Prince Sultan University

Department of Mathematics and General Sciences

Physics I (PHY105)

Final Exam

Term 141

Date: Monday 12/1/2015

Name:

Student ID #:

Section # or time:

Instructor's name:

Instructions:

1. Examination time: **2 hours**.
2. Write your name before starting with the questions.
3. **Switch off your mobile phone** and put any books and notes away.
4. Check that you have **7 pages** in total.
5. You may use a calculator but you may not borrow one.
6. Assume the acceleration of gravity $\boldsymbol{g = 9.8\ m/s^2}$.

Good luck!

	Mark
Part 1	
Part 2	
Part 3	
Total	

Part 1 (10 points total): 10 multiple choice questions, 1 point each

Indicate the answer choice that best answers the question or completes the statement.

Q1. The mechanical energy of an object remains constant

a) if only friction acts on it
b) if it undergoes an elastic collision
c) if only conservative forces act on it
d) always

Q2. The unit of power (watt) is equivalent to

a) N.s
b) J.s
c) N.m
d) J/s

Q3. A thrown stone hits a window, but doesn't break it. Instead it reverses direction and ends up on the ground below the window. In this case, we know:

a) the force of the stone on the glass $>$ the force of the glass on the stone.
b) the force of the stone on the glass $=$ the force of the glass on the stone.
c) the force of the stone on the glass $<$ the force of the glass on the stone.
d) the force of stone on the glass is zero.

Q4. Which of the following has dimensions of velocity? (a is acceleration, x is distance, and t is time)

a) ax
b) a/x
c) at^2
d) at

Q5. Two blocks are released from the top of a building. One falls straight down while the other slides down a smooth ramp. If friction is ignored, which one is moving faster when it reaches the bottom?

a) The block that went down the ramp.
b) The block that went straight down.
c) They both will have the same speed.
d) Insufficient information.

Q6. A 0.4 kg projectile is launched with an initial velocity of $\vec{v}_0 = 4\,\hat{x} + 6\,\hat{y}\ \ (\mathrm{m/s})$. What is its kinetic energy at its maximum height?

a) 3.2 J
b) 4 J
c) zero
d) 1.44 J

Q7. A horizontal force of 60 N is applied to move a 20 kg cart across a 4 m horizontal surface. What work is done by the 60 N force?

a) 240 J
b) 4800 J
c) 490 J
d) 80 J

Q8. A 0.2 kg ball falling vertically hits the ground at 10 m/s and bounces straight back at 8 m/s. What is the magnitude of the impulse delivered to the ball?

a) 90 N.s
b) 0.4 N.s
c) 3.6 N.s
d) 8 N.s

Q9. A wheel rotating at an angular velocity of 1 rad/s starts to accelerate with a constant angular acceleration of 4 rad/s^2. How many revolutions it completes after 3 seconds?

a) 1.23 rev.
b) 18 rev.
c) 13 rev.
d) 3.34 rev.

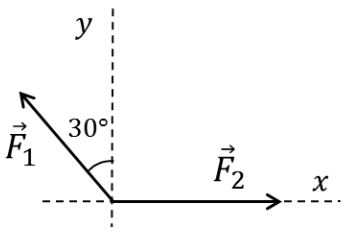
Q10. 210 revolutions per minute is equivalent to about:

a) 22 rad/s
b) 3.5 rad/s
c) 33.4 rad/s
d) 30 rad/s

Part 2 (12 points total): 6 multiple choice questions, 2 points each.
Indicate the answer choice that best answers the question or completes the statement.

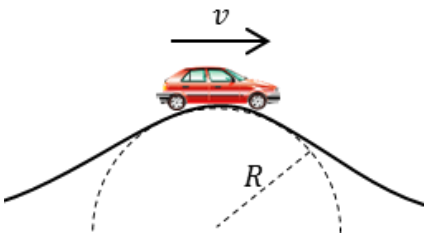
Q1. The two forces $F_1 = 6$ N and $F_2 = 4$ N are acting in the directions shown. What is the magnitude of their sum?

a) 10 N
b) 7.21 N
c) 3.23 N
d) 5.29 N



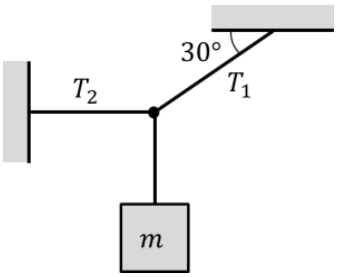
Q2. A car traveling at 7 m/s passes over a bump in a roadway that follows the arc of a circle of radius $R = 20$ m, as in the figure. What is the normal force acting on a 70 kg passenger as the car passes the highest point of the bump?

a) 514.5 N
b) 171.5 N
c) 857.5 N
d) 413.2 N



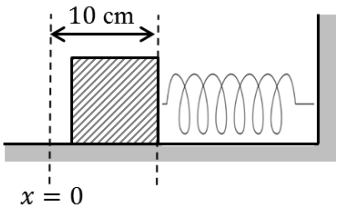
Q3. The system in the figure is in equilibrium. The mass $m = 2$ kg. What is the tension in the upper cord T_1?

a) 39.2 N
b) 22.6 N
c) 19.6 N
d) 35.2 N



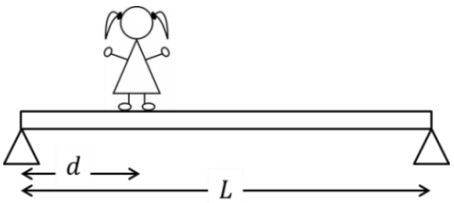
Q4. A spring with a spring constant of $k = 200$ N/m is mounted horizontally over a frictionless surface. The spring is then compressed 10 cm and is used to launch a mass 0.5 kg along the surface. What is the speed of the mass as it leaves the spring?

a) 200 m/s
b) 2 m/s
c) 10 m/s
d) 5 m/s



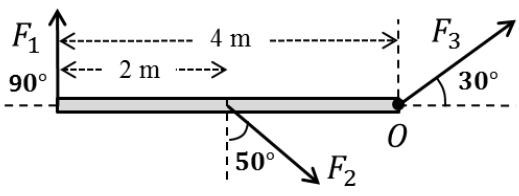
Q5. An 8 kg plank has a length of $L = 4$ m is resting on two pivots placed at its ends, as shown. A 40 kg girl stands on the plank at $d = 1$ m from the left end. What is the normal force acting on the plank from the left pivot? (Assume the plank's center of mass is at its midpoint).

a) 431.2 N
b) 235.2 N
c) 333.2 N
d) 392.0 N



Q6. Three forces act on a rod as shown. $F_1 = 10$ N, $F_2 = 15$ N and $F_3 = 20$ N. What is the net torque acting on the rod about an axis through the point O perpendicular to the page?

a) 49.6 N.m clockwise
b) 17 N.m counterclockwise
c) 10 N.m counterclockwise
d) 20.7 N.m clockwise



Part 3 (20 points total): 4 problems, 5 points each.

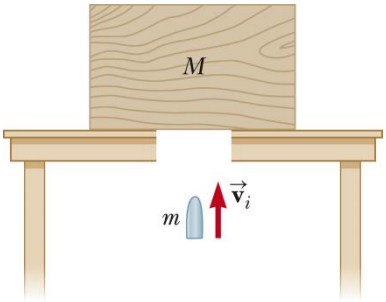
Solve the following problems in the provided space. Show your work in details and indicate the units.

Q1. A 2500 kg truck moving at 54 km/h to the West collides in a head-on collision with a 1000 kg car moving at 90 km/h to the East and the two vehicles stick together.

a) Calculate the velocity of the two vehicles just after the collision.

b) Assume that only friction starts to act right after the collision such that the two cars slide on the road until they stop completely. What distance will the cars slide before coming to rest, given that the coefficient of kinetic friction between the tires and the road is 0.3?

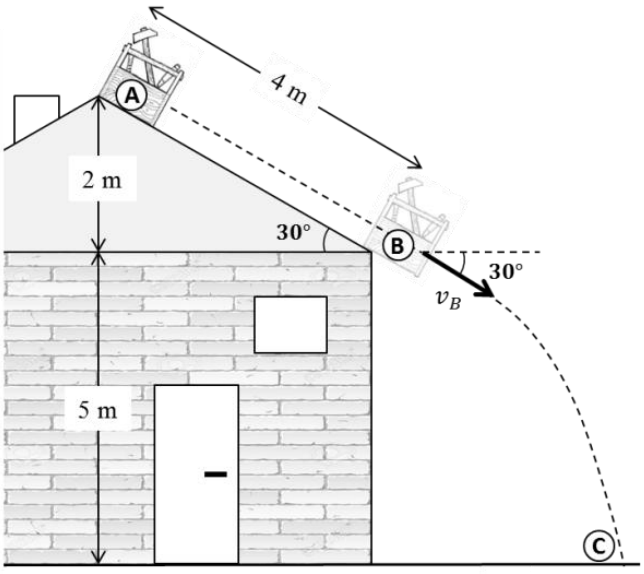
Q2. A wooden block of mass M rests on a table over a large hole as in the figure. A bullet of mass m with an initial velocity v_i is fired upward into the bottom of the block and remains in the block after the collision. The block and bullet rise to a maximum height of h. Derive an expression for the initial velocity of the bullet as a function of $M, m,$ and h.



Q3. In the figure, a 3 kg toolbox starts to slide from rest at point A from the top of a house roof inclined at $30°$. As it reaches the end of the roof (point B) it falls to hit the ground underneath (point C). The coefficient of kinetic friction between the toolbox and the roof is $\mu_k = 0.2$. Given the dimensions in the figure and assuming no air resistance, calculate:

a) The speed of the toolbox v_B as it leaves the roof (at point B).

b) The velocity vector of the toolbox just before it hits the ground at point C.



Q4. Consider a pendulum consisting of a light cord of length 1 m and a small object of mass $m = 0.2$ kg attached to its end, as shown. The pendulum swings without friction. When the angle the cord makes with the vertical is $\theta = 40°$ the tangential speed of the object is $v = 3$ m/s. At this instant:

a) Draw a free-body diagram for the object and calculate the tension in the string

b) Calculate the centripetal and the tangential accelerations, and the magnitude of the total acceleration of the object

c) As the pendulum continues to move, calculate the maximum height it reaches measured from the lowest point in its path.