**MA22S4 - Classical Mechanics**

**Assignment 1**

Marina Krstic Marinkovic  
(*mmarina@maths.tcd.ie*)  
School of Mathematics, TCD

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**Rules**

The deadline for submission is **Thursday, February 15th at 10am**. You may hand in your writeup either in the Wednesday's tutorials session (Feb. 14th, 4pm) or by the start of the first lecture on Thursday (Feb. 15th, 10am). Late submissions without prior arrangement or a valid explanation will result in reduced marks. Late submissions after Wednesday 4pm in the following week will not be accepted, as the solutions will be discussed in tutorials each week after the submission deadline.

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**Questions**

1. A particle moves outward along a spiral. Its trajectory is given by $r = A\theta$, where $A$ is a constant: $A = \frac{1}{\pi} \frac{m}{\text{rad}}$. The angle $\theta$ increases in time according to $\theta = \alpha t^2/2$, where $\alpha$ is a constant.

   (a) Sketch the motion, and indicate the approximate velocity and acceleration at two different points in time. [10p]  
   (b) Find angle $\theta$ for which the radial acceleration is zero. [20p]  
   (c) At what angles do the radial and tangential accelerations have equal magnitude? [20p]

2. A particle describes a curve $r = a + \sin \theta$ such that $r^2 \dot{\theta} = h$, where $a$ and $h$ are constants.

   (a) Prove that $\dot{r} = -\frac{h}{a} \cos \theta$. [20p]  
   (b) Show that the acceleration of the particle is equal to $\ddot{a} = -\frac{h^2}{ar^5} \dot{r}$. [30p]