Mechanics (non-examinable) Mathematical Tripos, Part IA
Dr M B Wingate Michaelmas Term 2013

On these sheets, no attempt is made to "model" real-life situations: no trains, cars, cyclists, lifts, etc. It is assumed that there are no "real" forces, such as air-resistance unless they are specifically mentioned. Most questions, but not all, avoid numbers and units, prefering general algebraic formulae with consistent dimensions.

Exercises for Lecture 1

1. A particle is in equilibrium under the action of 3 forces of magnitudes $3P$, $5P$, and $7P$. Show that the angle between the forces with magnitudes $3P$ and $5P$ is $\cos^{-1}\frac{1}{2}$. [If you resolve forces, you should choose two sensible directions. You could also do this geometrically, representing the three vector forces as the sides of a triangle.]

2. A particle of mass m hangs vertically, attached to one end of a light, enextensible string, the other end of which is fixed to a point O. The particle is acted on by a horizontal force P so that the particle is in equilibrium and the string is inclined at an angle θ to the vertical. Find P in terms of m, g, and θ, where g is the gravitational acceleration, hence the particle's weight is $W = mg$.

3. The ends of light inextensible string are attached to two fixed points A and B at the same horizontal level. A smooth ring O of mass m, which can slide freely on the string, is acted on by a horizontal force of magnitude P. The string is taut and the two sections of the string, AO and BO, make angles of θ and ϕ respectively with the vertical through O. Assuming that the tensions in the two sections of the string are the same, show that
$$P = \frac{|\sin\phi - \sin\theta|}{\cos\phi + \cos\theta}\, mg\,.$$

Problems 4 and 5, originally appearing on this sheet, actually belong on the next sheet.

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