**standard correction**

**Exercise N°1** *(12 pts)*

1 : Kinetic energy: (1)

Potential energy: (1)

The Lagrangian: (1)

The dissipation function: (1)

Lagrange formalism:

, , (1)

The differential equation of motion:

 (0. 5)

 (0.25)

The equation is of the form:

 (0.25)

Avec : et (0.5)

2. The permanent solution is : (0.5)

Let's use the complex representation to find the amplitude A and the phaseφ.

 (0. 25)

 (0. 25)

The result is :

 (0.5)

 (0 5)

The amplitude is :  (0.5)

 And the phase is given by

So (0.5)

3. The resonance condition . (0. 5)

 (0. 5)

**Exercise N°2*(8 pts)***

1. The disc on the surface corresponds to the limit of total reflection (0.5) . From this we can deduce:

 (2)

 The radius of the light disc is therefore: (1.5)

1. By applying the principle of the inverse return of light, the eye of the fish sees the zone of space from which it can be seen. The fish therefore sees all the space in the air through a cone whose vertex is its eye and whose half-angle at the vertex is equal to the refraction limit angle for the water/air dioptre. At outside this cone, there is total reflection. (0.5)

 (2)

 the fish therefore sees the space beyond the surface of the water as a cone of angle 98° whose intersection with the surface of the water is a disc of radius **r**

with (1.5)