2D Kinematics Trajectory Problems

Question 1

A golf ball is hit so that it leaves the ground at 60° above the horizontal and feels no air resistance as it travels. Which of the following statement about the subsequent motion of the ball while it is in the air is true? Only one correct answer!

A) Its speed is zero at its highest point. B) Its velocity is zero at its highest point

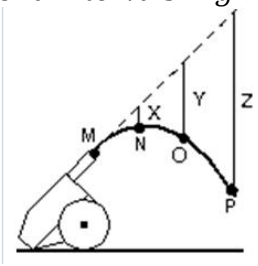
C) Its acceleration is always 9.8 m/s^2 downward.

D) Its forward acceleration is 9.8 m/s^2.

E) Its acceleration is zero at its highest point.

Question 2

A cannon fires a projectile as shown. The dashed line shows the trajectory in the absence of gravity; points MNOP correspond to the position of the projectile at one second intervals. If g = 10 m/s^2, the lengths X,Y,Z are:



A) 5 m, 20 m, 45 m
B) 0.2 m, 0.8 m, 1.8 m
C) 10 m, 20 m, 30 m
D) 5 m, 10 m, 15 m
E) 10 m, 40 m, 90 m

HINT: The projectile has initial velocity $\vec{v}_0 = v_{0x}\hat{i} + v_{0y}\hat{j}$. Without gravity, the projectile would follow the dotted path. Hence, the difference between the dotted path and the actual path (i.e. X,Y,Z) is $(1/2)gt^2$

As discussed X, Y, Z are given by $(1/2)gt^2$. With g = 10 m/s^2, t = 1s,

$X = 5m \bullet s^{-2}(1s)^2 = 5m$; t = 2s, $Y = 5m \bullet s^{-2}(2s)^2 = 20m$; t = 3s,

$X = 5m \bullet s^{-2}(3s)^2 = 45m$. **ANSWER: A**

Question 3

A hiker throws a stone from the upper edge of a vertical cliff. The stone ' s initial velocity is 25.0 m/s directed at 40.0° with the face of the cliff, as shown in Figure below (see back for Figure). The stone hits the ground 3.75 s after being thrown and feels no appreciable air resistance as it falls. The height of the cliff is closest to:

a) 129 m b) 60.3 m c) 71.8 m d) 141 m e) 163 m

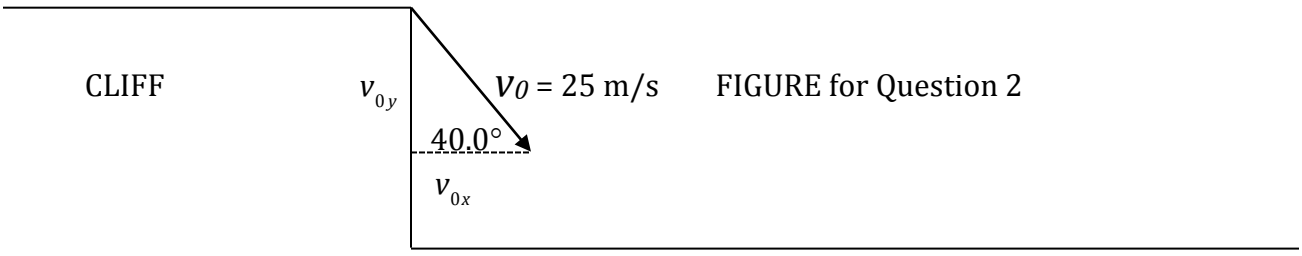
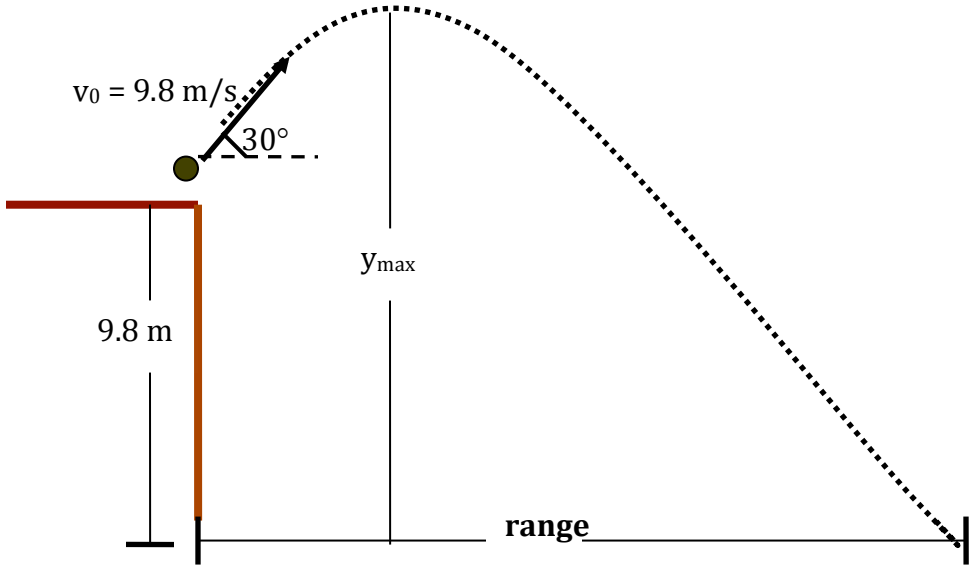


FIGURE for Question 2

Question 4

A ball is thrown off a 9.8 m high cliff with an initial speed of v_0 = 9.8 m/s at 30°, as shown in the diagram below.



a) Find the x- and y- components of the initial velocities; b) Find the **maximum height** of the ball, y_{max}, from the **ground**; c) Find the time it takes for the ball to hit the ground. **ANSWER:** t = 2.0 s; d) Find the **range** (see diagram) of the trajectory. **ANSWER: 17 m**; e) At the instant just before the ball hits the ground, find the x- and y- components of the velocity. **ANSWER: v_x = 8.49m/s, v_y = -14.7 m/s**

Newton's Law

Question 5

A ball with a weight of 1.5 N is thrown at an angle of 30° above the horizontal with an initial speed of 12 m/s. At its highest point, the net force on the ball is:

A) 1.5 N, down B) 9.8 N, 30° below horizontal C) 0 N D) 9.8 N down E) 9.8 N up

Question 6

You are driving your car along the road and hit a patch that is so icy that there is effectively no friction between your tires and the road. Which statement is most accurate?

A) Your car will start to spin

B) Nothing you do will have any effect; without any friction, you will continue to move in a straight line at a constant speed, as there is no net external force on you.

C) If you hit the accelerator, you will get out of the icy patch faster.

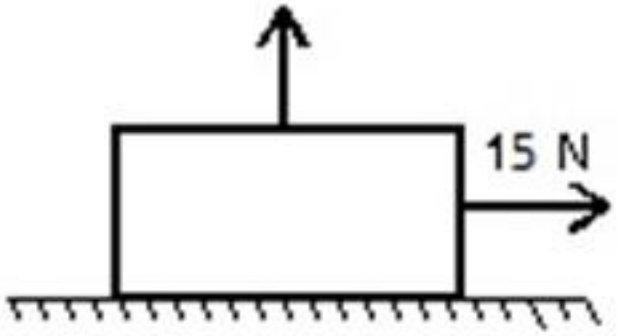
D) If you hit the brakes, you will eventually stop.

E) If you twist the steering wheel, you can turn into the skid

Question 7

A box with a weight of 50 N rests on a horizontal surface. A person pulls horizontally on it with a force of 15 N and it does not move. To start it moving, a second person pulls

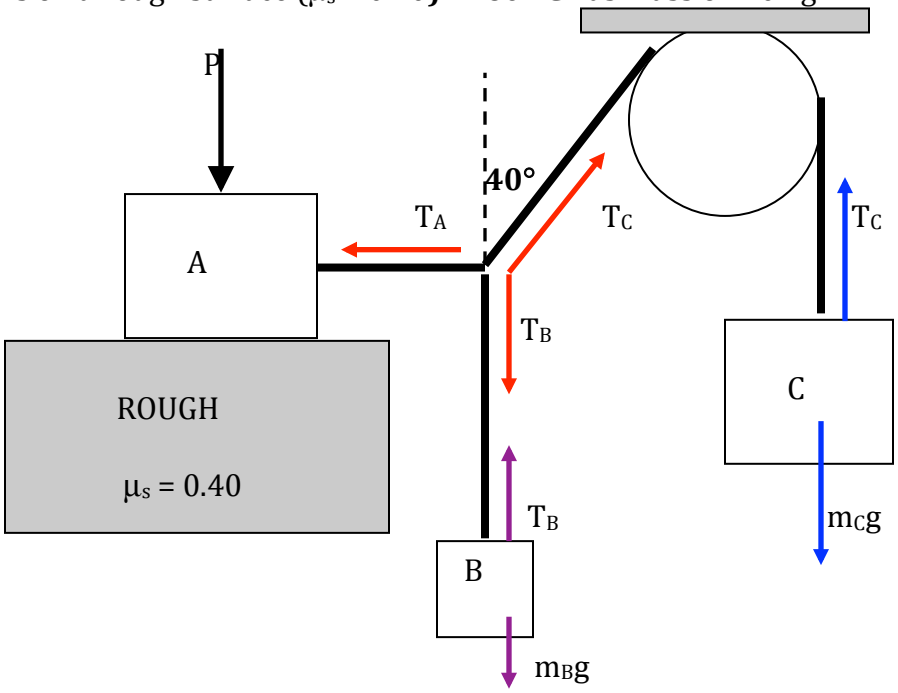
vertically upward on the box. If the coefficient of static friction is 0.4, what is the smallest vertical force for which the box moves?



A) 5N B) 12 N C) 20N D) 25N E) 35N

Question 8

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.



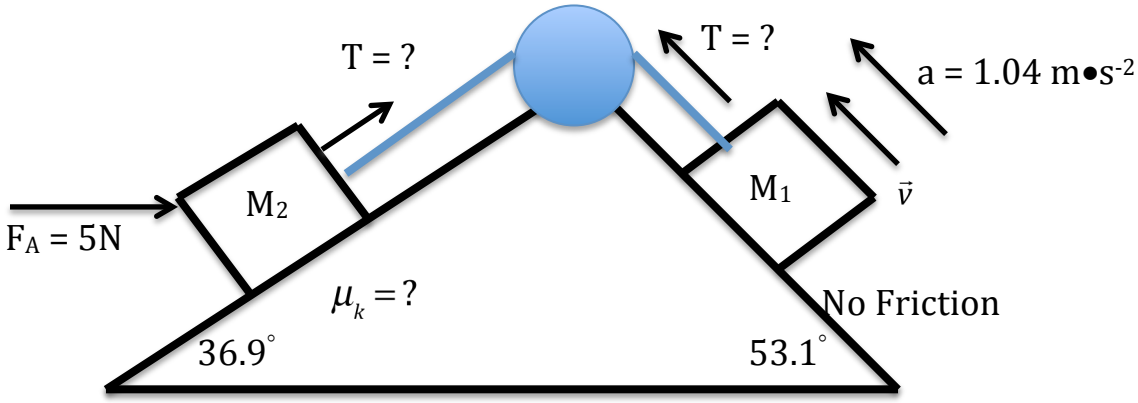
An external force P = 25.0 N is applied vertically on Block A to keep system in **equilibrium**. The **mass** of **block B** is closest to:

a) 2.6 kg b) 2.8 kg c) 2.3 kg d) 3.1 kg e) 2.1 kg

Question 9

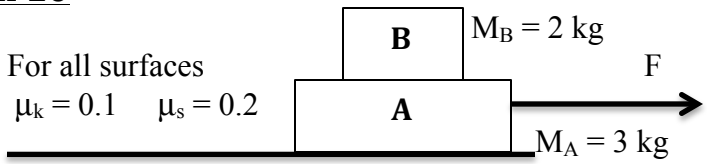
In the diagram below, block 1($M_1 = 2.0kg$) lies on **frictionless incline** of 53.1°, and is **moving up** the incline with acceleration $a = 1.04m \cdot s^{-2}$. Block 1 is connected by an ideal rope through a frictionless pulley to block 2 ($M_2 = 7kg$), which rests on a 36.9° incline with friction. Block 2 is acted on by an applied horizontal force of

magnitude F_A = 5N. The **tension** (T = ?) and **kinetic coefficient** ($\mu_k = ?$) are **unknown**.



a) Draw a free-body-diagram (FBD) of all forces on block 1 (M_1), which includes the direction of its acceleration. **Calculate** the **tension**, T. b) Draw a free-body diagram (FBD) of all forces acting on block 2 (M_2). Use this to determine the **magnitude** and **direction** of the friction force $f_{k,2}$, acting on block 2. Calculate the **coefficient** of **kinetic friction**, μ_k, between surfaces of block 2 and incline. **ANSWER:** T = 17.76N; $f_{k,2} = 12.12N$; $\mu_k = 0.21$.

Question 10



In above system there is friction between box A and the floor, as well as between the contact between surface A and B.

A) Let F = 10 N, and **assume** that there is **no slipping** between any surface, calculate the acceleration, a. Verify that the force of friction between the floor and A is a kinetic force of friction. Then draw a FBD on box B and determine the force of static friction on box B due to box A, f_S^{BA}. Verify that the friction f_S^{BA} is static force of friction. **ANSWER:** $a = 1.02m \bullet s^{-2}$, $f_S^{BA} = 2.04N$.

B) Let F = 20 N, show that in this case there will be slipping between box A and B. Draw FBD of box B and calculate the acceleration of box B, a_B. Draw FBD of box A and calculate the acceleration of box A, a_A. **ANSWER:** $a_A = 4.38m \bullet s^{-2}$ and $a_A = 0.98m \bullet s^{-2}$

Question 11

In the figure below two blocks connected by a rope slides down an incline, where the coefficient of kinetic friction between the 4kg box and the incline is 0.25 and between the 8kg box and the incline is 0.35. What is the acceleration of the boxes and the tension in

the rope? **ANSWER:** $a = 2.21 m \cdot s^{-2}; T = 2.26 N$ What happens if the positions of the boxes are exchanged?