THE UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF PHYSICS

PHYS1121 PHYSICS 1A

EXAMINATION 2003

MID-SESSION 2

Total number of questions = 6

Total number of marks = 60

Question 1 [8 marks] An object is launched horizontally from the top of an inclined plane (Figure 1). The plane makes an angle of 40^o with the horizontal. The launch speed is 5 m/s. Calculate how far down the incline the object 'lands'. Ignore all forces except gravity.

Question 2 [9 marks] A small spherical bead with a mass of 100 g slides along a frictionless, semicircular wire of radius of 10 cm. The wire is rotating about a vertical axis at a rate of 2 revolutions per second (Figure 2).

(a) Draw a clear diagram showing all the forces acting on the bead.

(b) Calculate the value of the angle θ at which the bead will remain stationary relative to the rotating wire.

Question 3 [10 marks] A 2 kg block resting on a frictionless, inclined plane is released 4 m from a massless spring whose force constant is k = 100 N/m. The plane makes an angle of 30^o with the horizontal (Figure 3). Calculate the maximum compression of the spring caused when the mass hits the spring. [Hint: don't forget the compression of the spring when calculating distance travelled.]

Question 4 [12 marks] A uniform, solid rod of mass M = 0.8 kg and length L = 1.2 m hangs vertically from a pivot at its top. The rod is struck by a particle of mass 0.3 kg initially moving horizontally. The particle makes a perfectly inelastic collision

with the rod at a distance of 0.8L from the top of the rod. The maximum angle of the rod + particle with the vertical is 60^o after the collision. [note: Rotational Inertia of rod $= ML^2/3$].

(a) Write down a simple expression for the angular momentum of the particle relative to the pivot before the collision, in terms of the particle's initial horizontal speed v.

(b) Calculate the Rotational Inertia of the rod + particle after the collision.

(c) Calculate the value of the particle's initial horizontal speed v.

Question 5 [12 marks] A uniform sphere of radius R and mass M is held at rest on a rough, inclined plane of angle θ by a horizontal rope (Figure 4). R = 20 cm, M = 3 kg and $\theta = 30^o$.

(a) Draw a clear diagram showing all the forces acting on the sphere

(b) Calculate the value of the tension in the rope

(c) Calculate the value of the normal force exerted on the sphere

(d) Calculate the value of the frictional force acting on the sphere.

Question 6 [9 marks]

(a) The planet Uranus has a moon, Umbriel, whose circular orbit around Uranus has a radius of 2.67×10^8 m and a period of 3.58×10^5 s. Another of Uranus' moons, Oberon, has an orbital radius of 5.86×10^8 m. Calculate the period of Oberon's orbit. [Note: you do not need to know the mass of Uranus !].

(b) Using the known values of the Universal Gravitational Constant G, the mean radius of the Earth and the acceleration due to gravity at the Earth's surface, derive a value for the mass of the Earth. (Gravitational Constant $G = 6.67 \times 10^{-11}$ $N.m^2/kg^2$, Earth radius (mean) = 6370 km).