Print your full name: ______________________________

Sign your name: ______________________________

Please fill in your Student ID number: _______–______–______

IMPORTANT

Read these directions carefully:

• There are 4 problems totalling 100 points. Check your exam to make sure you have all the pages. Work each problem on the page the problem is on. You may use the back. If you need extra pages, I have plenty up front.

• **Indicate what you are doing!** We cannot give full credit for merely writing down the answer. **Neatness counts!** I will give generous partial credit if I can tell that you are on the right track. This means you must be neat and organized.

• Each problem with its associated figure is self explanatory. If you must ask a question, then come to the front, being as discrete as possible so as not to disturb others.

• Put your name on each page it is asked for. You will lose credit if you fail to print your name on each page it is asked for.
Print your name: ____________________________________________

Physics 218: Mechanics, Exam 1

Problem 1. 25 points.

A projectile is launched off the edge of a cliff. The initial velocity of the projectile is \( v_0 \) and the angle above the horizontal that the projectile is launched at is \( \theta \).

(a) (10 points) Calculate the horizontal and vertical components of the projectile’s velocity when it hits the ground. Express your answers in terms of \( v_0 \), \( \theta \), and \( g \).

(b) (5 points) Calculate the magnitude of the particle’s velocity when it hits the ground and show that it is independent of \( \theta \).

(c) (10 points) For the special case when \( \theta = 0 \), calculate the horizontal distance \( L \) that the particle travels before it hits the ground.
Problem 2. 25 points.

A turntable consists of a flat horizontal surface rotating about a central axis. The radius of the turntable is \( R = 30.0 \text{ cm} \) (0.300 m). At the edge of the turntable is a gold coin of mass \( M = 337.7 \text{ g} \) (0.3377 kg). The coefficient of kinetic friction between the coin and the turntable is \( \mu = 0.5371 \). Neglect the diameter of the coin with respect to the diameter of the turntable.

(a) (10 points) What is the magnitude of the friction force between the turntable and the coin, if the turntable is turning once every 2.000 seconds.

(b) (15 points) The turntable is rotated faster and faster, meaning the time \( T \) for one rotation gets smaller and smaller. At some point the coin flies off the turntable. Calculate the minimum time for one rotation such that the coin does not fly off the turntable.
Physics 218: Mechanics, Exam 1

Problem 3. 25 points.

A small block of mass $M_1 = 7.653$ kg sits on top of a large block of mass $M_2 = 2.482$ kg. Do not be confused by the fact that the small block is much heavier than the large one. The coefficient of static friction between the blocks is $\mu_1 = 0.400$, the coefficient of static friction between the bottom block and the surface is $\mu_s = 0.210$ and the coefficient of kinetic friction between the bottom block and the surface is $\mu_2 = 0.200$.

A constant horizontal force $P$ is applied to the top block.

(a) (10 points) Calculate the maximum value of $P$ such that the top block does not slip along the bottom block.

(b) (15 points) When $P$ has the value found in part (a), what will be the acceleration of the blocks. (Both blocks have the same acceleration, since the top one is not slipping along the bottom one.)
Problem 4. 25 points.

An automobile of mass $M=1500 \text{ kg}$ is initially at rest. The car then starts to move in the $+x$-direction, and the net force $F(x)$ on the car is plotted below as a function of its position. In the diagram, $x$ is shown in meters and $F(x)$ is shown in Newtons. (Note, negative force means the car is decelerating.)

(a) (10 points) Calculate the acceleration of the car when it is at the following positions:

1. $x = 50 \text{ m}$
2. $x = 200 \text{ m}$
3. $x = 500 \text{ m}$

(b) (15 points) Calculate the velocity of the car when it is at $x = 800 \text{ m}$