THE UNIVERSITY OF BRITISH COLUMBIA

2011/2012 WINTER SESSION

SESSIONAL EXAMINATIONS

PHYSICS 170 MECHANICS I

12 noon to 2:30 pm, Wednesday, April 17, 2013

MARKS

This exam counts for a total of 70 marks towards your Final Grade for the course.

The exam consists of 4 questions.

Questions 1 and 3 are each worth 20 marks. Questions 2 and 4 are each worth 15 marks.

Write all work to be marked in the Answer Booklets provided.

NUMERICAL ANSWERS

You must give numerical answers correctly to three figures and with correct units

to get any marks for your numerical answers.

No marks are given for correctly solving incorrect equations.

CALCULATOR

You may use a graphing calculator.

INFORMATION SHEET

You may consult one 8 ½ inch by 11 inch hand-written double-sided Information Sheet.

Your Information Sheet must not contain any sample problems or solutions to sample problems.

Put your name and student number on your Information Sheet.

You must hand in your Information Sheet with your Answer Booklet in order for your exam to be marked.

PHYSICS 170 MECHANICS I Final Exam: 12 noon to 2:30 pm, Wednesday, April 17, 2013

QUESTION 1 (20 marks)

The diagram below shows a rigid body with centre of mass at G held in equilibrium by a ball-and-socket joint at A and by wires BC and BD. The mass of the body is 100 kg. G lies 0.5 m below the xy-plane. The z-axis is vertical. The body is acted upon by a couple moment $\vec{M} = (-500\vec{i} + 600\vec{k})$ N · m at B.

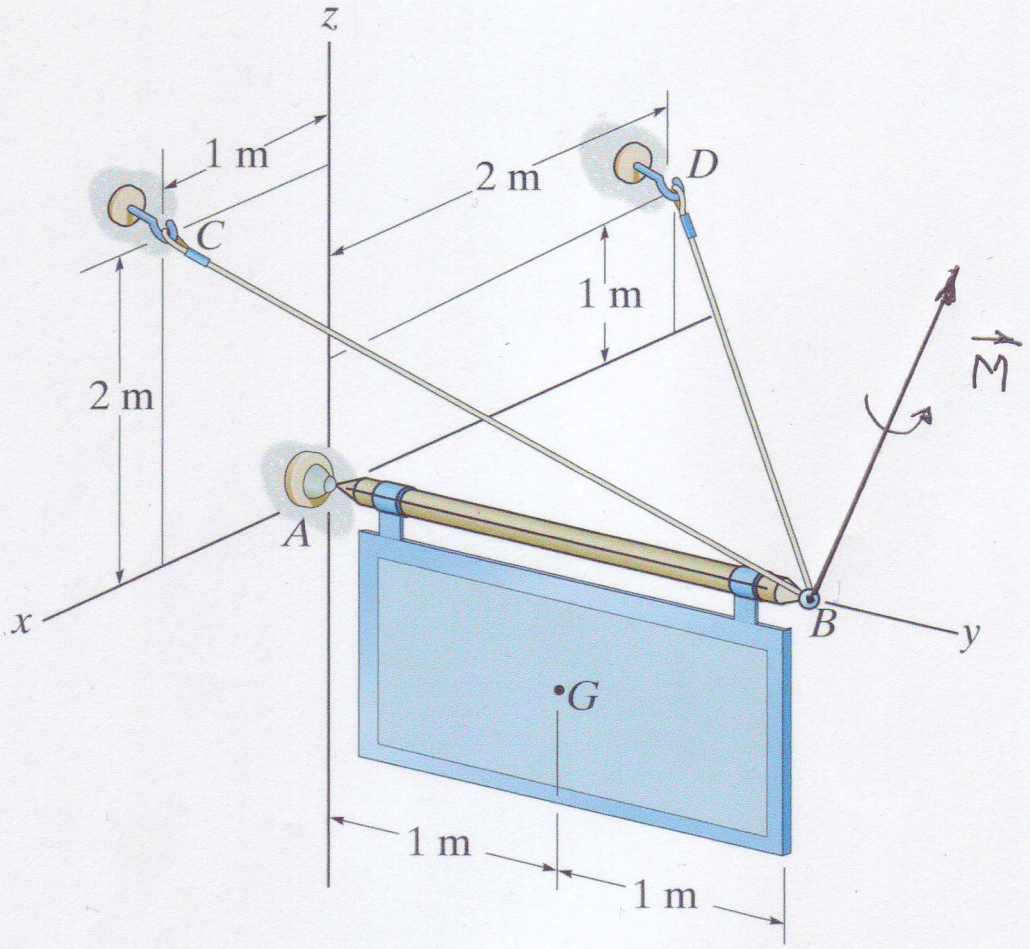
a) Draw a large, clear free-body diagram for the body. (4 marks)

b) Determine Cartesian component force equations of equilibrium for the body. (4 marks)

c) Determine a vector moment equation of equilibrium for the body. (4 marks

d) Determine Cartesian component moment equations of equilibrium for the body. (4 marks)

e) Solve the Cartesian component equations of equilibrium to determine the Cartesian components of reaction at the ball-and-socket joint and the magnitudes of the forces in the wires (4 marks)



QUESTION 2 (15 marks)

In the diagram below, particle P of mass 0.8 kg travels along the curved guide due to rotation of the slotted rod. Motion is in the **horizontal** plane.

The rod exerts a force $\vec{F}$ on P. The guide exerts a normal force $\vec{N}$ on P. The size of P may be neglected. Friction may be neglected.

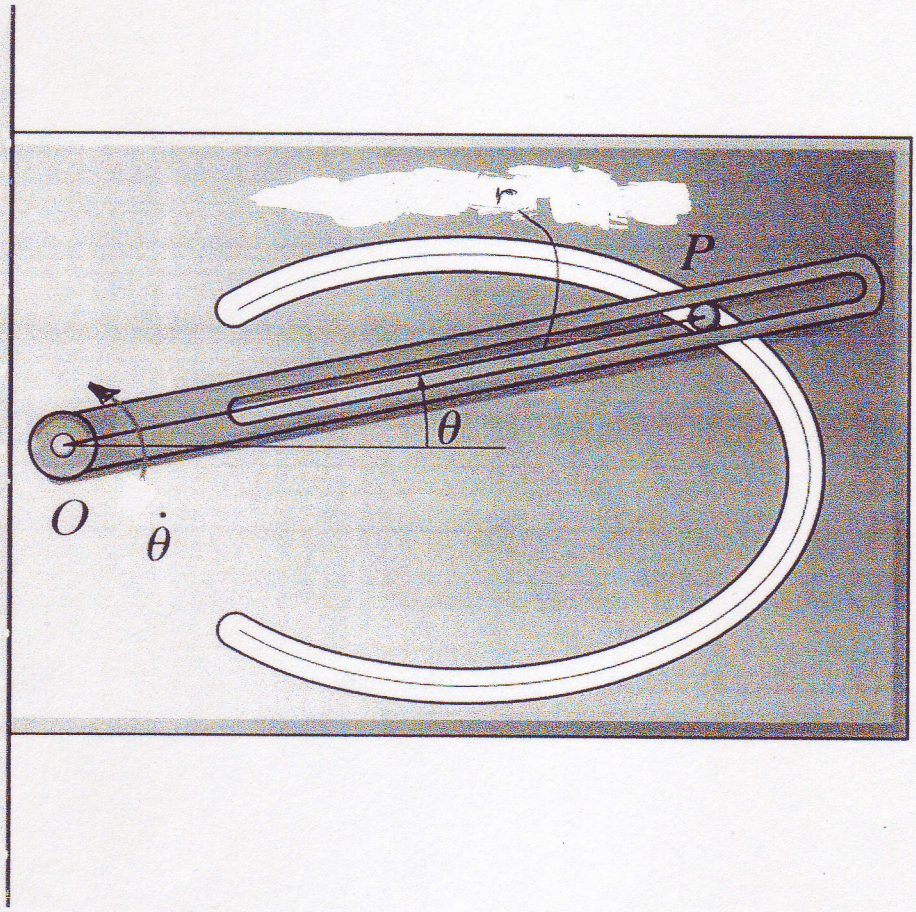
At the instant shown, $r = 0.564$ m, $\dot{r} = -0.164$ m/s, $\ddot{r} = -0.484$ m/s^2, $\dot{\theta} = 0.4$ rad/s, $\ddot{\theta} = 0.3$ rad/s^2. $dr/d\theta = \dot{r}/\dot{\theta}$.

a) Draw a large, clear free-body diagram for P at the instant shown. On this diagram, draw radial and transverse unit vectors, and tangential and normal unit vectors. (4 marks)

b) Determine the radial and transverse components of the acceleration of P. (3 marks)

c) Determine the equations of motion for P. (4 marks)

d) Solve the equations of motion to determine the magnitudes of $\vec{F}$ and $\vec{N}$. (4 marks)



PHYSICS 170 MECHANICS I Final Exam: 12 noon to 2:30 pm, Wednesday, April 17, 2013

QUESTION 3 (20 marks)

The diagram below shows a system of blocks, a rope and pulleys. *A* hangs vertically. *B* is on a horizontal surface. *C* is on the horizontal top surface of *B*.

The mass of *A* is 8 kg. The mass of *B* is 10 kg. The mass of *C* is 5 kg.

The coefficient of kinetic friction between *B* and the horizontal surface is 0.2.

The coefficient of kinetic friction between *B* and *C* is 0.1.

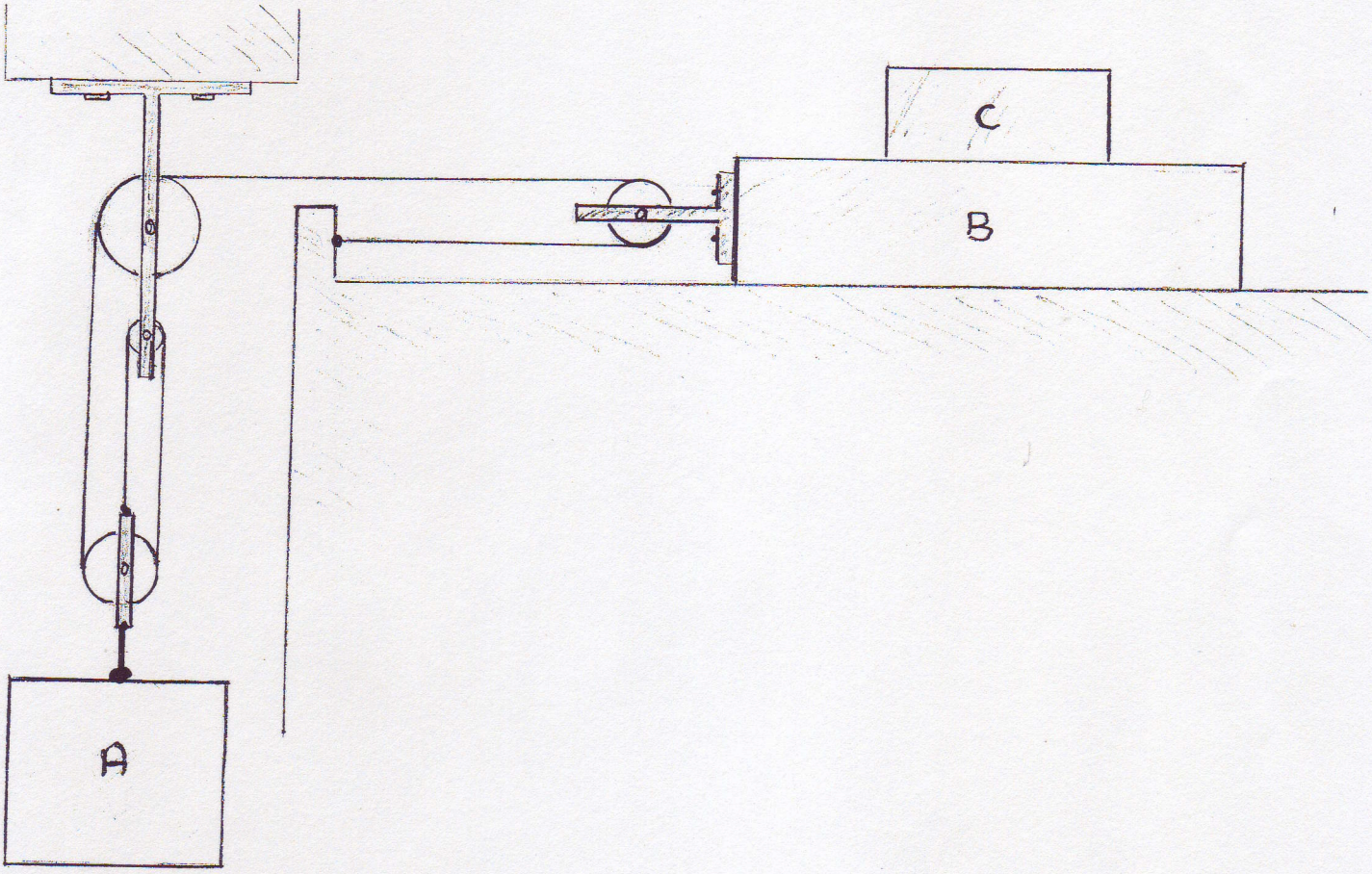
The masses of the pulleys and the rope may be neglected. Friction in the pulleys may be neglected.

All blocks accelerate: *A* moves down, *B* slides, *C* slides.

a) Draw large, clear free-body diagrams for the blocks. (6 marks)

b) Determine equations of motion for the blocks. (8 marks)

c) Solve these equations to determine the acceleration of each block and the tension in the rope. (6 marks)



QUESTION 4 (15 marks)

The diagram below shows A and B connected by a cord of fixed length that passes through a smooth hole in a smooth table. The surface of the table is horizontal. The mass of A is 4 kg. The mass of B is 2 kg. The mass of the cord may be neglected. The sizes of A and B and the hole may be neglected.

Motion of A and B starts when B is given velocity 1.2 m/s perpendicular to the cord when B is 0.5 m from the hole and A is 0.3 m above the floor. During the motion, A falls and B spirals towards the hole.

a) Determine the total energy of A and B at the start of motion. (4 marks)

b) Determine the angular momentum of B about the hole at the start of motion. (3 marks)

c) Determine the speed of A just before it hits the floor. (8 marks)