total momentum of the system is conserved
   b) Total energy of the system remains constant
   c) Total kinetic energy of the system remains constant
   d) Only A and B are true
   e) A, B, and C are all true

4. A 0.140-kg baseball is dropped and reaches a speed of 1.20 m/s just before it hits the ground. It rebounces with a speed of 1.00 m/s. What is the change of the ball's momentum?
   a) 0.0280 kg·m/s upwards.
   b) 0.0280 kg·m/s downwards.
   c) 0.308 kg·m/s upwards
   d) 0.308 kg·m/s downwards
   e) 0 kg·m/s

5. The rotating systems shown in Fig.1 differs only in that the two identical movable masses are positioned a distance r from the axis of rotation (left), or a distance r/2 from the axis of rotation (right). If you release the hanging blocks simultaneously from rest?

   a) the block at left lands first
   b) the block at right lands first
   c) both blocks land at the same time
   d) it is impossible to tell which block reaches the bottom first

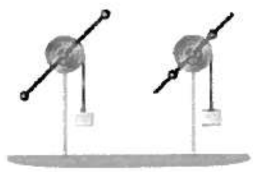


Fig.1

6. A uniform solid sphere of mass M and radius R rotates with an angular speed ω and a uniform solid cylinder of mass M, radius R, and height 2R. Both have the same rotational kinetic energy. What must be the angular speed of the cylinder?

a) $2\omega/5$ b) $\sqrt{2/5}\,\omega$ c) $4\omega/5$ d) $2\omega/\sqrt{5}$ e) $\omega/\sqrt{5}$

7. A skater rotating at 5.00 rad/s with arms extended has a moment of inertia of 2.25 kg.m2. If the arms are pulled in so the moment of inertia decreases to 1.80 kg.m2, what is the final angular speed?

a) 2.25 rad/s b) 4.60 rad/s c) 6.25 rad/s d) 1.76 rad/s e) 0.81 rad/s

8. What is the angular momentum about the origin of a particle with a mass of 500 g when it is located at $\vec{r} = 4\hat{\imath} + 3\hat{\jmath} - 2\hat{k}$ m and moving at $5\hat{\imath} - 2\hat{\jmath} + 4\hat{k}$ m/s?

a) $24\hat{\imath} - 6\hat{\jmath} - 8\hat{k}$ kg.m2/s
b) $12\hat{\imath} - 3\hat{\jmath} - 4\hat{k}$ kg.m2/s
c) $8\hat{\imath} + 14\hat{\jmath} - 13\hat{k}$ kg.m2/s
d) $10\hat{\imath} + 1\hat{\jmath} + 2\hat{k}$ kg.m2/s
e) $4\hat{\imath} - 13\hat{\jmath} - 11.5\hat{k}$ kg.m2/s

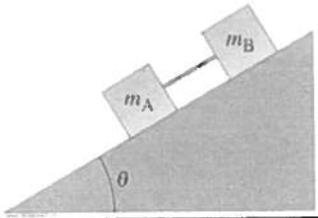
9. A heavy boy and a light weight girl are balanced on a massless seesaw. If they both move forward so that they are one-half their original distance from the pivot point, what will happen to the seesaw?
a) It is impossible to say without knowing the masses.
b) It is impossible to say without knowing the distances.
c) The side the boy is sitting on will tilt downward.
d) Nothing, the seesaw will still be balanced.
e) The side the girl is sitting on will tilt downward.

10. A sphere hanging freely from a cord is in
a) stable equilibrium.
b) unstable equilibrium.
c) neutral equilibrium.
d) positive equilibrium.
e) negative equilibrium.

<u>Part B</u> (20 point). Please solve the following problems using *pen* and show all the steps of your work in a clear organized way.

____ / 20

1. Two blocks made of different materials connected together by a thin cord, slide down a plane ramp inclined at an angle θ to the horizontal as shown in the figure below (block B is above block A). The masses of the blocks are m_A and m_B, and the coefficients of friction are μ_A and μ_B . If $m_A = m_B = 5.0$ kg, and $\mu_A = 0.20$ and $\mu_B = 0.30$, determine (*a*) the acceleration of the blocks and (*b*) the tension in the cord, for an angle θ=32°. (4 marks).

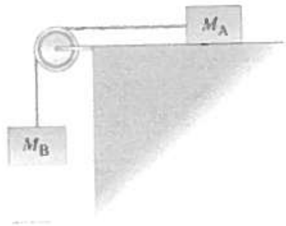


2. A small ball A of mass $m_A = 0.120$ kg moving with speed $v_A = 2.80\ m/s$ strikes ball B, initially at rest, of mass $m_B = 0.140$ kg. As a result of the collision, ball A is deflected off at an angle of 30.0° with a speed $v_B' = 2.10\ m/s$. **(5 points)**

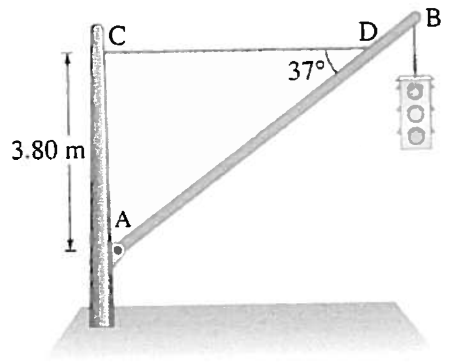
(a) Taking the x axis to be the original direction of motion of ball A, write down the equations expressing the conservation of momentum for the components in the x and y directions separately.

(b) Solve these equations for the speed v_B', and angle, θ_B' of ball B. Do not assume the collision is elastic.

3. The figure below shows two masses connected by a cord passing over a pulley of radius R_0 and moment of inertia I. Mass M_A slides on a frictionless surface, and M_B hangs freely. Determine a formula for (*a*) the angular momentum of the system about the pulley axis, as a function of the speed v of mass M_A or M_B, and (*b*) the acceleration of the masses. **(5 points)**



4. A traffic light hangs from a pole as shown in the figure below. The uniform aluminum pole AB is 7.20 m long and has a mass of 12.0 kg. The mass of the traffic light is 21.5 kg. Determine (*a*) the tension in the horizontal massless cable CD, and (*b*) the vertical and horizontal components of the force exerted by the pivot A on the aluminum pole. **(6 points)**



College of Arts and Sciences
Department of Mathematics, Statistics, and Physics
Physics Program
Instructor: Drs. D. Al-Abdulmalik and H. Merabet

Name……..………..…………………………..……………………………….

Student ID………..………………………………………………………………

Section …..…………..……………………Student No.…………………………

Physics for Engineers I
PHYS 191 (all sections), PHYS 101 (all sections)
Final Exam, Fall 2012
January 2, 2013

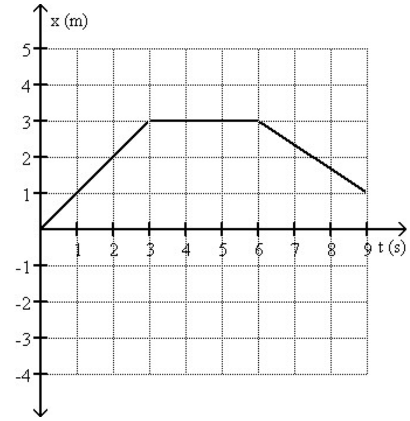
Instructions:

1. Show all the steps of your work.
2. Calculators are permitted but no mobile phones.
3. Include units in all calculations and answers.
4. If additional space is required use the last page and indicate that this has been done.
5. This is a timed exam (120 min). Do not spend too much time in any particular question.
6. A list of important formulae is provided in the last page.

Total Questions:	/60
Total Problems:	/40
Bonus Question:	/3

Total:	/100

Question 1: (6 pts): The figure below shows the position of an object as a function of time. What is the average speed of the object between time t = 0.0 s and time t = 9.0 s?



A) 0.11 m/s
B) -0.33 m/s
C) 0.33 m/s
D) 0.56 m/s
E) -0.11 m/s

Justification:

Question 2: (6 pts) A speeding car is traveling at a constant 30.0 m/s when it passes a stationary police car. If the police car delays its motion for 1.00 s before starting, what must the constant acceleration of the police car be to catch the speeding car after the police car travels a distance of 300 m?

A) 6.00 m/s^2
B) 3.00 m/s^2
C) 7.41 m/s^2
D) 1.41 m/s^2
E) 3.70 m/s^2

Justification:

Question 3: **(6 pts)** Action-reaction forces are

A) equal in magnitude and point in the same direction
B) equal in magnitude but point in opposite directions
C) unequal in magnitude but point in the same direction
D) unequal in magnitude and point in opposite directions
E) none of the above.

Justification:

Question 4: **(6 pts)** A 60.0-kg person rides in an elevator while standing on a scale. The scale reads 400 N. What is the acceleration of the elevator?

A) 3.14 m/s^2 downward
B) 6.67 m/s^2 downward
C) zero
D) 9.81 m/s^2 downward
E) 16.67 m/s^2 upward

Justification:

Question 5: **(6 pts)** A car enters a 300-m radius flat curve on a rainy day when the coefficient of static friction between its tires and the road is 0.600. What is the maximum speed which the car can travel around the curve without sliding?

A) 29.6 m/s B) 33.1 m/s C) 24.8 m/s D) 42.0 m/s E) 37.9 m/s

Justification:

<u>Question 6:</u> (6 pts) A 6.00-kg block starts from rest and slides down a frictionless incline. When the block has slid a distance 2.00 m, its speed is 3.00 m/s. At what angle above the horizontal is the inclined plane tilted?

A) 6.58^o B) 27.3^o C) 8.80^o D) 5.26^o E) 13.3^o

<u>Justification:</u>

<u>Question 7:</u> (6 pts) mass of 3.0 kg is subject to a force F(x) = 8.0 N - (4.0 N/m)x. The potential energy of the mass is zero at x = 0. What is the potential energy of the mass at x = 2.0 m?

A) 4.0 J B) 0.0 J C) 8.0 J D) -4.0 J E) -8.0 J

<u>Justification:</u>

Question 8: **(6 pts)** A 1000-kg car approaches an intersection traveling north at 20.0 m/s. A 1200-kg car approaches the same intersection traveling east at 22.0 m/s. The two cars collide at the intersection and lock together. Ignoring any external forces that act on the cars during the collision, what is the velocity of the cars immediately after the collision?

A) 29.7 m/s in a direction 47.7^o east of north
B) 21.1 m/s in a direction 47.7^o west of south
C) 15.1 m/s in a direction 52.8^o east of north
D) 21.1 m/s in a direction 52.8^o east of north
C) 21.1 m/s in a direction 47.7^o east of north

Justification:

Question 9: **(6 pts)** A wheel rotates through an angle of 320° as it slows down from 78.0 rpm to 22.8 rpm. What is the magnitude of the average angular acceleration of the wheel?

A) 2.34 rad/s^2
B) 5.48 rad/s^2
C) 6.50 rad/s^2
D) 8.35 rad/s^2
E) 10.9 rad/s^2

Justification:

<u>Question 10:</u> (6 pts) What is the angular momentum about the origin of a particle with a mass of 500 g when it is located at $\vec{r} = \left(4\hat{i} + 3\hat{j} - 2\hat{k}\right)$ m and moving at $\vec{v} = \left(5\hat{i} - 2\hat{j} + 4\hat{k}\right)$ m/s?

A) $\left(24\hat{i} - 6\hat{j} - 8\hat{k}\right)$ 2.34 kg.m^2/s

B) $\left(12\hat{i} - 3\hat{j} - 4\hat{k}\right)$ 5.48 kg.m^2/s

C) $\left(8\hat{i} + 14\hat{j} - 13\hat{k}\right)$ 6.50 kg.m^2/s

D) $\left(10\hat{i} + 1\hat{j} + 2\hat{k}\right)$ 8.35 kg.m^2/s

E) $\left(4\hat{i} - 13\hat{j} - 11.5\hat{k}\right)$ kg.m^2/s

Justification:

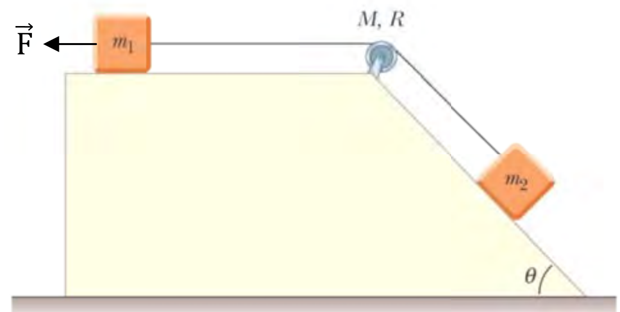
Problem 1: (16 pts) A block of mass m_1 and a block of mass m_2 are connected by a massless string over a pulley in the shape of a solid disk having radius R and mass M ($I = \frac{1}{2}MR^2$). These blocks are allowed to move on a fixed block-wedge of angle θ as in the figure below. The coefficient of kinetic friction is 0.200 for the incline while the horizontal plan is frictionless. The system is set to motion when a horizontal force F = 100 N is applied to the left of m_1.

(a) Draw free-body diagrams of both blocks and of the pulley when the mass m_1 moves to the left. **(4 pts)**

(b) Determine the expression of the acceleration a of the two blocks as function of m_1, m_2, M, θ, μ_k, g, and F. **(6 pts)**

(c) Determine the value of a for $m_1 = 4.00$ kg, $m_2 = 10.0$ kg, mass $M = 6.00$ kg, and $\theta = 20.0°$. **(2 pts)**

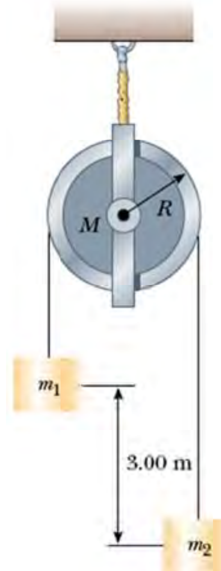
(d) Determine the tensions in the string on both sides of the pulley. **(4 pts)**



Problem 2: **(12 pts)** Consider the system shown in the figure below with m_1= 20.0 kg and m_2= 12.5 kg suspended and joined by a cord that passes over a pulley with radius R = 0.200 m and mass M = 3.00 kg (treat the pulley as a uniform disk with moment of inertia $I = \frac{1}{2}MR^2$). The cord has negligible mass and does not slip on the pulley. The pulley rotates on its axis without friction. m_2 is resting on the floor, and m_1 is 3.00 m above the floor when it is released from rest.

(a) If m_1 is allowed to fall, use *conservation of energy* to find the velocity of the masses just before m_1 hits the floor. **(8 pts)**

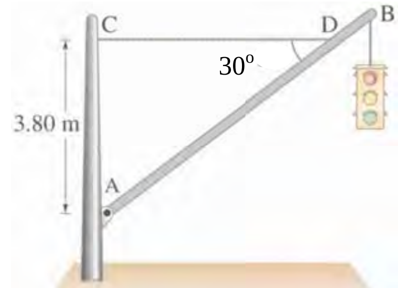
(b) Use the *kinematics equations* to calculate the time interval required for m_1 to hit the floor. **(4 pts)**



Problem 3: **(12 pts)** A traffic light hangs from a pole as shown in the figure below. The uniform aluminum pole AB is 8.50 m long and has a mass $m = 10.0$ kg. The mass of the traffic light is $M = 19.5$ kg. Determine:

(a) the tension in the horizontal massless cable CD. **(6 pts)**

(b) the vertical and horizontal components of the force exerted by the pivot A on the aluminum pole. **(6 pts)**



<u>Extra Credit Question:</u> (3 pts): Calculate the true mass (in vacuum) of a piece of aluminum whose apparent mass (because of buoyancy) is 20.000 kg when weighed in air.

End of the exam

Best Wishes

Use the following empty space below as extra-space for your answers when needed and indicate the corresponding question and/or problem number

College of Arts and Sciences

Department of Mathematics, Statistics, and Physics

Physics Program

PHYS191

Spring 2014

15th June 2014

PHYS191 Final Exam

Instructors: Dr K. Al-Qadi, Dr M. Al-Muraikhi, Dr. L. Al-Sulai, Dr. M. Zayed

Student Name: ……………………………………

Student ID: ………………………………………

Section number: …………………………………

Please read the instructions carefully:

- Make sure you have 9 pages including the cover page, including 2 parts A and B.
- Part A consist of 10 multiple choice questions where you select only one of the proposed answers.
- Part B consists of four problems that you have to solve all.
- Calculators are permitted, but no electronic dictionaries.
- Mobile devices and cell phones are strictly forbidden.
- All work must be done on exam paper, no loose paper is allowed.
- This is a timed exam (120 minutes). Manage your time and do not spend too much time on any particular question.

Useful Information:

$\vec{P} = m\vec{v}$

$\Delta K + \Delta U + \Delta(\text{other energy types}) = 0$ $\quad\quad$ $\vec{\mathbf{p}}_A + \vec{\mathbf{p}}_B = \vec{\mathbf{p}}'_A + \vec{\mathbf{p}}'_B$

$E = K + U = constant$

$\Delta\vec{P} = \vec{P}_f - \vec{P}_i$

$\frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2 = \frac{1}{2}m_A v_A'^2 + \frac{1}{2}m_B v_B'^2$

$K_{rotational} = \frac{1}{2}I\omega^2$

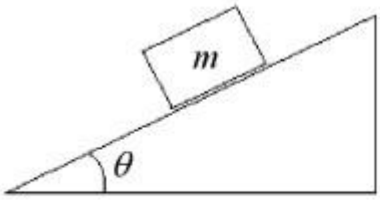
$\boldsymbol{I_{cylinder} = \frac{1}{2}MR^2}$, $\boldsymbol{I_{sphere} = \frac{2}{5}MR^2}$, $\quad \boldsymbol{I_{hoop} = MR^2}$

$\boldsymbol{L = I\omega =}$, $\quad \boldsymbol{\vec{L} = \vec{r} \times \vec{p}}$,

$\boldsymbol{\vec{\tau} = I\,\vec{\alpha} = \vec{r} \times \vec{F} = \frac{d\vec{L}}{dt}}$

Angular	Linear
$\omega = \omega_0 + \alpha t$	$v = v_0 + at$
$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$	$x = v_0 t + \frac{1}{2}at^2$
$\omega^2 = \omega_0^2 + 2\alpha\theta$	$v^2 = v_0^2 + 2ax$
$\overline{\omega} = \dfrac{\omega + \omega_0}{2}$	$\overline{v} = \dfrac{v + v_0}{2}$

1) In the figure, the block of mass m is at rest on an inclined plane that makes an angle θ with the horizontal. The force of static friction f must be such that



A) $f > mg$.

B) $f > mg\ cos\theta$.

C) $f > mg\ sin\theta$.

D) $f = mg\ cos\theta$.

E) $f = mg\ sin\theta$.

2) A person carries a mass of 10 kg and walks along the +x-axis for a distance of $100m$ with a constant velocity of $2\ m/s$. What is the work done by gravity on the mass?

A) 0 J

B) 20 J

C) 200 J

D) 1000 J

E) None of the other choices is correct.

3) A mass of 3.0 kg is subject to a force $F(x) = 8.0\ N - (4.0\ N/m)x$. The potential energy of the mass is zero at $x = 0$. What is the potential energy of the mass at $x = 2.0\ m$?

A) 4.0 J

B) 0.0 J

C) 8.0 J

D) -4.0J

E) -8.0 J

4) At what rate is a $60.0kg$ boy using energy when he runs up a flight of stairs $10.0m$ high, in $8.00s$?

A) 80.0 W

B) 75.0 W

C) 736 W

D) 4.80 kW

E) 48 W

5) Ahmed and Ali meet in the middle of a lake while paddling in their small boats (each person in a separate boat). They come to a complete stop and talk for a while. When they are ready to leave, Ahmed pushes Ali's boat with a force $\vec{F}$ to separate the two boats. What is correct to say about the final momentum and kinetic energy of the system?

A) The final momentum is in the direction of $\vec{F}$ but the final kinetic energy is zero.

B) The final momentum is in the direction opposite of $\vec{F}$ but the final kinetic energy is zero J.

C) The final momentum is in the direction of $\vec{F}$ and the final kinetic energy is positive.

D) The final momentum is zero kg·m/s and the final kinetic energy is zero J.

E) The final momentum is zero kg·m/s but the final kinetic energy is positive.

6) A $2.00kg$ mass object traveling east at $20.0m/s$ collides with a $3.00kg$ mass object traveling west at $10.0\ m/s$. After the collision, the $2.00kg$ mass has a velocity $5.00\ m/s$ to the west. How much kinetic energy was lost during the collision?

A) 0.00 J

B) 458 J

C) 516 J

D) 91.7 J

E) 175 J

7) Consider a hoop of radius R and mass M rolling without slipping. Which form of kinetic energy is larger, translational or rotational?

A) Translational kinetic energy is larger.

B) Rotational kinetic energy is larger.

C) Both are equal.

D) You need to know the speed of the hoop to tell.

E) You need to know the acceleration of the hoop to tell.

8) A string is wrapped around a pulley with a radius of $2.0\ cm$. The pulley is initially at rest. A constant force of $50\ N$ is applied to the string, causing the pulley to rotate and the string to unwind. If the string unwinds $1.2\ m\ in\ 4.9\ s$, what is the value of the moment of inertia of the pulley?

A) $0.17\ kg \cdot m^2$

B) $17\ kg \cdot m^2$

C) $14\ kg \cdot m^2$

D) $0.20\ kg \cdot m^2$

E) $0.017\ kg \cdot m^2$

9) A merry-go-round spins freely when $Reem$ moves quickly to the center along a radius of the merry-go-round. It is true to say that:

A) the moment of inertia of the system decreases and the angular speed increases.

B) the moment of inertia of the system decreases and the angular speed decreases.

C) the moment of inertia of the system decreases and the angular speed remains the same.

D) the moment of inertia of the system increases and the angular speed increases.

E) the moment of inertia of the system increases and the angular speed decreases.

10) A force at $\vec{F} = 4.00N\hat{\imath} - 3.00N\hat{\jmath}$ is applied to an object at position $\vec{R} = 2.00m\hat{\imath} + 3.00m\hat{\jmath}$. What is the torque about the origin?

A) $8.00N.m\ \hat{\imath} - 9.00N.m\ \hat{\jmath}$

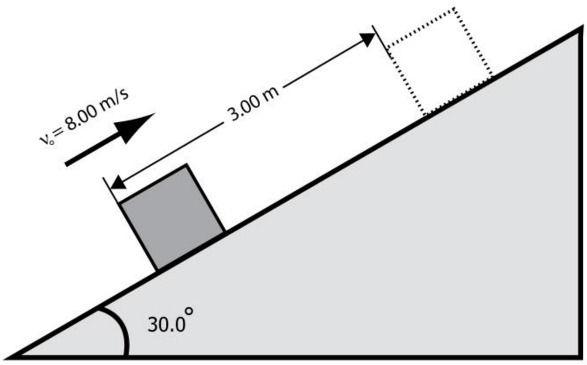
B) $-1.00N.m\ \hat{k}$

C) $8.00N.m\ \hat{\imath} + 9.00N.m\ \hat{\jmath}$

D) $17.0N.m\ \hat{k}$

E) $-18.0N.m\ \hat{k}$

<u>Problem 1) (*5 marks)*</u> A $5.00 kg$ block is set into motion up an inclined plane with an initial speed of $8.00\, m/s$, as in the figure. The block comes to rest after traveling $3.00\, m$ along the plane, which is inclined at an angle of $30.0°$ to the horizontal. For this motion determine:



(a) the change in the block's kinetic energy,

(b) the change in the potential energy of the block-Earth system,

(c) the mechanical energy converted due friction,

(d) the friction force exerted on the block (assumed to be constant), and

(e) what is the coefficient of kinetic friction?

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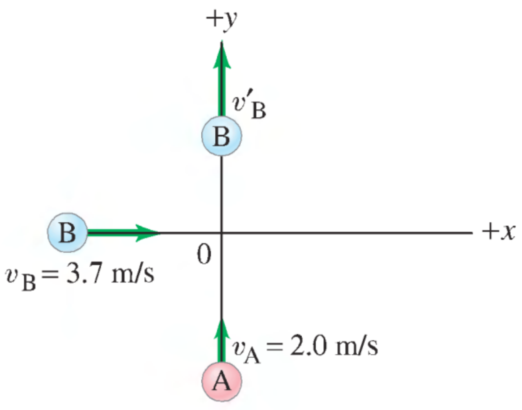
<u>Problem 2) (*5 marks*)</u> Two billiard balls of equal mass move at right angles and meet at the origin of an xy coordinate system. Initially ball A is moving upward along the y-axis at $2.0\,m/s$, and ball B is moving to the right along the x-axis with speed $3.7m/s$. After the collision (assumed elastic), the second ball is moving along the positive y-axis (See figure).



a) What is the speed of ball A after the collision?
b) What is the speed of ball B after the collision?
c) In what direction is ball A moving after the collision?
d) What is the total momentum of the two balls after the collision?
e) What is the total kinetic energy of the two balls after the collision?

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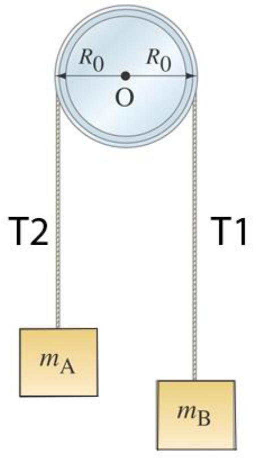
<u>Problem 3) (*5 marks*)</u> An Atwood machine consists of two masses, $m_a = 19.6\ kg$ and $m_b = 6.30\ kg$, which are connected by an inelastic cord of negligible mass that passes over a pulley. If the pulley, which is approximated as a cylinder, has a mass $m_{pully} = 9.50\ kg$.



a) Derive the equation of the acceleration of the system.
b) Calculate the acceleration of the system.
c) Calculate $\boldsymbol{T_1}$.
d) Calculate $\boldsymbol{T_2}$.

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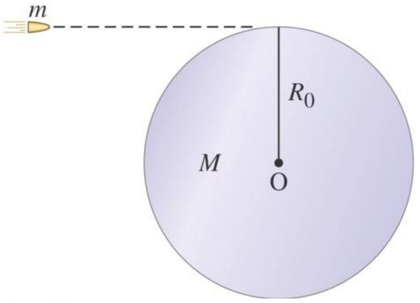
<u>Problem 4) (*5 marks*)</u> A bullet of mass $m_{bullet} = 7.00g$ moving with velocity $v_{bullet} = 550m/s$ strikes and becomes embedded at the edge of a cylinder of mass $m_{cylinder} = 3.00kg$ and radius $R_o = 30.0cm$. The cylinder, initially at rest, begins to rotate about its symmetry axis, which remains fixed in position. Assume no frictional torque. Calculate:



a) the total angular momentum of the system, with respect to origin, <u>before</u> the collision;
b) the total angular momentum of the system, with respect to origin, <u>after</u> the collision;
c) the angular velocity of the cylinder after this collision;
d) the initial and final kinetic energies;
e) is kinetic energy conserved?

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College of Arts and Sciences
Department of Mathematics, Statistics, and Physics
Physics Program
Instructor: Dr. Maitha Al-Muraikhi, Dr. Hocine Merabet, Dr. Ahmad Ayesh, Dr. Mohammad Gharaibeh

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Name……………………………………………………………………………
Student ID………………………………List #…………………………
Section:…………………………………………………………………….

General 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 **8** pages including two parts, A and B. Part A consists of 15 multiple choice questions, while Part B consists of **3** 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 min). Do not spend too much time in any particular question.

Good Luck

Useful Information

TABLE 3–1 Kinematic Equations for Constant Acceleration in 2 Dimensions

x Component (horizontal)		y Component (vertical)
$v_x = v_{x0} + a_x t$	(Eq. 2–12a)	$v_y = v_{y0} + a_y t$
$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$	(Eq. 2–12b)	$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$
$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$	(Eq. 2–12c)	$v_y^2 = v_{y0}^2 + 2a_y(y - y_0)$

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$|\vec{A}\times\vec{B}| = AB\sin\phi$$

$$\vec{A}\bullet\vec{B} = AB\cos\phi. \qquad \vec{A}\bullet\vec{B} = A_xB_x + A_yB_y + A_zB_z$$

$$\Delta\vec{\mathbf{r}} = (x_2 - x_1)\hat{\mathbf{i}} + (y_2 - y_1)\hat{\mathbf{j}} + (z_2 - z_1)\hat{\mathbf{k}}. \qquad \vec{\mathbf{v}} = \frac{d\vec{\mathbf{r}}}{dt} \qquad \vec{\mathbf{a}} = \frac{d\vec{\mathbf{v}}}{dt}$$

$$\vec{\mathbf{v}} = \vec{\mathbf{v}}_0 + \vec{\mathbf{a}}t$$

$$\vec{\mathbf{r}} = \vec{\mathbf{r}}_0 + \vec{\mathbf{v}}_0 t + \tfrac{1}{2}\vec{\mathbf{a}}t^2$$

$$\vec{\mathbf{a}} = \vec{\mathbf{a}}_{\tan} + \vec{\mathbf{a}}_{R} \qquad a_R = \frac{v^2}{r} \qquad T = \frac{1}{f} \qquad v = \frac{2\pi r}{T}$$

$$\Sigma\vec{\mathbf{F}} = m\vec{\mathbf{a}} \qquad f_s \le \mu_s n \qquad f_k = \mu_k n \qquad W = Fd\cos\theta = \vec{\mathbf{F}}\cdot\vec{\mathbf{d}} \qquad P = \vec{\mathbf{F}}\cdot\vec{\mathbf{v}}$$

$$W = \int_a^b \vec{\mathbf{F}}\cdot d\vec{\boldsymbol{\ell}} = \int_a^b F\cos\theta\, d\ell \qquad \Delta U = U_2 - U_1 = -\int_1^2 \vec{\mathbf{F}}\cdot d\vec{\boldsymbol{\ell}}$$

$$K_1 + U_1 + W_{\text{other}} = K_2 + U_2 \qquad U_{\text{grav}} = mgy \qquad U_{\text{el}} = \tfrac{1}{2}kx^2 \qquad \vec{\mathbf{F}}(x,y,z) = -\hat{\mathbf{i}}\frac{\partial U}{\partial x} - \hat{\mathbf{j}}\frac{\partial U}{\partial y} - \hat{\mathbf{k}}\frac{\partial U}{\partial z}$$

$$W_{\text{net}} = \Delta K = \tfrac{1}{2}mv_2^2 - \tfrac{1}{2}mv_1^2.$$

$$\boxed{\Delta\vec{\mathbf{p}} = \vec{\mathbf{p}}_f - \vec{\mathbf{p}}_i = \int_{t_i}^{t_f}\vec{\mathbf{F}}\,dt = \vec{\mathbf{J}}} \qquad \boxed{P = \frac{dW}{dt} = \frac{dE}{dt}} \qquad \boxed{\vec{\mathbf{P}} = \Sigma m_i\vec{\mathbf{v}}_i = M\vec{\mathbf{v}}_{CM}}$$

$$\boxed{\tfrac{1}{2}m_A v_A^2 + \tfrac{1}{2}m_B v_B^2 = \tfrac{1}{2}m_A v_A'^2 + \tfrac{1}{2}m_B v_B'^2} \qquad \boxed{\vec{\mathbf{p}}_A + \vec{\mathbf{p}}_B = \vec{\mathbf{p}}'_A + \vec{\mathbf{p}}'_B} \qquad \mathbf{r}_{CM} = \frac{\sum_i m_i\mathbf{r}_i}{M}$$

Translation	Rotation	Connection
x	θ	$x = R\theta$
v	ω	$v = R\omega$
a	α	$a = R\alpha$
m	I	$I = \Sigma mR^2$
F	τ	$\tau = RF\sin\theta$
$K = \frac{1}{2}mv^2$	$\frac{1}{2}I\omega^2$	
$W = Fd$	$W = \tau\theta$	
$\Sigma F = ma$	$\Sigma\tau = I\alpha$	

$$\omega = \frac{d\theta}{dt} \qquad \alpha = \frac{d\omega}{dt}$$

$$\omega = \omega_0 + \alpha t; \qquad \theta = \omega_0 t + \tfrac{1}{2}\alpha t^2;$$

$$\omega^2 = \omega_0^2 + 2\alpha\theta; \qquad \bar{\omega} = \frac{\omega + \omega_0}{2}.$$

$$\boxed{\Sigma F_x = 0, \quad \Sigma F_y = 0, \quad \Sigma\tau = 0.}$$

$$\boxed{\vec{\mathbf{L}} = \vec{\mathbf{r}}\times\vec{\mathbf{p}}} \qquad \boxed{I = \sum_i r_i^2 m_i, \qquad I = I_{CM} + MD^2}$$

$$\sum\vec{\boldsymbol{\tau}} = I\,\vec{\boldsymbol{\alpha}} = \vec{\boldsymbol{r}}\times\vec{\boldsymbol{F}} = \frac{d\vec{L}}{dt}\ , \quad |\vec{L}| = rmv\sin\theta\ , \quad L = I\omega$$

$$K_{Rollig} = \tfrac{1}{2}I_{CM}\omega^2 + \tfrac{1}{2}Mv_{CM}^2, \qquad v_{CM} = R\omega$$

Young's modulus **is tensile stress divided by tensile strain and is given by** $Y = (F_{\perp}/A)(l_0/\Delta l)$

Bulk modulus **is bulk stress divided by bulk strain and is given by** $B = -\Delta p/(\Delta V/V_0)$.

Sheer modulus **is sheer stress divided by sheer strain, and is given by** $S = (F_{\parallel}/A)(h/x)$

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

<u>Question 1:</u> (1 pt) You walk 55 m to the north, then turn 60° to your right and walk another 45 m. How far are you from where you originally started?

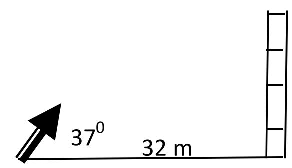
A) 87 m
B) 50 m
C) 94 m
D) 46 m

<u>Question 2:</u> (1 pt) Suppose that a car traveling to the west (the -*x* direction) begins to slow down as it approaches a traffic light. Which statement concerning its acceleration in the *x* direction is correct?

A) Both its acceleration and its velocity are positive.
B) Both its acceleration and its velocity are negative.
C) Its acceleration is positive but its velocity is negative.
D) Its acceleration is negative but its velocity is positive.

<u>Question 3:</u> (1 pt): A fire fighter 32 m away from a building directs a stream of water from a fire hose at an angle of 37^o with a muzzle speed of 40 m/s. At what height h does the stream hits the building?

A) 21.93 m
B) 22.51 m
C) 19.20 m
D) 20.97 m

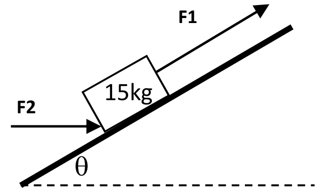


<u>Question 4:</u> (1 pt) A ball is tied to the end of a cable of negligible mass. The ball is spun in a circle with a radius 2.00 m making 7.00 revolutions every 10.0 seconds. What is the magnitude of the acceleration of the ball?

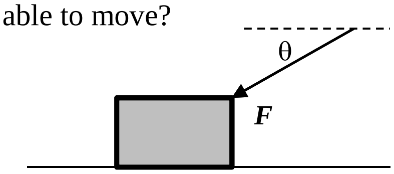
A) 67.9 m/s^2
B) 38.7 m/s^2
C) 29.3 m/s^2
D) 14.8 m/s^2

<u>Question 5</u>: (1 pt) The 15-kg block is being pushed up the incline with constant acceleration equals to 2 m/s^2. The surfaces are rough. Find the net force (resultant) acting on the block?

A) 30N
B) 15N
C) 150N
D) 300N



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

Question 7: **(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.

Question 8: **(1 pt)** In a collision between two objects having unequal masses, how does magnitude of the impulse imparted to the lighter object by the heavier one compare with the magnitude of the impulse imparted to the heavier object by the lighter one?

A) The lighter object receives a larger impulse.
B) The heavier object receives a larger impulse.
C) Both objects receive the same impulse.
D) The answer depends on the ratio of the masses.

Question 9: **(1 pt)** A firecracker breaks up into several pieces, one of which has a mass of 200 g and flies off along the x-axis with a speed of 82.0 m/s. A second piece has a mass of 300 g and flies off along the y-axis with a speed of 45.0 m/s. What are the magnitude and direction of the total momentum of these two pieces?

A) 361 kg·m/s at 56.3° from the x-axis
B) 93.5 kg·m/s at 28.8° from the x-axis
C) 21.2 kg·m/s at 39.5° from the x-axis
D) 361 kg·m/s at 0.983° from the x-axis

Question 10: **(1 pt)** As you are leaving a building, the door opens outward. If the hinges on the door are on your right, what is the direction of the angular velocity of the door as you open it?

A) up
B) down
C) to your left
D) to your right

Question 11: **(1 pt)** 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? $I=0.5MR^2$

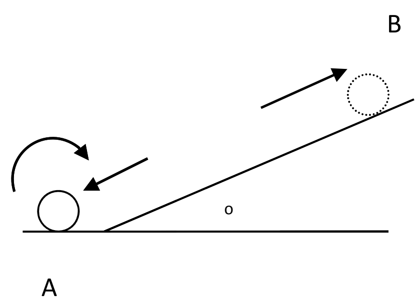
A) 5.2 kg
B) 4.4 kg
C) 6.0 kg
D) 6.8 kg

Question 12: **(1 pt)** A torque of 12 N · m is applied to a solid, uniform disk of radius 0.50 m, causing the disk to accelerate at 5.7 rad/s^2. What is the mass of the disk? $I=0.5MR^2$

A) 17 kg
B) 13 kg
C) 8.5 kg
D) 4.3 kg

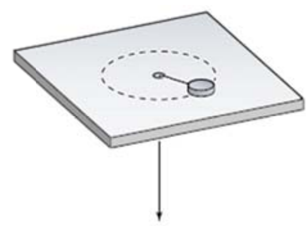
Question 13: **(1 pt)** A cylinder is rolling on a flat horizontal surface. The velocity of the center of mass of this cylinder at point A is 2m/s, what is the distance (d) that it moves on the inclined surface before coming to rest (at point B) momentarily? ($I_{c.m}$(cylinder) = $0.5MR^2$).

A) 0.15 m
B) 1.38 m
C) 2.45 m
D) 0.61 m



Question 14: **(1 pt))** A puck on a frictionless air hockey table has a mass of 5.0 g and is attached to a cord passing through a hole in the surface as in the figure. The puck is revolving at a distance 2.0 m from the hole with an angular velocity of 3.0 rad/s. The cord is then pulled from below, shortening the radius to 1.0 m. The new angular velocity (in rad/s) is:

A) 4.0
B) 6.0
C) 12
D) 2.0

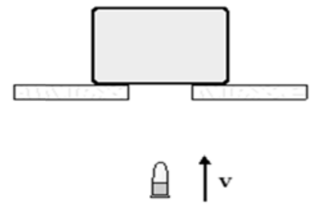


Question 15: **(1 pt)** A 0.600-mm diameter wire stretches 0.500% of its length when it is stretched with a tension of 20.0 N. What is the Young's modulus of this wire?

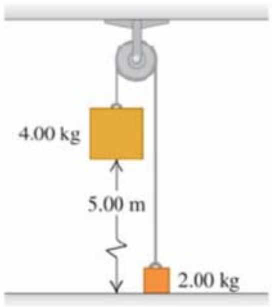
A) 5.66×10^{10} N/m^2
B) 3.54×10^{9} N/m^2
C) 1.41×10^{10} N/m^2
D) 6.43×10^{9} N/m^2

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

<u>Problem 1:</u> (5 pts) A 10-g bullet moving 1000 m/s strikes and passes through a 2-kg block initially at rest, as shown. The bullet emerges from the block with a speed of 400 m/s. To what maximum height will the block rise above its initial position?



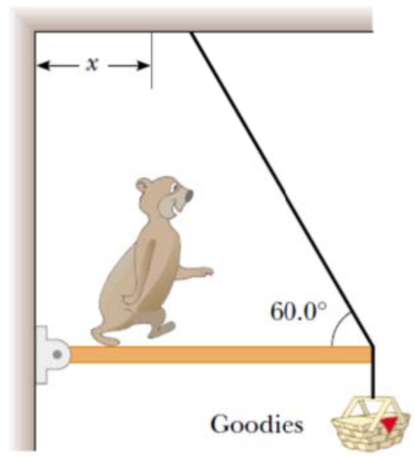
<u>Problem 2</u>: (5 pts) The pulley in the figure below has radius 0.160 m and moment of inertia 0.560 $kg.m^2$. The rope does not slip on the pulley rim. Use energy methods to calculate the speed of the 4.00-kg block just before it strikes the floor.



Problem 3: **(6 pts)** A hungry bear weighing 700 N walks out on a beam in an attempt to retrieve a basket of food hanging at the end of the beam. The beam is uniform, weighs 200 N, and is 6 m long; the basket weighs 80 N.

(a) Draw a free-body diagram for the beam.

(b) When the bear is at $x = 1$ m, find the tension in the wire and the components of the force exerted by the wall on the left end of the beam.



End of Exam

College of Arts and Sciences
Department of Mathematics, Statistics, and Physics
Physics Program

General Physics for Engineering I
PHYS 191
Spring 2016

9th June 2016

Instructors: Dr. M. Al-Muraikhi, Dr. A. Shalaby, Dr. H. Merabet,
Dr. D. Al-Abdulmalik, Dr. L. Al-Sulaiti, Dr. M. Gharaibeh

FINAL EXAM

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Student Name:

Student ID:

Section number:

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 10 multiple choice questions, and part B consists of 4 problems.
2. Calculators are permitted but no electronic dictionaries or mobile phones.
3. All your work must be done on your exam paper; no loose papers are allowed.
4. This is a timed exam (120 min). Do not spend too much time on any particular question.

Best Wishes

Useful Information

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

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

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

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

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

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

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

$P_{av} = \frac{\Delta W}{\Delta t}$, $P = \vec{F}.\vec{v}$,

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

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

$v = r\,\omega$, $a_{tan} = r\,\alpha$, $a_{rad} = \frac{v^2}{r} = \omega^2\, r$,

$\tau = F\, l\, sin\emptyset$, $\vec{\tau} = \vec{r}\times\vec{F}$, $\sum\tau = I\,\alpha$, $I = \sum_i m_i r_i^2$,

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

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

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

Part A. Please choose the correct answer for each question. ***Circle your choice using pen*.**

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Make sure that only ONE of the alternatives is chosen for each question. Two answers to one question will result in loss of the mark of that question

1. A box of mass *m* is pulled with a constant acceleration *a* along a horizontal frictionless floor by a wire that makes an angle of 15° above the horizontal. If *T* is the tension in this wire, then

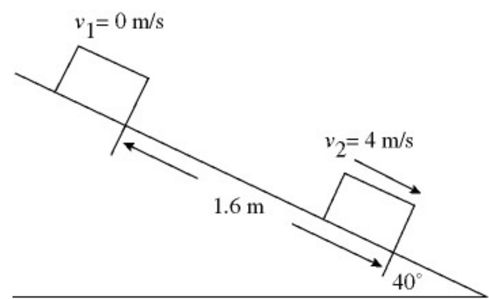
A. T < ma
B. T > ma
C. T = ma
D. T = 0
E. none of the above

2. A 600-kg car is going around a banked curve with a radius of 110 m at a speed of 24.5 m/s. What is the appropriate banking angle so that the car stays on its path without the assistance of friction?

A. 13.5^o
B. 29.1^o
C. 33.8^o
D. 56.2^o
E. 60.9^o

3. An 8.0-kg block is released from rest on a rough incline as shown in the figure. The block moves a distance of 1.6-m down the incline in a time interval of 0.80 s and acquires a velocity of 4.0 m/s. How much work does gravity do on the block during this process?

A. +120 J
B. +100 J
C. -100 J
D. +81 J
E. -81 J



4. It requires 49 J of work to stretch an ideal very light spring from a length of 1.4 m to a length of 2.9 m. What is the spring constant of this spring?

A. 11 N/m
B. 15 N/m
C. 22 N/m
D. 29 N/m
E. 44 N/m

5. Two objects, one of mass *m* and the other of mass 2*m*, are dropped from the top of a building. When they hit the ground

A. both of them have the same kinetic energy.
B. the heavier one will have twice the kinetic energy of the lighter one.
C. the heavier one will have four times the kinetic energy of the lighter one.
D. the heavier one will have $\sqrt{2}$ times the kinetic energy of the lighter one.
E. none of the above choices is correct.

6. A batter hits a 0.140-kg baseball that was approaching him at 40.0 m/s and, as a result, the ball leaves the bat at 30.0 m/s in the direction of the pitcher. What is the magnitude of the impulse delivered to the baseball?

A. 1.40 N.s
B. 4.90 N.s
C. 5.60 N.s
D. 7.00 N.s
E. 9.80 N.s

7. As you are leaving a building, the door opens outward. If the hinges on the door are on your left, what is the direction of the angular velocity of the door as you open it?

A. Up
B. Down
C. To your right
D. To your left
E. Forwards

8. A 4.50-kg wheel that is 34.5 cm in diameter rotates through an angle of 13.8 rad as it slows down uniformly from 22.0 rad/s to 13.5 rad/s. What is the magnitude of the angular acceleration of the wheel?

A. 0.616 rad/s^2
B. 5.45 rad/s^2
C. 10.9 rad/s^2
D. 22.5 rad/s^2
E. 111 rad/s^2

9. A skater rotating at 5.00 rad/s with her arms extended has a moment of inertia of 2.25 kg·m^2. If she pulls in her arms so the moment of inertia decreases to 1.80 kg·m^2, what is her final angular speed?

A. 0.810 rad/s
B. 1.76 rad/s
C. 2.25 rad/s
D. 4.60 rad/s
E. 6.25 rad/s

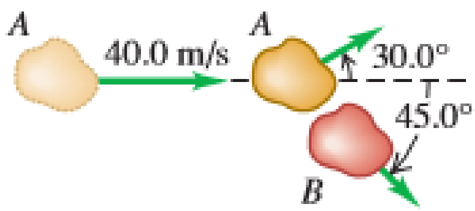
10. A cable is 100-m long and has a cross-sectional area of 1 mm^2. A 1000-N force is applied to stretch the cable. If the elastic modulus for the cable is 1.0×10^{11} N/m^2, how far does it stretch?

A. 0.001 m
B. 0.01 m
C. 0.10 m
D. 1.0 m
E. 10 m

Part B. Please solve the following problems using *pen* and showing *all the steps of your solution in a clear tidy way*.

20

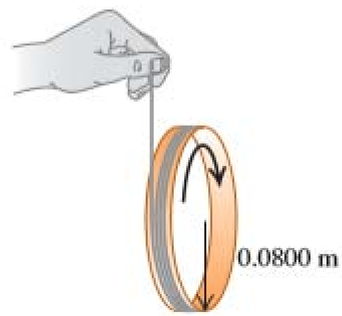
1. Two asteroids of equal mass in the asteroid belt between Mars and Jupiter collide together. Asteroid *A*, which was initially traveling at 40.0 m/s, is deflected 30.0° from its original direction, while asteroid *B*, which was initially at rest, travels at 45.0° to the original direction of *A* (see figure below).
   - **A.** Find the speed of each asteroid after the collision. (4 points)
   - **B.** What fraction of the original kinetic energy dissipates during this collision? (2 points)



2. A string is wrapped several times around the rim of a small hoop with radius $R = 8.00$ cm and mass $M = 0.180$ kg. The free end of the string is held in place and the hoop is released from rest. The moment of inertia for a hoop with an axis at the center is MR^2. After the hoop has descended 75.0 cm, use conservation of energy method to calculate:

A. the angular speed of the rotating hoop. (4 points)

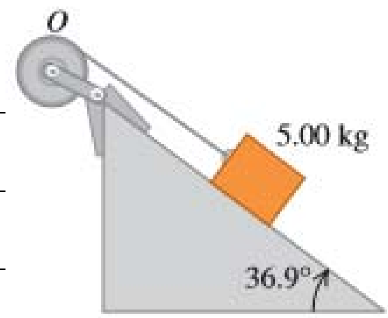
B. the speed of the center of mass of the hoop. (1 points)



3. A block with a mass of 5.00 kg slides down a surface inclined 36.9° to the horizontal as shown in the figure. The coefficient of kinetic friction between the block and the incline is 0.25. A string attached to the block is wrapped around a pulley on a fixed axis at *O*. The pulley has a mass of 25.0 kg and a moment of inertia 0.500 kg.m^2. The string pulls without slipping at a perpendicular distance of 0.200 m from the pulley's axis.

A. What is the acceleration of the block down the plane? (4 points)

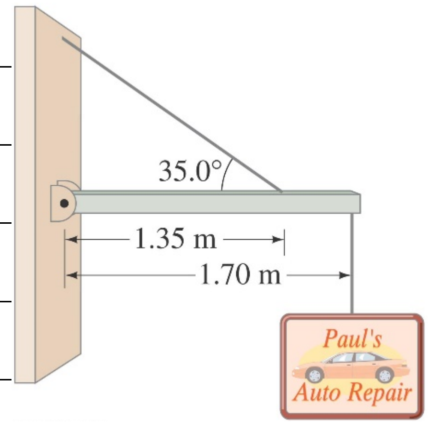
B. What is the tension in the string? (2 points)



4. A shop sign weighing 215 N is supported by a uniform 155-N beam as shown in the figure below.

A. Find the tension in the wire between the beam and the wall. (3 points)

B. Find the horizontal and vertical forces exerted by the hinge on the beam. (3 points)



College of Arts and Sciences
Department of Mathematics, Statistics, and Physics
Physics Program

General Physics I (PHYS101) & General Physics for Engineering I (PHYS191)
Spring 2017

7th June 2017

Instructors: Dr. M. Al-Muraikhi, Dr. A. Ayesh, Dr. M. Gharaibeh

Final EXAM

30

Student Name:

Student ID:

Section number: List Number:

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 11 multiple choice questions, and part B consists of 4 problems.
2. Calculators are permitted but no electronic dictionaries or mobile phones.
3. All your work must be done on your exam paper; no loose papers are allowed.
4. This is a timed exam (120 min). Do not spend too much time on any particular question.

Best Wishes

Useful Information

TABLE 3–1 Kinematic Equations for Constant Acceleration in 2 Dimensions

x Component (horizontal)		y Component (vertical)
$v_x = v_{x0} + a_x t$	(Eq. 2–12a)	$v_y = v_{y0} + a_y t$
$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$	(Eq. 2–12b)	$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$
$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$	(Eq. 2–12c)	$v_y^2 = v_{y0}^2 + 2a_y(y - y_0)$

$$|\vec{A}\times\vec{B}| = AB\sin\phi \quad \vec{A}\bullet\vec{B} = AB\cos\phi. \quad \vec{A}\bullet\vec{B} = A_xB_x + A_yB_y + A_zB_z$$

$$\Delta\vec{\mathbf{r}} = (x_2 - x_1)\hat{\mathbf{i}} + (y_2 - y_1)\hat{\mathbf{j}} + (z_2 - z_1)\hat{\mathbf{k}} \qquad \vec{\mathbf{v}} = \frac{d\vec{\mathbf{r}}}{dt} \qquad \vec{\mathbf{a}} = \frac{d\vec{\mathbf{v}}}{dt}$$

$$\vec{\mathbf{v}} = \vec{\mathbf{v}}_0 + \vec{\mathbf{a}}t \qquad \vec{\mathbf{a}} = \vec{\mathbf{a}}_{\tan} + \vec{\mathbf{a}}_R \qquad a_R = \frac{v^2}{r} \qquad T = \frac{1}{f} \qquad v = \frac{2\pi r}{T}$$

$$\vec{\mathbf{r}} = \vec{\mathbf{r}}_0 + \vec{\mathbf{v}}_0 t + \tfrac{1}{2}\vec{\mathbf{a}}t^2 \qquad f_s \le \mu_s n \qquad f_k = \mu_k n$$

$$\Sigma\vec{\mathbf{F}} = m\vec{\mathbf{a}} \qquad W = Fd\cos\theta = \vec{\mathbf{F}}\cdot\vec{\mathbf{d}} \qquad P = \vec{\mathbf{F}}\cdot\vec{\mathbf{v}}$$

$$W = \int_a^b \vec{\mathbf{F}}\cdot d\vec{\boldsymbol{\ell}} = \int_a^b F\cos\theta\, d\ell \qquad \Delta U = U_2 - U_1 = -\int_1^2 \vec{\mathbf{F}}\cdot d\vec{\boldsymbol{\ell}}$$

$$K_1 + U_1 + W_{\text{other}} = K_2 + U_2 \qquad U_{\text{grav}} = mgy \qquad U_{\text{el}} = \tfrac{1}{2}kx^2$$

$$\vec{\mathbf{F}}(x, y, z) = -\hat{\mathbf{i}}\frac{\partial U}{\partial x} - \hat{\mathbf{j}}\frac{\partial U}{\partial y} - \hat{\mathbf{k}}\frac{\partial U}{\partial z} \qquad W_{\text{net}} = \Delta K = \tfrac{1}{2}mv_2^2 - \tfrac{1}{2}mv_1^2.$$

$$\boxed{\Delta\vec{\mathbf{p}} = \vec{\mathbf{p}}_f - \vec{\mathbf{p}}_i = \int_{t_i}^{t_f}\vec{\mathbf{F}}\,dt = \vec{\mathbf{J}}} \qquad \boxed{P = \frac{dW}{dt} = \frac{dE}{dt}} \qquad \boxed{\vec{\mathbf{P}} = \Sigma m_i\vec{\mathbf{v}}_i = M\vec{\mathbf{v}}_{CM}}$$

$$\boxed{\tfrac{1}{2}m_A v_A^2 + \tfrac{1}{2}m_B v_B^2 = \tfrac{1}{2}m_A v_A'^2 + \tfrac{1}{2}m_B v_B'^2} \qquad \boxed{\vec{\mathbf{p}}_A + \vec{\mathbf{p}}_B = \vec{\mathbf{p}}'_A + \vec{\mathbf{p}}'_B}$$

Translation	Rotation	Connection
x	θ	$x = R\theta$
v	ω	$v = R\omega$
a	α	$a = R\alpha$
m	I	$I = \Sigma mR^2$
F	τ	$\tau = RF\sin\theta$
$K = \frac{1}{2}mv^2$	$\frac{1}{2}I\omega^2$	
$W = Fd$	$W = \tau\theta$	
$\Sigma F = ma$	$\Sigma\tau = I\alpha$	

$$\boxed{\omega = \frac{d\theta}{dt} \qquad \alpha = \frac{d\omega}{dt}}$$

$$\boxed{\omega = \omega_0 + \alpha t; \quad \theta = \omega_0 t + \tfrac{1}{2}\alpha t^2; \quad \omega^2 = \omega_0^2 + 2\alpha\theta; \quad \bar{\omega} = \frac{\omega + \omega_0}{2}.}$$

$$\vec{\mathbf{L}} = \vec{\mathbf{r}}\times\vec{\mathbf{p}}$$

$$|\vec{L}| = rmv\sin\theta, \quad L = I\omega$$

$$\sum\vec{\tau} = I\,\vec{\alpha} = \vec{r}\times\vec{F} = \frac{d\vec{L}}{dt}, \quad K_{Rollig} = \tfrac{1}{2}I_{CM}\omega^2 + \tfrac{1}{2}Mv_{CM}^2 \qquad v_{CM} = R\omega$$

$$\boxed{\Sigma F_x = 0, \quad \Sigma F_y = 0, \quad \Sigma\tau = 0.}$$

***Young's modulus* is tensile stress divided by tensile strain and is given by** $Y = (F_\perp/A)(l_0/\Delta l)$

***Bulk modulus* is bulk stress divided by bulk strain and is given by** $B = -\Delta p/(\Delta V/V_0)$.

***Sheer modulus* is sheer stress divided by sheer strain, and is given by** $S = (F_\parallel/A)(h/x)$

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

11

1- If $\vec{C} = -3\hat{\imath} - 2\hat{\jmath} - 4\hat{k}$ what is $\vec{C} \times \hat{\jmath}$ **?**

A) $+4\hat{\imath} - 3\hat{k}$
B) $+3\hat{\imath} - 4\hat{k}$
C) $-3\hat{\imath} - 4\hat{k}$
D) $+4\hat{\imath} + 2\hat{\jmath} - 3\hat{k}$
E) $-3\hat{\imath} - 2\hat{\jmath} + 4\hat{k}$

2- Two objects are dropped from a bridge, an interval of 1.0 s apart, and experience no appreciable air resistance. As time progresses, the DIFFERENCE in their speeds

A) increases.
B) decreases.
C) increases at first, but then stays constant.
D) remains constant.
E) decreases at first, but then stays constant.

3- 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 4.00 revolutions every 10.0 seconds. What is the magnitude of the acceleration of the ball?

A) 19.7 m/s^2
B) 28.4 m/s^2
C) 50.5 m/s^2
D) 38.7 m/s^2
E) 12.6 m/s^2

4- Puck slides a total of 12 m before coming to rest. If the coefficient of kinetic friction between the puck and the horizontal board is 0.18, what was the initial speed of the puck?

A) 10.6 m/s
B) 9.5 m/s
C) 6.5 m/s
D) 8.1 m/s
E) 11.7 m/s

5- A block slides down a frictionless inclined ramp. If the ramp angle is 13.0° and its length is 30.0 m, find the speed of the block as it reaches the bottom of the ramp, assuming it started sliding from rest at the top.

A) 13.1 m/s
B) 11.5 m/s
C) 12.3 m/s
D) 13.8 m/s
E) 14.5 m/s

6- In a collision between two objects having unequal masses, how does magnitude of the impulse imparted to the lighter object by the heavier one compare with the magnitude of the impulse imparted to the heavier object by the lighter one?

A) The lighter object receives a larger impulse.
B) The heavier object receives a larger impulse.
C) The answer depends on the ratio of the masses.
D) The answer depends on the ratio of the speeds.
E) Both objects receive the same impulse.

7- When you ride a bicycle, in what direction is the angular velocity of the wheels?

A) to your left
B) to your right
C) forwards
D) backwards
E) up

8- A uniform solid sphere has a moment of inertia I about an axis tangent to its surface. What is the moment of inertia of this sphere about an axis through its center? $I_{CM} = \frac{2}{5}MR^2$

A) 1/7 I
B) 3/5 I
C) 2/5 I
D) 2/7 I
E) 7/5 I

9- A solid, uniform sphere of mass 2.0 kg and radius 1.1 m rolls from rest without slipping down an inclined plane of height 7.0 m. What is the angular velocity of the sphere at the bottom of the inclined plane? $I_{CM} = \frac{2}{5}MR^2$

A) 7.6 rad/s
B) 6.6 rad/s
C) 5.2 rad/s
D) 5.8 rad/s
E) 9.0 rad/s

10- A skater rotating at 5.00 rad/s with arms extended has a moment of inertia of 2.00 kg·m^2. If the arms are pulled in so the moment of inertia decreases to 1.80 kg·m^2, what is the final angular speed?

A) 8.33 rad/s
B) 6.94 rad/s
C) 5.56 rad/s
D) 6.25 rad/s
E) 9.72 rad/s

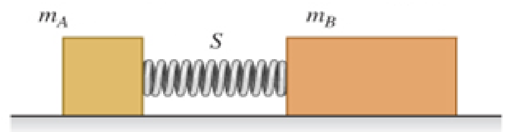
11- A shear force of 350 N is applied to one face of an aluminum cube with sides of 30 cm while the opposite face is held fixed in place. What is the resulting displacement of the face? (The shear modulus for aluminum is 2.5×10^{10} N/m^2)

A) 5.3×10^{-8} m
B) 4.7×10^{-8} m
C) 6.0×10^{-8} m
D) 7.3×10^{-8} m
E) 8.7×10^{-8} m

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

20

Problem 1: Block A in the figure has mass 2.00 kg, and block B has mass 5.00 kg. The blocks are forced together, compressing a spring S between them; then the system is released from rest on a level, frictionless surface. The spring, which has negligible mass, is not fastened to either block and drops to the surface after it has expanded. Block B acquires a speed of 1.80 m/s.



- **(a)** What is the final speed of block *A*? **(1.5 pts)**
- **(b)** How much potential energy was stored in the compressed spring? **(2.5 pts)**
- **(c)** What was the maximum compression in the spring if the spring constant 500 N/m. **(1 pts)**

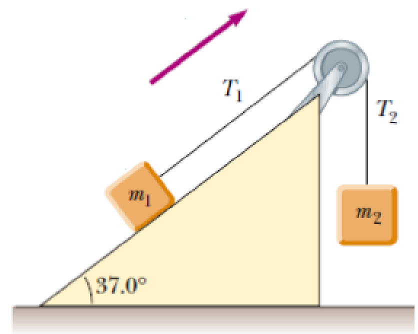
<u>Problem 2</u>: When a 3.75-kg fan, having blades 22.5 cm long, is turned off, its angular speed decreases uniformly from 11.0 rad/s to 7.20 rad/s in 6.00 s.

(a) What is the magnitude of the angular acceleration of the fan? **(2 pts)**
(b) Through what angle (in degrees) does it turn while it is slowing down during the 6.00 s? **(1 pt)**
(c) If its angular acceleration does not change, how long after it is turned off does it take the fan to stop. **(2 pts)**

Problem 3: Two blocks m_1 = 13.0 kg and m_2 = 23.0 kg, as shown in the figure, are connected by a string of negligible mass passing over a pulley of radius 0.300 m and moment of inertia *I*. The block on the frictionless incline is moving up with a constant acceleration of 2.50 m/s^2.

(a) Determine T_1 and T_2, the tensions in the two parts of the string. **(3 pts)**

(b) Find the moment of inertia of the pulley. **(2pts)**



<u>Problem 4</u>: An 92.0 kg-diver stands at the edge of a **<u>light</u>** 5.00-m diving board, which is supported by two narrow pillars 1.60 m apart, as shown in the figure. Find the **<u>magnitude</u>** and **<u>direction</u>** of the force exerted on the diving board

(a) Draw a sketch showing the forces that acting on the board. **(1pts)**
(b) by pillar *B*. **(2pts)**
(c) by pillar *A*. **(2 pts)**