THE UNIVERSITY OF ADELAIDE
DEPARTMENT OF MECHANICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF B.E.

2391: DYNAMICS

NOVEMBER, 1999

TIME: 2 HOURS

[In addition the candidates are allowed ten minutes before the exam to read the paper.]

[Notes and textbooks are **not** permitted in the examination room.]

[Calculating devices are permitted, as is the Dynamics formula sheet.]

Attempt ALL **FOUR** questions.

PLEASE SEE NEXT PAGE

1) A block slides, in a uniform gravitational field of strength g, down a frictionless surface described by

$y = 4x^{-1}$ (x and y in metres)

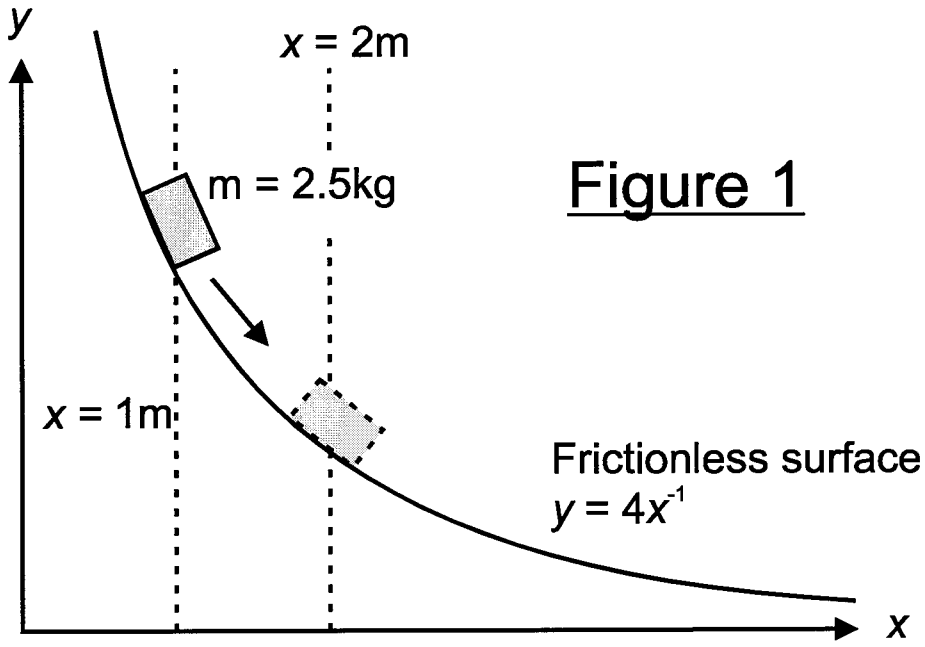


Figure 1

The block was released from rest at $x = 1$.

When x = 2 metres,

a) Find a_n, the normal component of acceleration. (8)

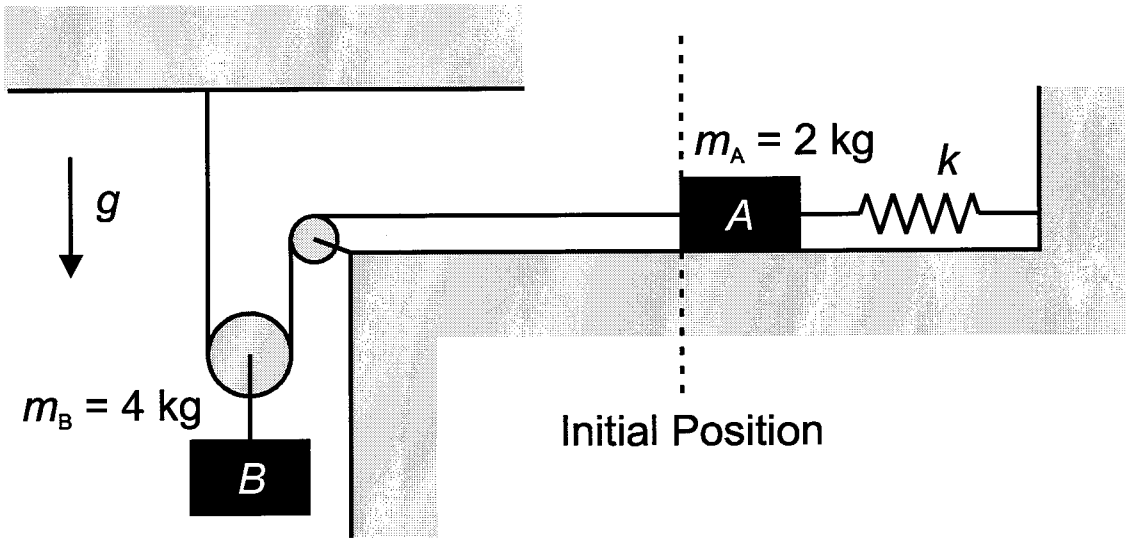
b) Find a_t, the tangential component of acceleration. (8)

c) With the mass of the block = 2.5 kg, find the magnitude of the normal force, N exerted by the surface on the block (4)

2) The system shown in Figure 2 is released from rest at time $t = 0$.

The spring has a stiffness of $k = 2000\ \text{Nm}^{-1}$. The coefficients of friction between mass A and the horizontal surface are $\mu_s = 0.5$ and $\mu_k = 0.3$. All components of the system have negligible mass except for the blocks indicated. The cord is inextensible. The pulleys have frictionless bearings. The spring is unextended in the initial position.

Figure 2



a) Show that the masses will move! (5)

b) What is the tension in the cable immediately after the masses have started moving? (5)

c) What is the acceleration of mass A immediately after the masses have started moving? (5)

d) What is the maximum displacement of mass A to the left of its initial position? (5)

3) Two circular pucks with smooth surfaces collide on a frictionless table. Puck 1 has an initial speed of v_1 = 10 ms^{-1}, whilst puck 2 is initially stationary. The line of motion of the centre of mass of puck 1 before the impact is offset 1 cm from a head-on collision as shown in Figure 3.

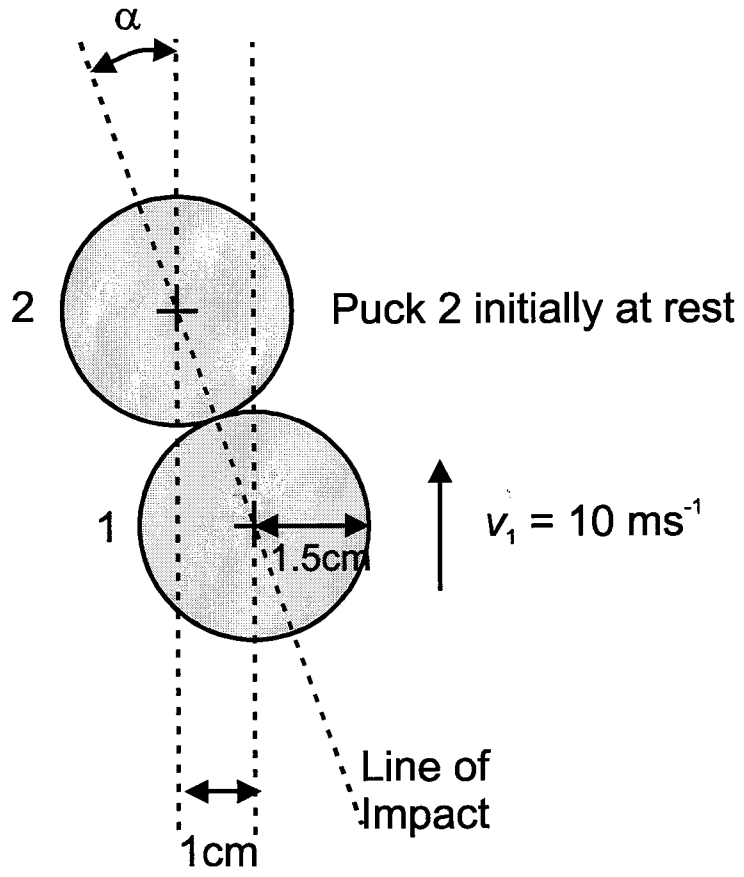


Figure 3

a) If both pucks have radius of 1.5cm, what is the angle α between the initial velocity of puck 1 and the line of impact for the collision? (5)

b) By considering the tangential component of puck 2's momentum (ie perpendicular to the line of impact), determine the direction of motion of puck 2 after the impact. (3)

c) If pucks 1 and 2 have masses of 2kg and 5kg respectively, and puck 1 is observed to recoil at an angle of 105.8° clockwise from its initial velocity, use the conservation of momentum to determine the speed of puck 2 after the collision. (5)

d) Determine the coefficient of restitution *e* for impact between these two pucks. (7)

4) In Figure 4 the bar *BD* is attached to two links *AB* and *CD* that connect via hinges to an immovable wall.

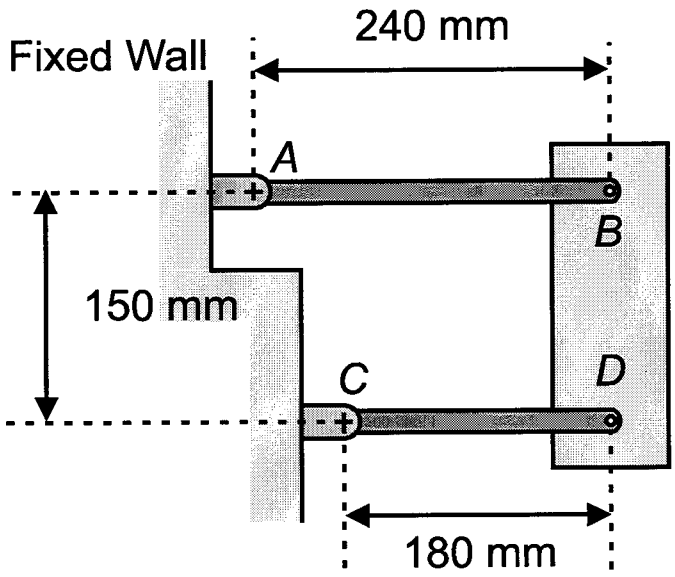


Figure 4

Knowing that at the instant shown the link *AB* rotates with a constant angular velocity of 3 rads^{-1} clockwise, determine the following.

a) The velocity of point B. (2)

b) The velocity of point D. (2)

c) The angular velocity (with sense) of link *CD*. (2)

d) The angular velocity (with sense) of bar *BD*. (2)

e) The angular acceleration (with sense) of link *CD* (6)

f) The acceleration of point *D*. (6)