Sultan Qaboos University
College of Science
Department of Physics

PHYS2107: Physics for Engineering I
Fall 2005: Final Examination
Saturday 17th December 2005

Time: 2.00 to 5.00 pm

Name:	
ID No:	

Full Mark: 100

Kindly check that your Examination Paper has <u>8 questions</u>

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

<u>Answer ALL questions</u>

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

Good–luck

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

1A. A particle moving along the x–axis has a position given by $x = 24t - 2t^3$, where t is the time measured in seconds and x in meters.

Find:

a) the acceleration of the particle at the instant when it momentarily stops?

b) the <u>distance</u> and <u>displacement</u> of the particle between $t = 0$ and $t = 3$ s

1B. The velocity of a particle moving along the x–axis is shown in the figure. If $x = 2.0$ m at $t = 1.0$ s, what is the position of the particle at $t = 6.0$ s.
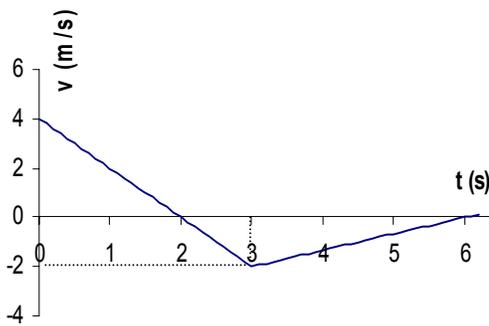
2A. Two vectors **A** and **B** are such as:

A + **B** = 6*i* + *j* + 3*k*   and   **A** − **B** = −4*i* + 7*j* − 9*k*

a) What is the vector **A**×**B** in unit-vector notation?
**b)** What is the angle between vectors (**A** + **B**) and **A**×**B**?

2B. A basketball player who is 2 m tall is standing on the floor 10 m from the basket, as shown in the figure below. If he shoots the ball at a 40° angle with the horizontal, at what initial speed must he throw so that it goes through the hoop without striking the backboard? The basket height is 3.05 m.
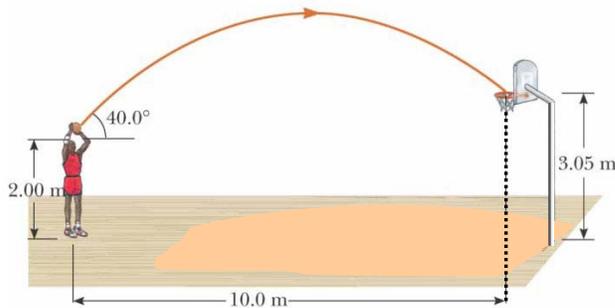
3A. Three objects of masses M, 2M and 3M, slide on a frictionless horizontal surface.
If $F = 12$ N, what is the <u>tension in string 1</u>?

2F   [M]   2   [2M]   1   [3M]   3F
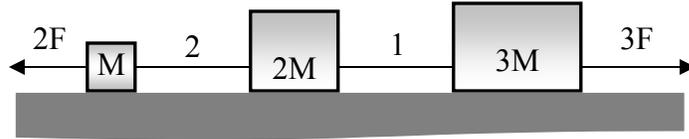
3B. A 0.5 kg ball is connected by means of two identical massless strings each of length
2 m, as shown in the figure. The strings make an angle of $\theta = 30°$ with the rod. The ball is
made to rotate about a vertical axis. The maximum tension that the upper string can
withstand is 50 N. What are the <u>maximum velocity</u> of the ball and the <u>centripetal force</u> on
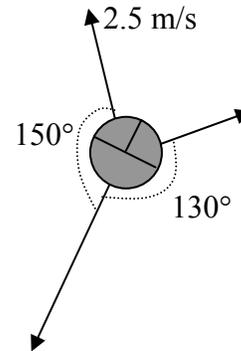the ball?

2 m
θ
θ
2 m
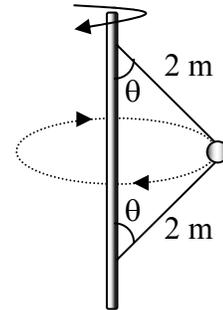
4. A 3 kg object has a velocity (6**i** – 2**j**)m/s at certain time.

a) What is its kinetic energy at this time?

b) Find the total work done on the object if its velocity changes to (8**i** + 4**j**)m/s.

5. A 10 kg –disk, initially at rest, suddenly explodes into three pieces: two with a quarter of the total mass each and the third one with half of the total mass. The three pieces then slide across a <u>frictionless horizontal plane</u>. One of the two small pieces has a final speed of 2.5 m/s, as shown in the figure. What are the speeds of the other two pieces?

2.5 m/s

150°

130°

6. A steel ball of mass 0.5 kg is attached to a cord that is fixed at the other end. The ball is then released when the cord is horizontal, as shown in the figure. At the bottom of its path, the ball elastically strikes a 2 kg steel block initially at rest on a frictionless horizontal surface. The ball is in contact with the block for 2 ms, and the force due to the elastic collision is given by:

$$F(t) = 8\times10^6 t - 2\times10^9 t^2$$

for $0 \le t \le 4$ ms, where t is the time in seconds. Both the ball and block are considered as point particles.

For elastic collision in one dimension ($v_{2i} = 0$): $v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i}, \quad v_{2f} = \frac{2m_1}{m_1 + m_2} v_{1i}$
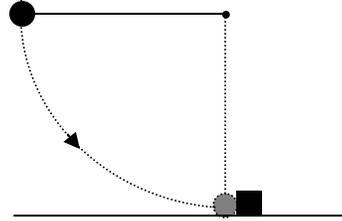
Find:
a) the impulse on the block due to the collision.
b) the average force of the block from the ball during the period of contact.
c) the maximum force on the block during the period of contact.
d) the <u>speed</u> of block immediately after the collision and the <u>length</u> of the cord.

7. A solid sphere, of mass 1.5 kg and radius 5 cm, is connected to the end of a vertical rod along a *y*–axis, of mass 2 kg and length 35 cm. The rod can rotate about *z*–axis passing through the other end, as show in the figure.
The moment of inertia about the center of mass: $I_{rod} = ML^2/12$ and $I_{sphere} = (2/5)mR^2$.

a) What is the moment of inertia of the system (sphere + rod) about *z*–axis?
b) Starting from rest, the system rotates clockwise around the *z*–axis from the initial vertical orientation, what is its angular speed when it is inverted?
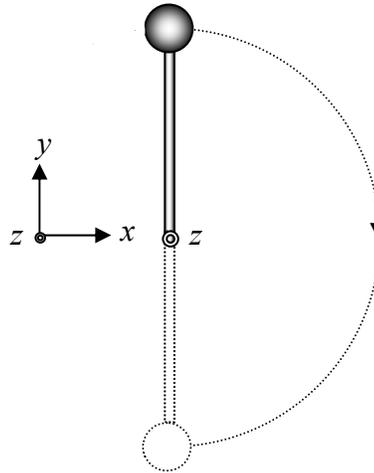
8. A solid sphere, of mass m = 2 kg and radius r = 10 cm, rolls without slipping along the track shown in the figure. It starts from rest with the lowest point of the sphere at height *h* above the bottom of the loop of radius R = 10 m.
a) What is the minimum value of *h* such that the sphere completes the loop?
b) What is the force exerted by the loop's track on the sphere at the point P if h = 50 m?