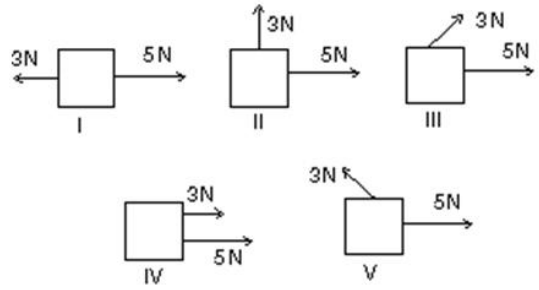
PHYS 1211 F2020, Midterm 2, November 2, 2020

5 Multiple choice

Q1)
Two forces, one with a magnitude of 3 N and the other with a magnitude of 5 N, are applied to an object. For which orientation of the forces shown in the diagrams is the **magnitude** of the **acceleration** of the object the **least**?

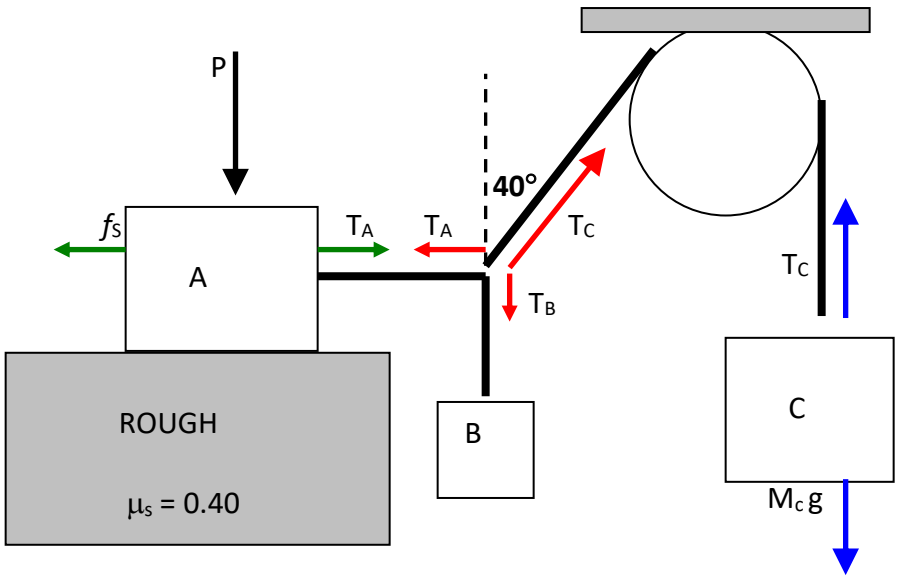


ANSWER: A

A) I
B) II
C) III
D) IV
E) V

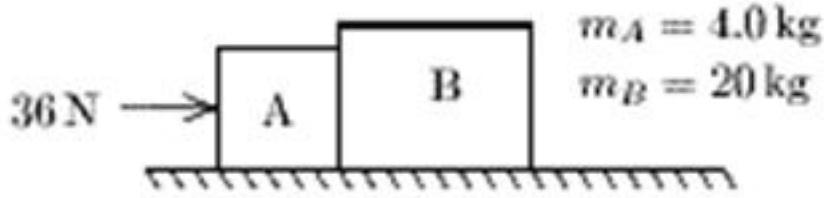
Q2) Shown below is a system of blocks and frictionless pulley. Block A has a mass of 5.0 kg and is on a rough surface (μ_s = 0.40). Block C has mass of 4.0 kg. An external force P = 25.0 N is applied vertically on Block A to keep system in **static equilibrium**. The magnitude of the force of friction, f, on block A is closest to:

A) 29.6 N B) 10 N C) 25.2 N D) 49 N E) 39.2 N



From the **blue force** diagram on block C: $T_C = M_C g = 4.0\ kg\ (9.8\ m/s^2) = 39.2\ N$
At the **red force** where 3 ropes meet three tensions, T_A, T_B, and T_C must be balanced. For the **horizontal component** $T_A = T_C \sin 40° = 39.2\ N \sin 40° = 25.2\ N$. Since Block A doesn't the static friction f_s must cancels the tension T_A, $T_A = f_s = 25.2\ N$. **ANSWER:** C)

Q3
Two blocks (A and B) are in contact on a horizontal frictionless surface. A 36-N constant force is applied to A as shown. The magnitude of the force of A on B is:



A) 1.5N B) 6.0N C) 29N D) 30N E) 36N

Answer D

Q4 Work

A 50-kg piano rolls down a 60° incline. A man tries to keep it from accelerating, and manages to keep its acceleration to 1.2 m/s^2. If the piano rolls 3 m, what is the net work done on it by all the forces acting on it?

A) 90J B) 155J C) 60J D) 180J E) 490 J

Answer D

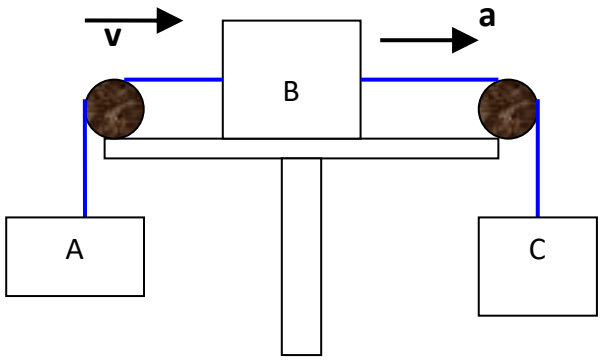
Q5 circular motion problem

The driver of a 1000-kg car tries to turn through a circle of radius 100 m on an unbanked curve at a speed of 10 m/s. The actual frictional force between the tires and a slippery road has a magnitude of 1000 N. The car:
A) make the turn
B) slows down due to frictional force
C) will make the turn only if it goes faster
D) slides off the outside of the curve
D) slides into the inside of the curve

Answer A

3 short-answer questions

Q6) In the diagram below block A has a mass of 4.00 kg and block B has mass 12.00 kg. The coefficient of kinetic friction between block B and the table is mu_k = 0.25. Block B is moving right and accelerating to the right with a = 2.00 m/s^2.



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

M_c g: gravity on C
T_BC: Tension between B and C
M_B g: Gravity B
F_k kinetic friction
F_NB Normal on B
T_AB Tension between B and A
M_A g: Gravity on A

A) What are the forces acting on box A, and what are their directions?

T_AB up, M_A g down

B) Use Newton's law to derive an equation relating the forces in **part A** and the acceleration, a. Use it to calculate the tension between box A and B, T_AB.

T_AB – M_A g = M_A a, T_AB = 47.2N

C) What are the forces acting on box B, and what are their directions? Calculate the friction force acting on box B.

T_AB left, M_B g down, F_NB up, f_k left, T_BC right
F_k = M_B g mu_k = 29.4 N

D) Use Newton's law to derive an equation relating the forces in **part C** and the acceleration, a. Use it to calculate the tension between box B and C, T_BC.

T_BC – f_k – T_AB = M_B a
T_BC = 100.6 N = 101N

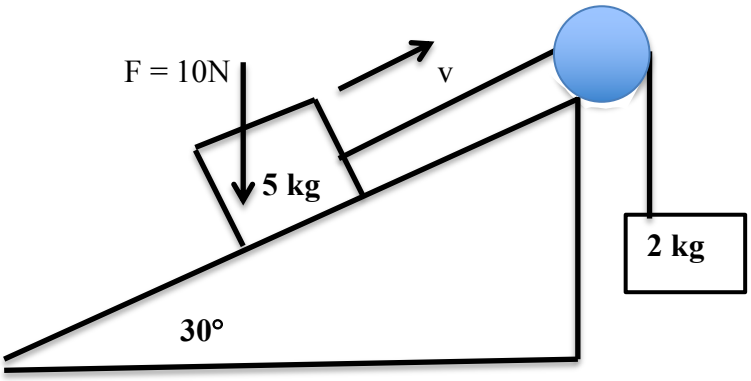
E) What are the forces acting on box C, and what are their direction?

T_BC up, M_C g down

F) Use Newton's law to derive an equation relating the forces in **part E** and the acceleration, a.

Use it to calculate the mass of box C.
T_BC – M_C g = -M_C a, M_C = 12.9 kg

Q7) 2017 Below a downward force, F = 10 N is applied to a **5 kg** crate **moving up** a 30° incline. The crate is connected to a hanging 2kg box by a rope through a frictionless pulley. Coefficient of friction between **crate** and **incline** are mu_k = 0.1 and mu_s = 0.2.



HINT: 1) Assume that the acceleration is down incline; 2) Note that the F = 10 N force is in the same direction as gravity (vertical)

Relevant Variables: gravity m_5kg g; applied force F; friction f_k; Tension T; gravity m_2kg g
A) What are the forces acting on 5kg crate, and what are their direction?

gravity M_5kg g down; applied force F down ; friction f_k down incline; Tension T up incline

B) Calculate normal force and friction force.

F_net,y = F_N – (mg + F) cos 30 = 0. F_N = (mg + F) cos 30 = (59N) cos 30 = 51.1 N

F_N = 51.1 N , f_k = F_N mu_k = 5.11 N

Common error: F_N = mg cos 30 + F = 52.4 N which is similar to 51.1 N but is wrong!

C) Use Newton's law to derive an equation relating the forces in **part A** and the acceleration, a.

34.61N – T = 5kg a. [1]

D) What are the forces acting on 2kg crate, and what are their direction?

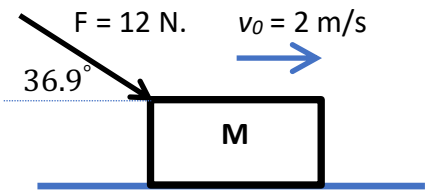
M_2kg g down, T up

E) Use Newton's law to derive an equation relating the forces in **part D** and the acceleration, a

T – 19.6N = M_2kg g [2]

F) Solve equations derived in C and E and find T and a.

Add [1] and [2]
a = 2.14 m s^-2, T = 23.9N
Q8) A box of mass M = 2.5 kg is moving at 2 m/s to the right is acted on by an applied force F = 12 N, directed downward at an angle of 36.9 as shown. Assume the coefficient of friction is mu_k = 0.11 and mu_s = 0.3.



Variables: applied force F, gravity Mg, Normal Force F_N, friction f_k,
A) What are the forces acting on the box, and what are their directions

F at 36.9 with Horizontal as shown, Gravity Mg down, normal force F_N up, f_k left

B) Find normal force and friction force

F_N = Mg + 12N sin 36.9 = 31.7 N, f_k = F_N mu_k = 3.5N

C) Calculate the total work done after it has moved 1.3 m

F_x = 9.6N, F_net,x = 9.6 N – 3.5 N = 6.1 N
W = F_net,x x 1.3m = 7.93 J

D) Use work energy theorem to find the speed after box has moved 1.3 m. State the equations used.
Use E21
V_F = sqrt (v_i^2 + 2 W/M)= 3.2 m/s