Name: _____ **Section:** _____ **Score:** _____**/20**

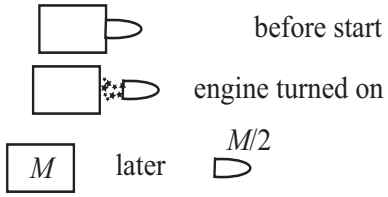
1. In a frictionless straight trough is a block. A constant force F pushes the block for t seconds to the right and the work done by the force is W. Initially, the block is stationary.

(a) Write down the momentum p of the block after t in terms of the symbols given above (F, W, and t; you need not use all of them).[5]

(b) The mass of the block is M. Write t down in terms of M, F and W. [5]

(**2** on the next page)

2. A spaceship consists of a main ship of mass M and a small explorer of mass $M/2$. Initially, they are connected and the center of mass is stationary (relative to distant stars). Then, the rocket engine of the explorer is turned on. After the rocket fuel is spent to produce mechanical energy E, the engine is turned off. The situation is illustrated in the figure.



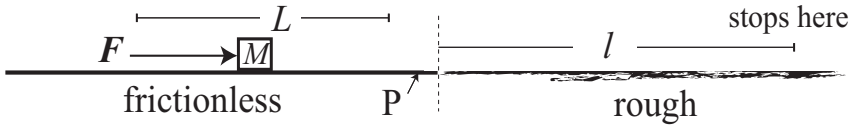
(a) Suppose the magnitude of the momentum of the explorer is p. What is the magnitude of the momentum of the main ship (relative to their center of mass)? [5]

(b) Express E (= the final total mechanical energy) in terms of p and M. [5]

Physics 101 (S11) **Q6B**

Name: _____ **Section:** _____ **Score:** _____**/20**

1. In a straight trough is a block of mass M. The left half of the trough is frictionless, and the block is initially stationary. On the frictionless portion of the trough a constant force F (horizontal and parallel to the trough) pushes the block while it undergoes a displacement of length L. Then, the force is turned off, and the block keeps moving and eventually into the rough portion of the trough. The block stops after running a distance ℓ due to a constant kinetic friction force f. See the figure below.

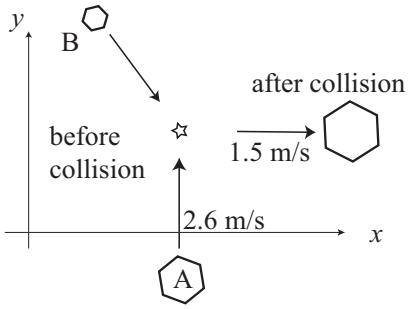


(a) Write down f in terms of the symbols given above (F, M, L, and ℓ; you need not use all of them.). [5]

(b) What is the magnitude of the momentum of the block just before going into the rough portion (say, at P in the figure)? [5]

(**2** on the next page)

2. Two blocks A and B collide around the star mark in the following figure (top view) and stick to each other. Block A is 5 kg and is initially moving in the positive y-direction at speed 2.6 m/s. Block B is 1 kg. After sticking the single piece moves in the positive x-direction with speed 1.5 m/s (see the figure below). Assume that the experiment is performed on a frictionless horizontal plane (the sheet of the quiz paper is the plane).



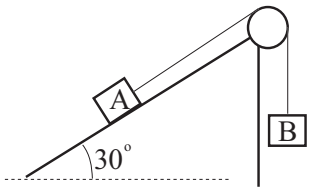
(a) Find the initial velocity of Block B. [Hint: Set the answer velocity to be (u, v).] [5]

(b) How much mechanical energy is lost by the collision?[5]

Physics 101 (S11) **Q6C**

Name: _____ **Section:** _____ **Score:** _____**/20**

1. On a frictionless inclined surface that makes 30° with the horizontal is Block A of mass M, which is connected with Block B with the same mass M by a massless and flexible string through a massless and frictionless pulley. Block B hangs vertically from the pulley. Initially, these blocks are stationary.



(a) The blocks are gently released. What is the speed of Block A when Block B descends by length L? [5]

(b) At the moment when B descends by length L, the string is cut. Block A can still climb up the slope. What is the height H of the highest point of Block A measured from its position at the moment the string is cut? [Answer H/L]. [5]

(**2** on the next page)

2. In a frictionless straight trough are two blocks A and B. Block A is with mass m and is running to the right with a speed V and collides with Block B of mass M, which is initially stationary. The collision is perfectly elastic and the total mechanical energy is conserved.

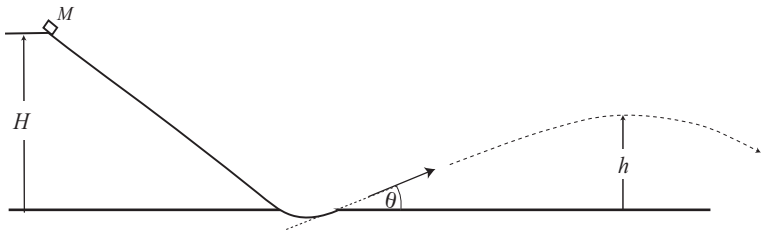
(a) Assume $M = 2m$. Let the final velocity of Block A be a and that of Block B b. Show $2a + b = 0$ and find the final speed of Block A. [5]

(b) Suppose M is much larger than m (i.e., $M/m \gg 1$), but still the total mechanical energy is conserved. What is a approximately? [5]

Physics 101 (S11) **Q6D**

Name: _____ **Section:** _____ **Score:** _____**/20**

1. A block of mass M slides down the frictionless slope from the initial height of H as illustrated below. The initial speed of the block is zero. After sliding down the slope, the block leaves the ground with the velocity making an angle θ with the horizontal.

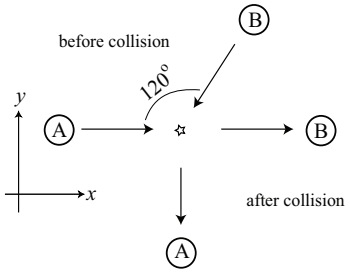


(a) Write down the height h of the highest point the block can reach in terms of H and θ. [5]

(b) Write down the magnitude p of the momentum immediately before the block lands on the ground (after it passes its highest point) in terms of g, H and M. [5]

(**2** on the next page)

2. Two dry ice pucks slide on a horizontal frictionless surface. Puck A of mass 2 kg initially moves along the x-axis with speed 6 m/s, and Puck B of mass 1 kg initially moves with speed 6 m/s in the direction shown in the figure below (it is a top view of the system). After the collision near the star mark in the figure Puck B moves along the x axis and Puck A along the y-axis as illustrated below.



(a) What is the speed of Puck B after the collision? [5]

(b) What is the loss of the mechanical energy? [5]