Name:______________________________

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Physics 201

Midterm 2

11/13/2024

Collaboration is not allowed. Allowed on your desk are: ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating graphing scientific calculator, a page of scratch paper, a straight edge or ruler, writing utensils, and the exam. You will have 80 minutes to complete this exam.

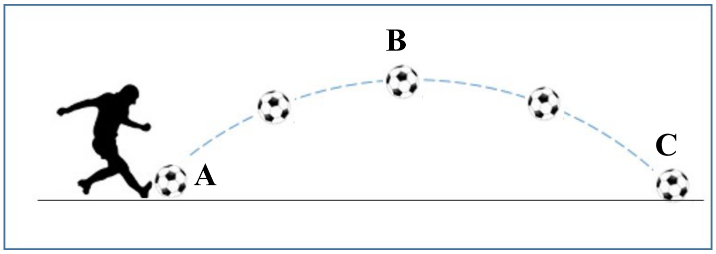
For questions 1 through 5 **fill in the square** next to all correct answers. A given problem may have more than one correct answer. Each correctly bubbled answer will receive two points. There are **8** correct answers in this section and only the first **8** filled in answers will be graded. There is no partial credit.

1. A ball is kicked by the famous footballer, Ronald O'Beckbeef. Three points are labeled in the diagram of the kick:

   A - The initial position, just after the ball has been kicked

   B - the highest point in the ball's flight

   C - just before the ball contacts the ground



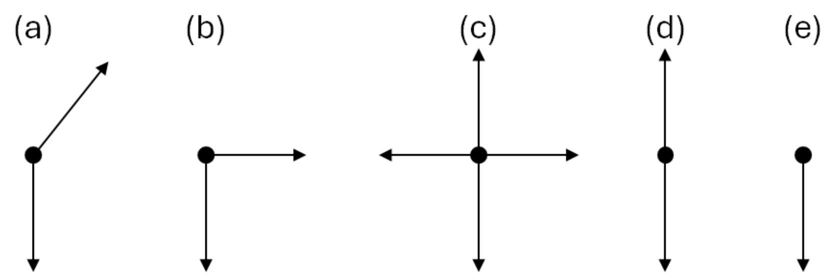
   Ignore effects caused by air resistance/drag and assume a standard coordinate system.

   Which of the following statements are true about this situation?

   □ (a) The ball's velocity vector at point A is equal to the velocity vector at point C
   □ (b) The ball's velocity at point B is in the positive x-direction
   □ (c) The ball's velocity at point B is zero
   □ (d) The ball's velocity at point C is zero
   □ (e) The acceleration of the ball at point B is zero
   □ (f) The y-displacement of the ball at point C is zero

2. Consider the previous situation. Which of the following free body diagrams most accurately describes the forces acting on the ball at point B? (fill in the square on the left corresponding to your answer)

   □ (a)
   □ (b)
   □ (c)
   □ (d)
   □ (e)



3. Which of the following quantities must point in the same direction as the net force acting on a system?

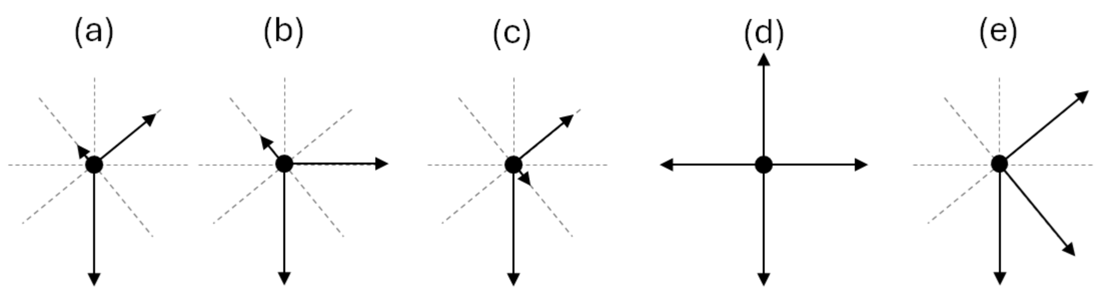
   □ (a) Displacement
   □ (b) Velocity
   □ (c) Change in velocity
   □ (d) Acceleration
   □ (e) Change in acceleration
   □ (f) Distance
   □ (g) Time
   □ (h) Magnitude of the net force
   □ (i) Force of gravity
   □ (j) Normal Force
   □ (k) Frictional Force

4. Which of the following could be Newton's third law force pairs?

   □ (a) Assuming you are sitting, stationary, in a chair: the gravitational force from the Earth pulling down on you, the normal force from the chair pushing up on you.
   □ (b) The static friction force from the road pushing on a car's tires, the static friction force from the same car's tires pushing on the road.
   □ (c) The static friction force from the ground on a person's shoes as they walk, the normal force from the ground on the person's shoes as they walk.
   □ (d) For a mass connected to a string that is being rotated in a vertical circle, the tension in the string is a force pair with the gravitational force on the mass.
   □ (e) The normal force of a windshield pushing on a bug during a high speed collision and the force of the bug pushing back on the windshield during the collision.
   □ (f) The friction force from the ground acting on a skier while they slide down the hill and the normal force from the ground acting on the skier.

5. Cody Burgsend, a world class skier, is skiing **down** a mountain slope. The slope is a very steep 55 degrees, measured from the horizontal. The coefficient of kinetic friction between the snow and his skies is 0.15. Which of the following most appropriately depicts the free body diagram for Cody? (Please fill in the square corresponding to your answer)

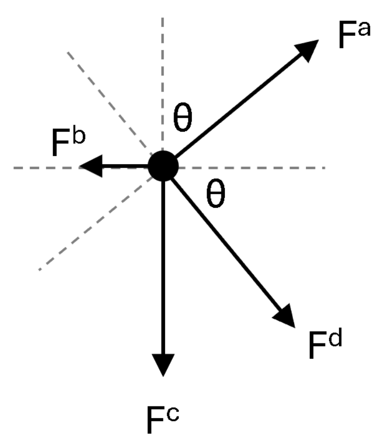
   □ (a)
   □ (b)
   □ (c)
   □ (d)
   □ (e)



6. (4 points) A 5,000 kg spaceship is deep in outer space. The only force acting on the ship is from their thrusters, which provide a force of <30, 40> kN. Assume a standard coordinate system. What is the magnitude of the acceleration of the ship? Carefully write your answer in the provided box.

Answer, including units

7. (4 points) Consider the provided free-body diagram for a particular system. Which of the following Newton's 2nd law equations best represents this system using a standard coordinate system. (Please fill in the box corresponding to your answer)



☐ (a)
X: $F^a + F^d - F^b = 0$
Y: $F^a - F^d - F^c = 0$

☐ (b)
X: $F^a \sin\theta - F^d \cos\theta - F^c = ma_x$
Y: $F^a \cos\theta + F^d \sin\theta - F^b = ma_y$

☐ (c)
X: $F^a \sin\theta + F^d \cos\theta - F^b = ma_x$
Y: $F^a \cos\theta - F^d \sin\theta - F^c = 0$

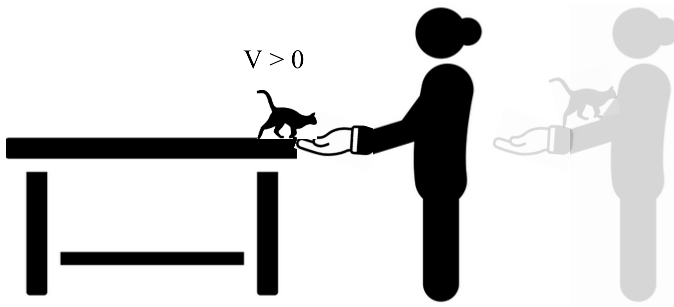
☐ (d)
X: $F^a \cos\theta + F^d \cos\theta - F^b = ma_x$
Y: $F^a \sin\theta - F^d \sin\theta - F^c = ma_y$

☐ (e)
X: $F^a \sin\theta + F^d - F^b = 0$
Y: $F^a - F^d \sin\theta - F^c = 0$

☐ (f)
X: $F^a \sin\theta + F^d \cos\theta - F^b = ma_x$
Y: $F^a \cos\theta - F^d \sin\theta - F^c = ma_y$

☐ (g)
X: $F^a \cos\theta + F^d \sin\theta - F^b = ma_x$
Y: $F^a \sin\theta - F^d \cos\theta - F^c = ma_y$

8. (8 points) A kitty is running full speed to the right on a stationary table when they hit a low friction patch that sends them sliding across the table. You catch them with your arms out horizontal and the primary force that slows them down is friction. You step backwards, moving to the right while you are catching them but in the end everyone is not moving.



Part A

While the kitty is sliding across the table, what is the direction of the net force acting on it?

□ (a) Right
□ (b) Left
□ (c) Upward
□ (d) Downward
□ (e) Not enough information

Part B

What is the direction of the frictional force on the kitty by the table when it's sliding on the table?

□ (a) Right
□ (b) Left
□ (c) Upward
□ (d) Downward
□ (e) Not enough information

Part C

What is the direction of the acceleration of the kitty when they are coming to rest in your arms?

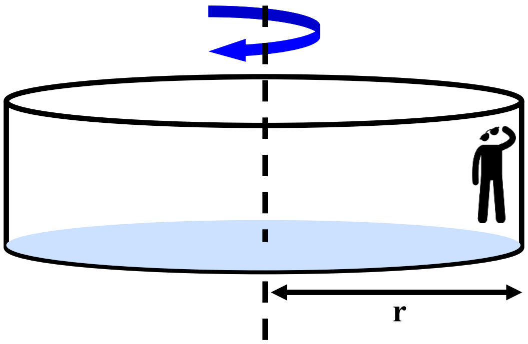
□ (a) Right
□ (b) Left
□ (c) Upward
□ (d) Downward
□ (e) Not enough information

Part D

What is the direction of the frictional force on the kitty by your arms when they are coming to rest?

□ (a) Right
□ (b) Left
□ (c) Upward
□ (d) Downward
□ (e) Not enough information

9. (8 points) An amusement park ride consists of a giant hollow cylinder that rotates. Riders are standing against the inside wall of the cylinder, going around in a circle with it. Once the rotational speed is large enough, the people can lift their feet off the floor and not slide down toward the ground.



Part A

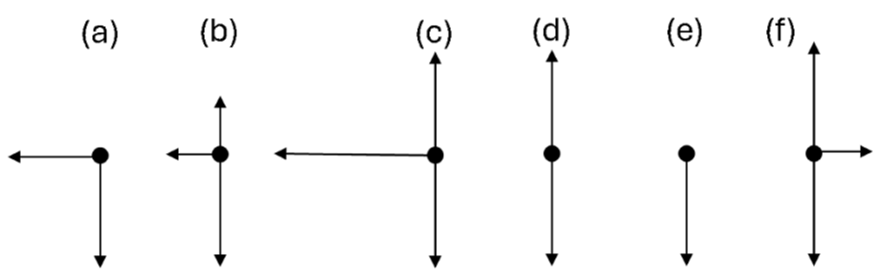
Which **two** of the following reasons, when combined, best account for this effect?

- □ (a) The centripetal acceleration creates a new force called the centrifugal force.
- □ (b) The normal force from the floor decreases as the normal force from the wall on their backs decreases.
- □ (c) The normal force from the wall on the people's back pushes on them to continually change their direction and it gets larger with more speed.
- □ (d) The centrifugal force counteracts gravity and increases with rotational speed. Eventually it is large enough to hold the person up.
- □ (e) The normal force from the wall on the people's back decreases the faster it rotates, decreasing the normal force from the floor until it is zero.
- □ (f) The frictional force from the wall on the people's back increases with an increased normal force from the wall until it's large enough to counteract their weight.

Part B

Which of the following FBDs could represent the forces acting on the person when they are on the right-hand-side of the cylinder? (please fill in the box corresponding to your answer)

- □ (a)
- □ (b)
- □ (c)
- □ (d)
- □ (e)
- □ (f)



Part C

Consider a situation where the cylinder has a radius **r** and is rotating at the minimum speed to allow someone to lift their feet off the floor and not slip down. The coefficient of static friction between the wall and the people's back is μ_s. Which of the following expressions could represent the minimum speed of the person in this situation.

□ (a) $\sqrt{\frac{gr}{\mu_s}}$ □ (b) $\sqrt{\mu_s gr}$ □ (c) $\sqrt{\frac{gr}{m}}$ □ (d) $\sqrt{mgr}$ □ (e) $\frac{gr}{\mu_s}$ □ (f) $\mu_s gr$ □ (g) $\frac{gr}{m}$ □ (h) mgr