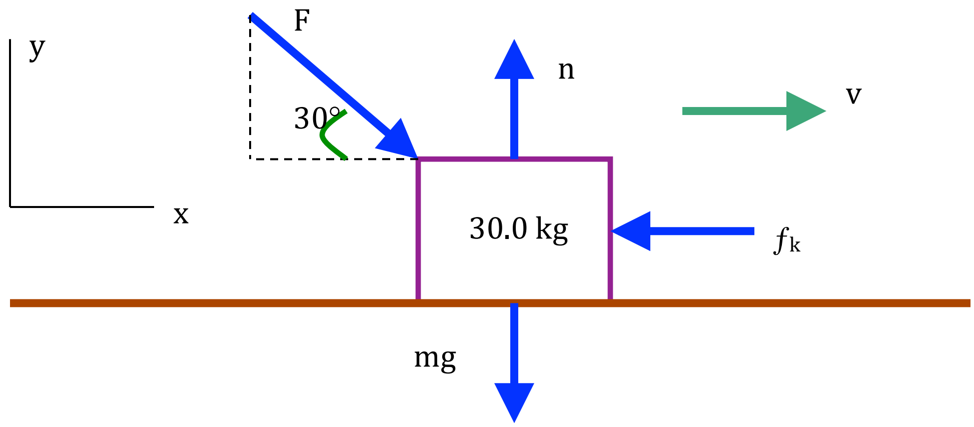
PART II Problems

Problem1

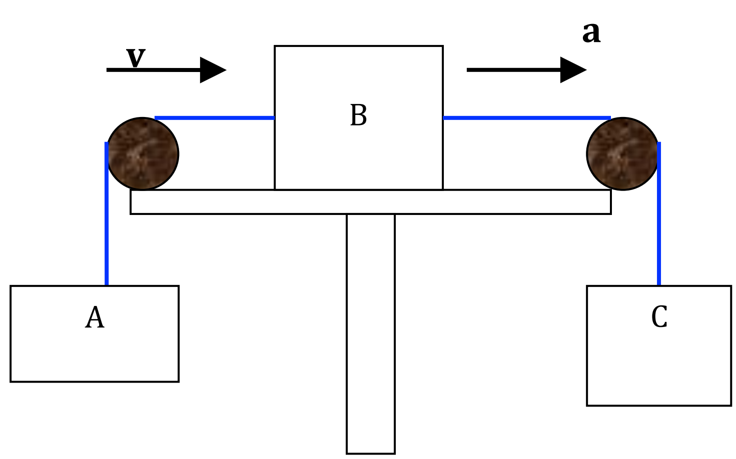
In the diagram below a 30 kg crate is being moved at constant velocity by a force F applied at 30° below horizontal. The coefficient of kinetic friction is $\mu_k = 0.25$. A) Find the magnitude of the applied force F. B) How much work is done by this force after the crate has moved 4.5 m? C) How much work is done by friction for the same displacement? D) How much work is done by the normal force n, and by gravity mg? E) Find the net work done on the crate.



ANSWER: A) F = 99.2 N; B) 387 J; C) $W_f = -f_k(4.5m) = -(85.9N)(4.5m) = -387J$;

D) Zero; E) Zero **HINT:** Normal force is $F_N = mg + F\sin 30^\circ$

Problem 2** This problem considers the same system as problem 5 of part I. In the diagram, block A has a mass of 4.00 kg, block B has mass 12.00 kg, and block C is 12.9kg. The coefficient of kinetic friction between block B and the table is $\mu_k = 0.25$.



The rope is massless and there is no friction in the pulley

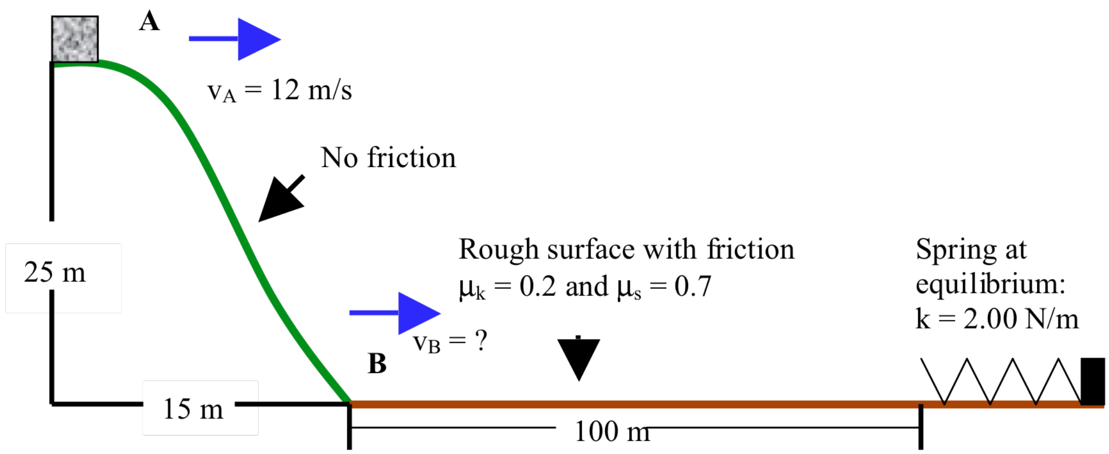
A) Calculate work done on block A by gravity. B) Calculate work done on block B by gravity and by the force of friction. C) Calculate the work done by gravity on block C. D) What is the work done on the system by the tension in the rope connecting B and C, T_{BC} and the work done by the tension in the rope connecting A and B, T_{AB}. **HINT:**

You do not need to do any calculations, but you must justify your answer. E) Add the work done from part A to D to find the total work. Now assume that the initial speed of B is $v_0 = 1 m \bullet s^{-1}$, and use the **work-energy theorem** to calculate the speed of B after C has fallen 0.2 m. **NOTE: you must use the work energy-theorem.**

ANSWER: $v_F = 1.34 m \bullet s^{-1}$

Problem 3**

In figure below a 14 kg stone slides down a snow covered hill, leaving point A with a speed of 12 m/s. There's no friction between point A and B, but there's friction after point B, where it reaches the spring and compresses it till it comes to a stop. A) Find the speed at the bottom of the hill (point B). B) Find the maximum compression of the spring.



ANSWER: A) $v_B = 25.2 m \bullet s^{-1}$; B) x = 29.7 m.

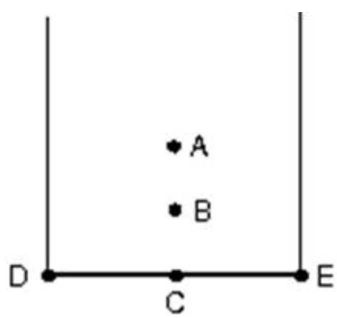
Problem 4

A 640-N hunter gets a rope around a 3200-N polar bear. They are stationary, 20 m apart, on frictionless level ice. When the hunter pulls the polar bear to him, the polar bear will move:

A) 1.0m B) 3.3m C) 10m D) 12 m E) 17m **ANSWER: B**, COM problem

Problem 5

A thick uniform wire is bent into the shape of the letter "U" as shown. Which point indicates the location of the center of mass of this wire? **ANSWER: B**



Problem 6

The center of mass of a a system of particles remains at the same place if:
A) it is initially at rest and the external forces sum to zero B) it is initially at rest and the internal forces sum to zero C) the sum of the external forces is less than the maximum force of static friction D) no friction acts internally E) None of the above
ANSWER A

Problem 7

A 0.3 kg rubber ball is dropped from the window of a building. It strikes the sidewalk below at 30 m/s and rebounds up at 20 m/s. The magnitude of the impulse due to the collision with the sidewalk is:
A) 3.0 N-S B) 6.0 N-s C) 9.0 N-s D) 15 N-s E) 29 N-s **ANSWER D**

$$J = \Delta P = mv_F - mv_I = 0.3kg \times 30m \bullet s^{-1} - 0.3kg\left(-20m \bullet s^{-1}\right) = 15kg \bullet m \bullet s^{-1}$$

Problem 8

A **hockey puck** of mass *m = 2 kg* traveling at 4.5 m/s along the **x axis** hits another **identical hockey puck** at **rest**. A) If after the collision the **second puck** travels at a speed of 3.5 m/s at an angle of 30° **above** the **x axis**, calculate the **final velocity** of the **first puck**? B) Calculate the **change** in **kinetic energy**, ΔK. Is the **collision elastic**? Briefly explain. **ANSWER:** A) **Velocity**: *v* = 2.28 m/s at 50° below the horizontal or $\vec{v} = 1.47\frac{m}{s}\hat{i} - 1.75\frac{m}{s}\hat{j}$; B) -2.8J

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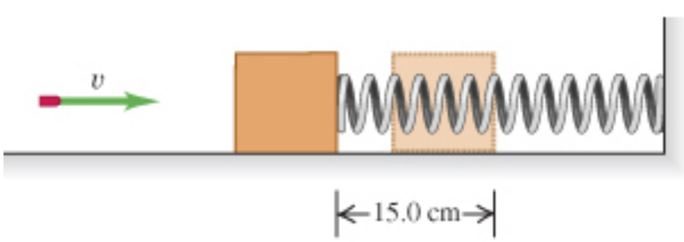
Problem 9

A bullet with a mass of 8.00×10^{-3} kg strikes and embeds itself in a block with mass 1.25 kg that rests on a **frictionless surface** and is attached to a coil spring with a **force constant** of $315\frac{N}{m}$. The impact compresses the spring 15.0 cm.



A) Find the **speed** of the block + bullet **just after** the **impact**. B) What was the **initial speed** (v) of the bullet **just before** it **hits** the block? C) Calculate the **impulse (magnitude and direction)** on the **box** due to its collision with the bullet.
ANSWER: A) 2.38 m/s; B) 373 m/s;

C) $J_x = P_2 - P_1 = Mv_F - 0 = (1.25kg)\left(2.38\frac{m}{s}\right) = 2.975\frac{kg \bullet m}{s}$ to the right.