Homework 6

1) A fish is held out at the top of a ladder at a height of h metres above the water surface of a pool. A seal rises vertically from the water, directly below the fish, with an initial speed of u metres per second. The fish is dropped at exactly the same instant as the seal emerges from the water. Given that the seal is still rising when it catches the fish, show that:

(a) $u > \sqrt{gh}$, where g is the magnitude of the acceleration due to gravity; **5**

(b) the seal catches the fish at a height of

$$h\left(1 - \frac{gh}{2u^2}\right) \text{ metres}$$

above the water surface of the pool. **1**

2) A body of mass m kilograms is released from rest at the top of a smooth slope which is inclined at an angle θ to the horizontal. Show that its velocity when it has travelled a distance of s metres down the slope is given by

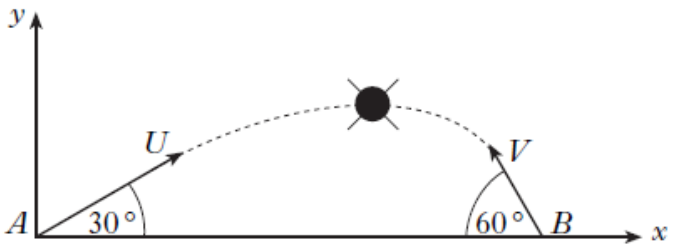
$$v = \sqrt{2gs\ sin\theta}$$ **4**

3) A ramp consists of a rough plane inclined at angle θ to the horizontal, where $\tan\theta = \frac{5}{12}$. A box of mass m kg is given a push up the line of greatest slope of the ramp, which gives the box an initial speed of $\sqrt{gL}\ \text{m s}^{-1}$, where L metres is the distance travelled before the box comes to rest.

Calculate the value of the coefficient of friction between the box and the surface of the ramp. **7**

4)

Two points A and B are a distance L metres apart on horizontal ground. A ball is thrown from A towards B with speed U m s^{-1} at an angle of projection of 30°. Simultaneously, a second ball is thrown from B towards A with speed V m s^{-1} and angle of projection 60°.



(*a*) Using the coordinate system shown in the diagram:

(i) write down expressions in terms of U and t for the x and y coordinates of the ball thrown from A at time t seconds after projection; **2**

(ii) show that at time t, the x-coordinate of the ball thrown from B is $x = L - \frac{1}{2}Vt$ and write down the corresponding expression for the y-coordinate. **2**

(*b*) The balls collide before reaching the ground.

(i) Show that $U = \sqrt{3}V$. **2**

(ii) Find an expression for the horizontal distance from A at which the collision takes place, giving your answer in terms of L. **4**