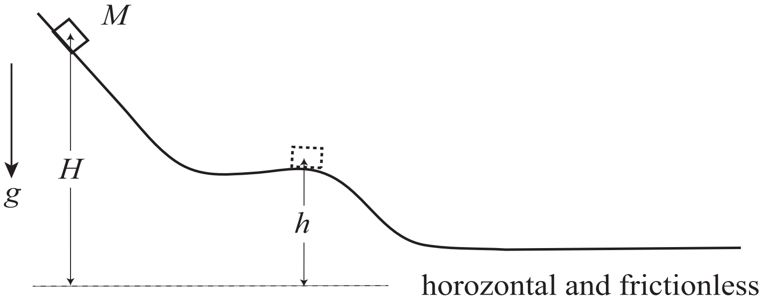
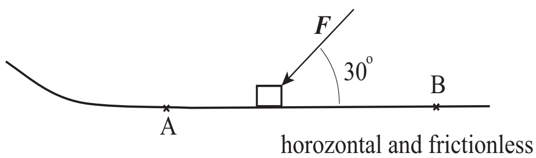
Name: ____________ **Section:** ________ **Score:** ________/20

1. A block of mass $M = 0.2$ kg is initially at rest at height $H = 23$ m on a frictionless slope. It is gently released and reaches the top of a small bump of height $h = 15$ m as illustrated below.



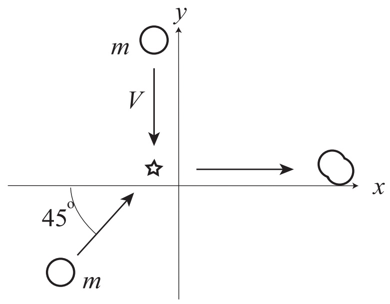
(a) What is the speed of the block at the top of the bump? [5]

(b) The speed of the block is $V = 18$ m/s when it reaches the bottom horizontal portion. Then, a constant external force $\boldsymbol{F}$ starts to be applied to the block at point A in the figure below, and it comes to a halt at B (before reversing its velocity). Suppose the magnitude of the force $F = |\boldsymbol{F}| = 32$ N. What is the distance between A and B? [5]



(**2** on the next page)

2. Two pucks of the same mass M are moving as illustrated (top view) in the figure on a frictionless horizontal floor. The puck coming along the y-axis has a speed of V. They collide around the star mark, and stick together.



(a) After sticking together two pucks move along the x-axis. What is its speed in terms of V? [5]

(b) What is the kinetic energy loss due to the collision? Assume $M = 1$ kg and $V = 1$ m/s. [5]

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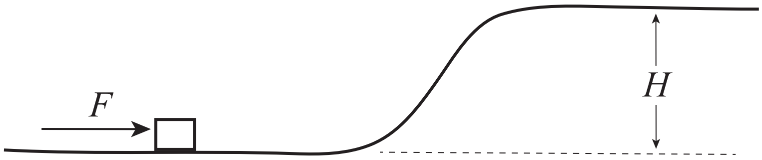
1. To push up a block of mass $M = 1.2$ kg to a higher floor of height $H = 12$ m, a horizontal force of magnitude $F = 12$ N is applied to the block to the right for 2 s before it reaches the slope as illustrated. The block successfully overcomes the slope and reaches the higher floor. The floor and the slope are assumed to be frictionless.

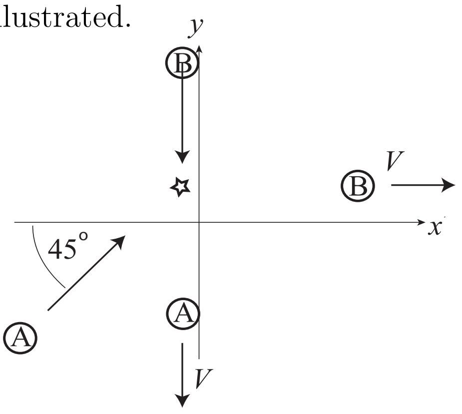


(a) What is the momentum and the kinetic energy of the block just before it reaches the slope? [5]

(b) What is the speed of the block after reaching the higher floor? [5]

(**2** on the next page)

2. Two pucks A and B with the same mass m collide around the star mark in the figure below. They have the same speed V after the collision; puck A leaves along the y-axis, and puck B along the x axis as illustrated.

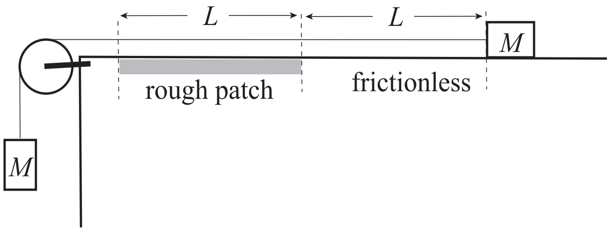


(a) What is the initial speed of puck B in terms of V? [5]

(b) Is the mechanical energy conserved? Justify your answer. [5]

Name: __________________ **Section:** __________ **Score:** __________**/20**

1. Two blocks of the same mass M are connected with a massless string through an ideal pulley. Initially, the system is stationary. Then, the hanging block is gently released. The table top is horizontal and frictionless except for the rough patch.



(a) What is the speed v of the block on the table when it reaches the rightmost edge of the rough patch after running the distance L in terms of L and g, the acceleration due to gravity? [5]

(b) While running inside the rough patch, the speed of the block is constant. What is the total work W (its magnitude) done by the friction force to the block in terms of L, M and g? [5]}

(**2** on the next page)

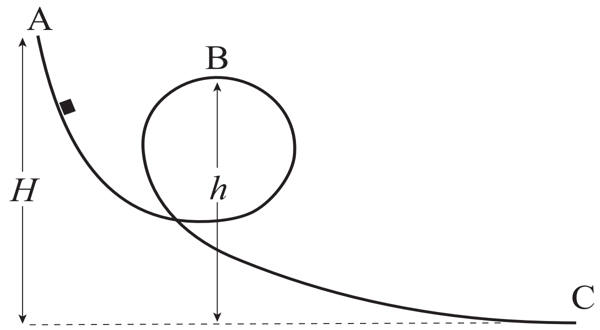
2. A rifle bullet of mass 2.6 g flying horizontally at 950 m/s hits a block of mass 1.2 kg stationary on a frictionless floor.

(a) The bullet goes through the block, emerging with a speed of 230 m/s. What is the speed of the block after the collision? [5]

(b) Is the mechanical energy conserved? Justify your answer. [5]

Name: ______________ **Section:** ________ **Score:** ________ **/20**

1. Along a frictionless toy coaster track is a block of mass m sliding down from A with zero initial speed.



(a) The ratio of the speed at C to the speed at B is 3. What is the ratio of the heights h/H? Assume that the block does not fall off the track. [5]

(b) The speed at B is actually 1.1 m/s. What is $H - h$? [5]

(**2** on the next page)

2. There are two space ships with the same mass M which are both initially stationary (relative to distant stars). Spaceship A has a cargo of mass m (i.e., its total initial mass is $M + m$). This cargo is transferred to Spaceship B.

(a) The cargo is pushed out from Spaceship A with a speed of v relative to Spaceship A. What is the speed of Spaceship A relative to distant stars in terms of v, m and M? [5]

(b) The cargo is received by Spaceship B. What is the ratio of the speeds of the spaceships v_A/v_B, where v_A (respectively, v_B) is the speed of Spaceship A (respectively, B) after the transfer? [5]