

# **MIE 100 Dynamics – Summer 2013**

**Midterm Test**

**Wednesday May 29, 2013**

**Start Time: 11:40 am      Duration: 1 hr 45 min**

## **COVER PAGE**

### **General Instructions:**

- Answer all questions in the exam booklet(s) provided.
- Write your full ROSI name, Student #, and Tutorial # on each exam booklet you use.
- You may keep the test paper and your aid sheet.

### **Number of Pages:**

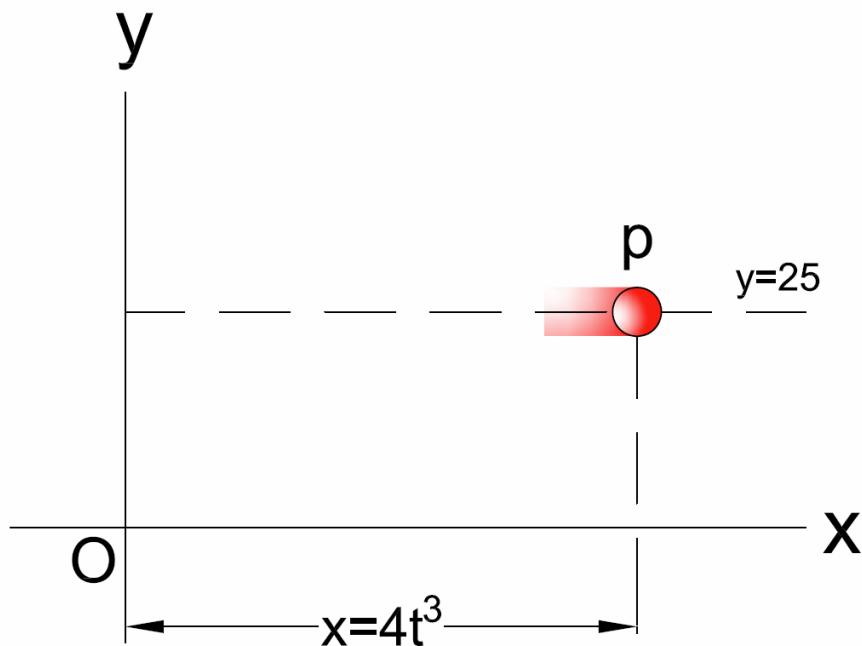
- 4 (including cover page)

### **Number of Questions:**

- Three (3) questions

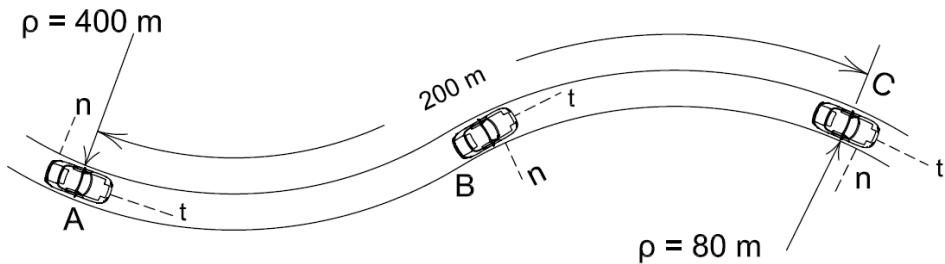
### **Permitted Aids:**

- Approved non-communicating/non-programmable calculator
- One (1) aid sheet - 8.5" x 11", double-sided, any colour

**Question 1 [35 marks total]**

A particle P travels along  $y = 25$  such that  $x = 4t^3$ ; time is measured in seconds and x and y are in meters.

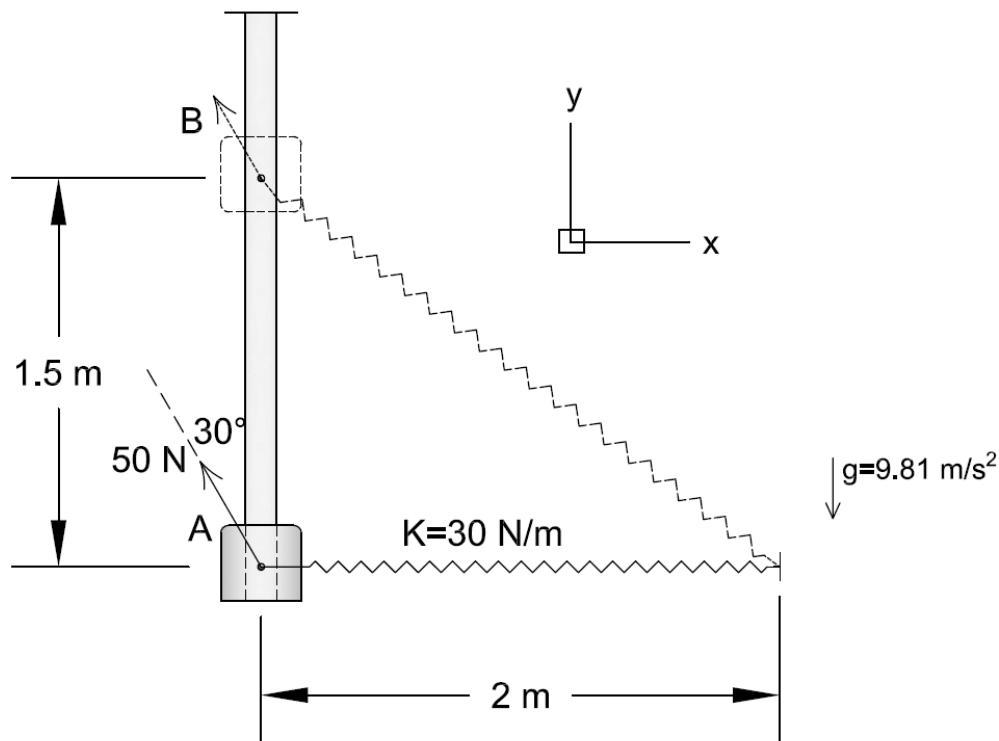
- Find the velocity of P at  $t = 1\text{s}$ . Use the rectangular co-ordinates shown.  
[5 Marks]
- Find the velocity of P at  $t = 2\text{s}$ . Use normal and tangential co-ordinates.  
[10 Marks]
- Find the position of particle P at  $t = 3\text{s}$ . Use polar co-ordinates centered at O.  
[5 Marks]
- Find the acceleration of P at  $t = 3\text{s}$ . Use polar co-ordinates centered at O.  
[15 Marks]

**Question 2 [30 marks total]**

A 1500 kg car enters a section of curved road in the *horizontal* plane and slows down at a uniform rate from a speed of 100 km/h at A to a speed of 50 km/h as it passes C. The radius of curvature  $\rho$  of the road at A is 400 m and at C is 80 m and point B is the inflection point (where it is instantaneously straight) of the curved path ABC.

(Hint: For parts (c) and (d) below, treat the car as a particle and find the external forces as required.)

- What is the constant tangential acceleration? [10 Marks]
- What is the normal component of the acceleration at B? [5 Marks]
- Determine the total horizontal force exerted by the road on the car when it is at position B. [5 Marks]
- Determine the total horizontal force exerted on the car when it is at position C. Use normal and tangential coordinates to express your answer. [10 Marks]

**Question 3 [35 marks total]**

The collar has a mass of 2 kg and is attached to the light spring, which has a stiffness of  $30 \text{ N/m}$  and an unstretched length of 1.5 m. The collar is released from rest at A and slides up the smooth rod under the action of the constant  $50 \text{ N}$  force.

- What is the potential energy of the spring at time  $t=0$ ? [10 Marks]
- Find the velocity of the collar as it passes position B. [15 Marks]
- Draw a free body diagram of the collar when it is in position B. Indicate the direction (as they act on the mass) of all forces in the plane of motion. It is not necessary to calculate their magnitudes.[10 Marks]