University of Louisville
College of Arts and Sciences

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

Fall 2014

Paper A – Mechanics

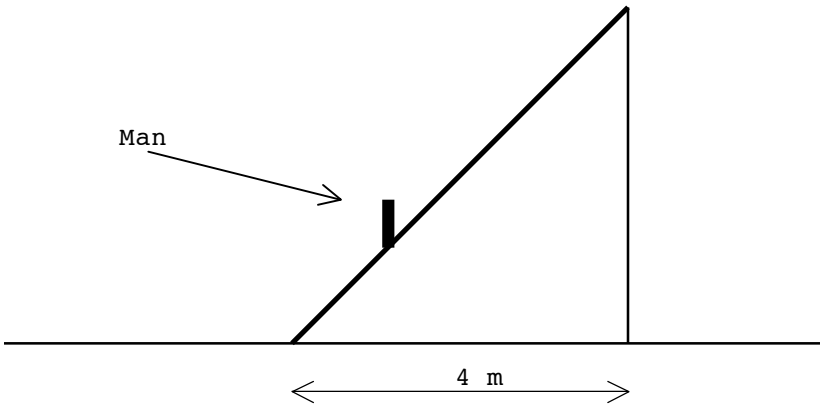
Time allowed – 90 minutes

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

The diagram below shows a uniform ladder 5 m long resting against a frictionless, vertical wall with its lower end 4 m from the wall. The ladder has a mass of 20 kg. The coefficient of static friction between the foot of the ladder and the ground is 0.8. A 100 kg man climbs slowly up the ladder. Assume that the man can be represented by a point mass.



(a) Copy the diagram to your answer sheet. Indicate and clearly label the forces acting on the ladder. (5)

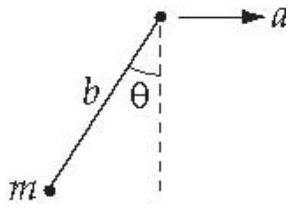
(b) Determine the ***maximum*** frictional force that the ground can exert on the ladder at its lower end (use $g = 10\ m/s^2$). (7)

(c) What is the actual frictional force when the man has climbed halfway up the ladder ? (13)

(d) How far along the ladder can the man climb before the ladder starts to slip ? (10)

Mechanics Intermediate

A simple pendulum of length b and bob with mass m is attached to a massless support moving horizontally with constant acceleration a, as shown in the following figure.



(a) Find the Lagrangian of the system using the angle θ as the generalized coordinate. (20)

(b) Determine the Lagrange equation of motion. (15)

(c) Find the angle $\theta = \theta_0$ at the equilibrium point. Please note that θ_0 should depend on a and g only. (5)

(d) Find the period of small oscillations near the equilibrium point. (25)