MIE100S Dynamics – Spring 2014

Midterm Test – February 25, 2014

6:15 – 7:45 p.m.

General Instructions:

- Answer all questions in the exam booklets provided.
- Print your full ROSI name, student # and TUTORIAL # on your exam booklet(s).
- All rough work must be *neatly* shown to earn credit for each question
- You must use a pen or *dark* pencil
- Answer all three questions
- Total marks on this test = 100

Number of Pages:

- 4 (including cover page)

Permitted Aids:

- Non-communicating/non-programmable calculator: Casio FX-991MS or Sharp EL-520X
- One 8 ½" x 11" aid sheet, any colour. You may write on both sides of the sheet.

1. A box of mass m = 50 kg slides down a hill. At the instant before it goes over the cliff (Position *A* in the diagram), the speed of the box is 17 m/s, the frictional force between the box and hill is 130 Newtons, the radius of curvature of the hill is 28 meters, and the hill is sloped down at 20 degrees.

(5 marks) (a) Find the normal component of the acceleration (a_n) at the instant shown in the diagram.

(15 marks) (b) Find the coefficient of kinetic friction.

(10 marks) (c) What is the horizontal distance that the box will travel after it goes over the cliff of height 40 meters?

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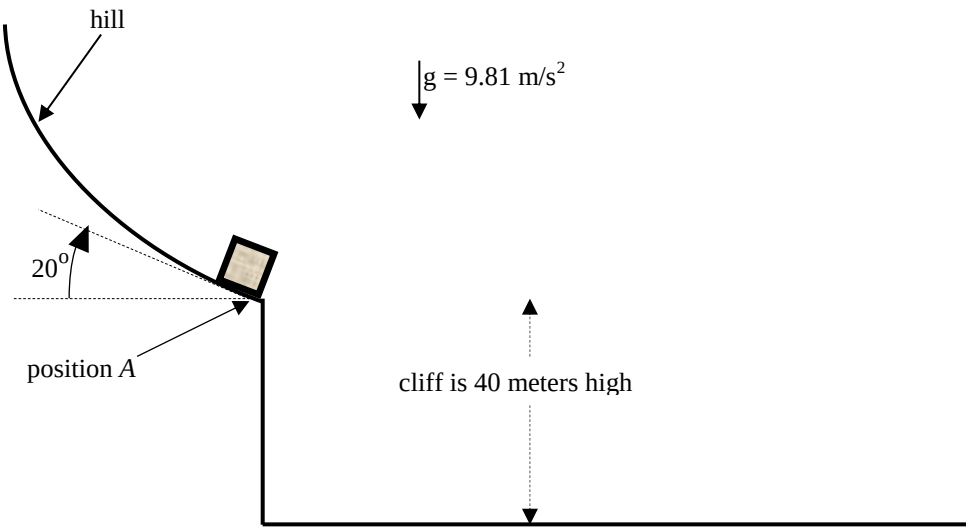

2. Crates *A* and *B* are connected by a rope and pulley system. At the instant shown in the diagram, the speed of crate *A* is 0.5 m/s to the right. The coefficient of kinetic friction μ_k between the crate *A* and the ground is 0.27.

   $mass_A$ = 44 kg. $mass_B$ = 21 kg.

(10 marks) (a) What is the kinetic energy of crate *B* at the instant shown in the diagram?

(20 marks) (b) What is the acceleration of crate *B* at the instant shown in the diagram?

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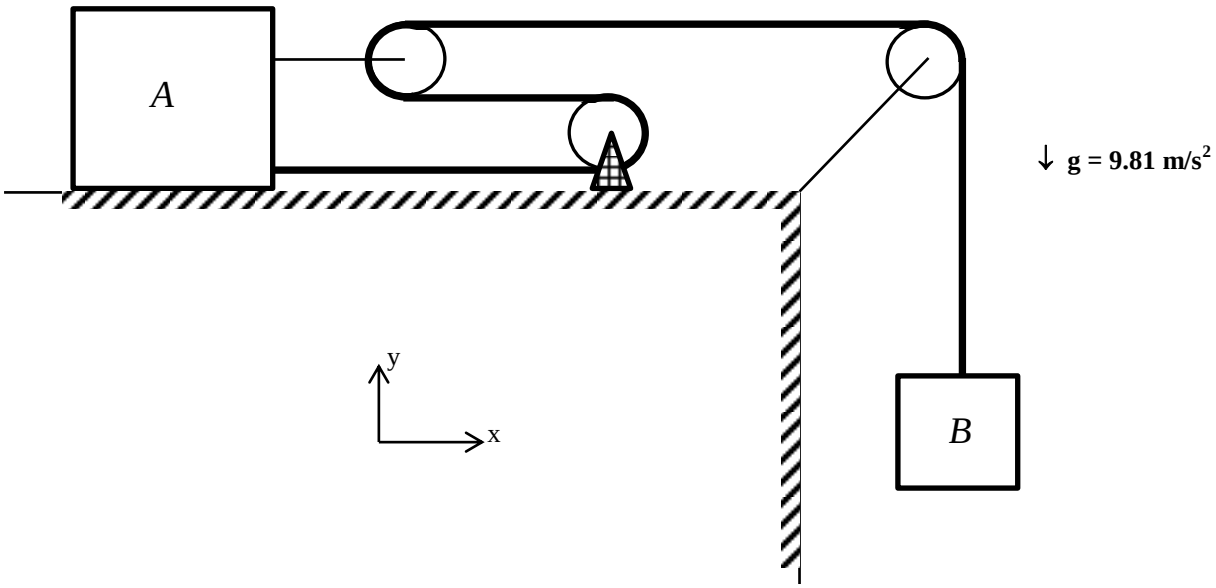

3. Collars *A* and *B* slide on a <u>frictionless</u> rod as shown in the diagram. At the instant shown, collar *B* has a velocity of 2 m/s to the left, and collar *A* is sitting at rest on two platforms. The platforms are each attached to a spring and are initially held stationary with the springs compressed to an initial length $x = 0.3\ m$, as shown. Each spring has an unstretched (relaxed) length of 1.5 m and a spring constant of 200 N/m. The mass of collar *A* is 4 kg and the mass of collar *B* is 5 kg. Assume that the dimensions of both collars and the platforms are extremely small.

(10 marks) (a) What is the total elastic potential energy of the two springs before the platforms are released?

(20 marks) (b) When the platforms are released, collar *A* slides along the rod to point C where it collides with collar *B*. The two collars then stick together. What is the velocity of collars *A* and *B* immediately after they stick together, expressed in x-y coordinates?

(10 marks) (c) How much heat is generated in the collision between collars *A* and *B*?

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