Sultan Qaboos University
College of Science
Department of Physics

PHYS2107: Physics for Engineering I
Spring 2006: Final Examination
Monday 15th May 2006

Time: 2.00 to 5.00 pm

Name:
ID No:

PAPERS WITHOUT NAME AND ID NUMBER WILL NOT BE GRADED

Full Mark: 100

Kindly check that your Examination Paper has 8 questions

You must show ALL necessary steps in order to get the full mark

Answer ALL questions

(Take g = 9.8 ms^{-2})

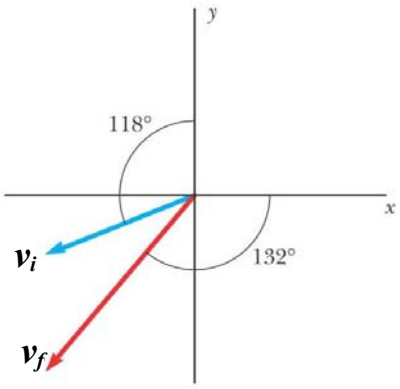
Good–luck

Q #	Mark
1	
2	
3	
4	
5	
6	
7	
8	
Total	

Mark: (8 + 4)

1A. At $t = 0$, a particle moving in the xy plane with constant acceleration has a speed v_i = 7.5 m/s and is at the origin. At $t = 3.0$ s, the particle has a speed of v_f = 10 m/s, with directions of the velocities as shown in the figure.

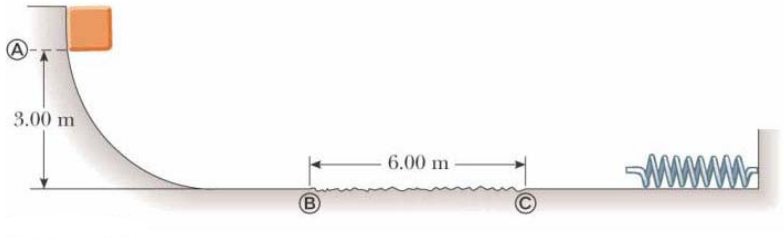
a) Calculate the scalar product of v_i and v_f.
b) Calculate the vector product of v_i and v_f.
c) What is the acceleration of the particle?
d) Find its coordinates (x,y) at any time t.



1B. A tire 0.5 m in radius rotates at a constant rate of 200 rev/min. Find the speed and acceleration of a small stone stuck on the surface of the tire (on its outer edge).

Mark: (10)

2. A 10.0-kg block is released from point A, as shown in the figure below. The track is frictionless except for the portion between points B and C, which has a length of 6.00 m. The block travels down the track, hits a spring of force constant 2250 N/m, and compresses the spring 0.3 m from its equilibrium position before coming to rest momentarily. Determine the coefficient of kinetic friction between the block and the rough surface between B and C.



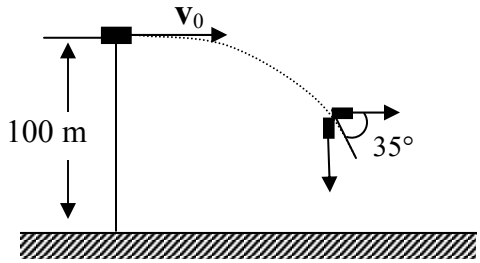
3. A 4.0-kg particle moves along the x axis. Its position varies with time according to:

$x = t + 2.0t^3$

where x is in meters and t is in seconds.

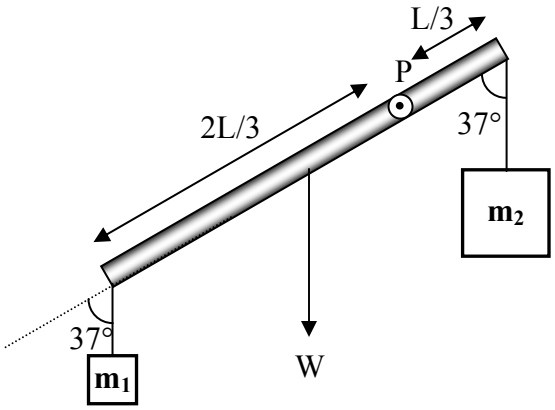
Find:
a) the kinetic energy at time $t = 2.0$ s.
b) the acceleration of the particle and the force acting on it at time $t = 2.0$ s.
c) the power being delivered to the particle at time $t = 2.0$ s.
d) the work done on the particle in the interval $t = 0$ to $t = 2.0$ s.

4. A 20.0–kg particle is shot horizontally with an initial speed v_0 = 10 m/s at a height of 100 m above the ground level (see figure). The particle explodes into identical fragments when its velocity makes an angle of 35° below the horizontal. Immediately after the explosion, one fragment moves down vertically; while the other fragment moves initially horizontally. (*Neglect the effect of gravitational force during the explosion*).



a) How much energy is released in the explosion?
b) At what times will the two fragments reach the ground?

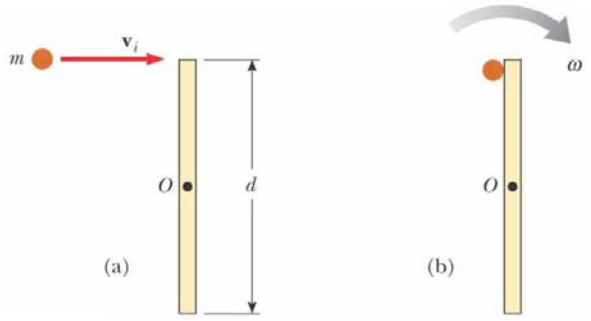
5. Two blocks of masses $m_1 = 5$ kg and $m_2 = 15$ kg are suspended from the ends of 1.5 m rigid rod of weight 75 N that can rotate about point P, as shown in the figure. The rod is held in a configuration such that it makes an angle of 37° with the vertical, and then released. The two blocks can be considered as point particles and the moment of inertia of the rod about its center of mass is $I_{com} = ML^2/12$.



a) What is the initial angular acceleration of the rod (immediately after the release)?
b) What are the initial magnitudes of the accelerations of the two blocks m_1 and m_2?

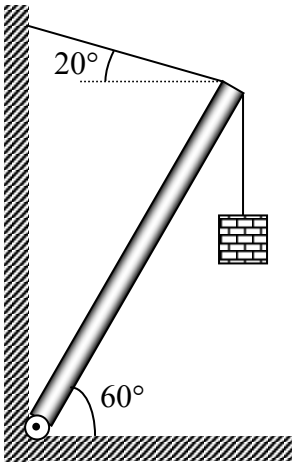
6A. A solid sphere has a mass $M = 5\ kg$ and a moment of inertia of $\frac{2}{5} MR^2$ (R being the radius of the sphere). If it starts from rest, how much work must be done on it to set it rolling without slipping at a linear speed $v = 2\ m/s$?

6B. A projectile of mass $m = 20\ g$ moves to the right with a speed $v_i = 100\ ms^{-1}$. The projectile strikes and sticks to the end of a stationary rod ($I_{com} = Md^2/12$) of mass $M = 4\ kg$, length $d = 2.5\ m$, pivoted about a frictionless axle through its center, as shown in the figure.



a) Find the angular speed of the system right after the collision.
b) Determine the fractional loss in mechanical energy due to the collision.

7. A 250-kg block is supported by a cable attached to a rod of mass 100 kg that can pivot at the base.



a) Calculate the tension in the tie-rope between the rod and the wall if it is holding the system in the position shown in Figure.
b) Find the horizontal and vertical forces exerted on the base of the rod.

8. A 200-g block is attached to a horizontal spring and executes simple harmonic motion with a period of 0.25 s. At t = 0, the block is released from rest when the spring is compressed by 3.0 cm (that is $x = -3.0$ cm).

Find:
a) the spring constant k.
b) the amplitude of the motion.
c) the equation of motion $x(t)$ (the position as a function of time).
d) the speed of the block when the mechanical energy of the system is half potential and half kinetic energy?