**University of Louisville**
**College of Arts and Sciences**

# Department of Physics and Astronomy PhD Qualifying Examination (Part I)

# Spring 2015

*Paper A – Mechanics*

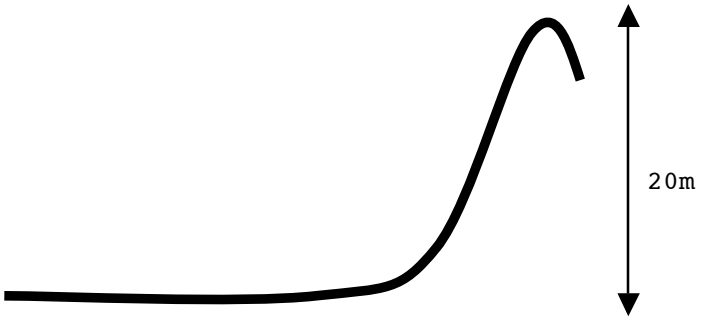
Time allowed – 90 minutes

**Instructions and Information:**

- Answer both questions
- This is a closed book examination
- Start each question on a new sheet of paper – use only one side of each sheet
- Write your identification number on the upper right hand corner of each answer sheet
- You may use a non programmable calculator
- Partial credit will be awarded.
- Correct answers without adequate explanations will not receive full credit.
- Make sure your work is legible and clear
- The points assigned to each part of each question is clearly indicated

## Mechanics Basic

A roller coaster ride follows the track indicated below. The coaster is given an initial velocity by a large spring compressed by 1 m from its natural length. The spring is located off the diagram at the far left.




(a) Given that 40000 J of energy stored is stored in the spring, determine its spring constant. (5)

(b) If the mass of the coaster car is 100 kg what is its velocity when it loses contact with the spring ? (6)
[ $\sqrt{8} = 2.8$ ]

(c) Determine the speed of the car at the top of the hill (assuming a frictionless track). (6)
[ use g =10 $m/s^2$ ]

For the remaining part of the question assume that for the horizontal part of the track (length 75 m) the coefficient of friction is 0.2 and that the rest of the track remains frictionless.

(d) Determine the magnitude of the force of friction on the car on the horizontal part of the track. (5)

(e) How much work is done by the frictional force ? (5)

(f) Recalculate the speed of the car at the top of the hill including the frictional effect on the horizontal part of the track (8)

## Mechanics Intermediate

A particle of mass m is projected vertically upward with an initial speed $v_0$ in a constant gravitational field, g. Assume that drag force from the air is proportional to the speed, $f = -m\alpha|v|$, where $v$ is the velocity of the particle and $\alpha$ is a positive constant.

(a) Find the maximum height H that the particle will reach in term of g, $v_0$ and $\alpha$ (20)

(b) Let $v_f$ be the speed of the particle right before it hits the ground. Find an equation that relates $v_f$ to g, $v_0$ and $\alpha$ (An implicit equation is sufficient). (20)

(c) Find the time the particle spends in the air in terms of g, $v_0$ and $v_f$ . Does the particle spend more time or less time in the air than it would if it were projected in vacuum? (25)