A Level H2 Physics Tutorial 4: Forces

Syllabus :
(a) recall and apply Hooke's law (F = kx, where k is the force constant) to new situations or to solve related problems .

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1. An elastic rope of length L is stretched by 2 cm when a mass of 200 g is attached to it.

(i) Find it elastic constant, assuming Hooke's law.

(ii) The mass is replaced by a 500 g one. Find the new extension of the rope.

(b) describe the forces on a mass, charge and current-carrying conductor in gravitational, electric and magnetic fields, as appropriate

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(c) show a qualitative understanding of normal contact forces, frictional forces and viscous forces including air resistance (no treatment of the coefficients of friction and viscosity is required)

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2. Acceleration due to gravity is $g = 9.8\ m/s^2$.

(i) Why does a feather fall much slower than g?

(ii) When a ball is dropped from a high place, it falls at $9.8\ m/s^2$. After some time, but before hitting the ground, the acceleration decreases to zero. Explain why.

(d) show an understanding that the weight of a body may be taken as acting at a single point known as its centre of gravity

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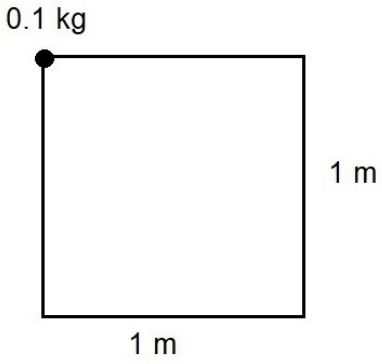
3. (a) State the definition of centre of gravity/

(b) A 1 m long rod negligible mass. One end P has a point mass of 0.1 kg attached, The other end

has a point mass of 0.2 kg.



(i) A student tired a string around a point on the rod and managed to balance it. Find the distance of this point from P.

(ii) State the position of the centre of gravity.

Determine the position of the centre of gravity of this uniform square sheet of mass 4 kg, with a small mass attached at one corner

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(e) define and apply the moment of a force and the torque of a couple

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4.

(a) State the definition of moment of a force.

(b) State the definition of couple.

(f) show an understanding that a couple is a pair of forces which tends to produce rotation only

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5. A force F acts at one corner of a square wooden sheet as shown.

A force F of 10 N acts at one corner of a uniform square sheet of wood as shown. The side of the square is 0.5 m.

(i) Redraw the forces by adding a pair of equal and opposite forces – one equal to F, one opposite - at the centre.

(ii) Thus, explain how F can produce a translation and rotation at the same time.

(iii) A couple is equal to the force times distance between them. Calculate the couple in this case.

(g) apply the principle of moments to new situations or to solve related problems

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(h) show an understanding that, when there is no resultant force and no resultant torque, a system is in equilibrium

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6. A horizontal force F pulls at point Q of a uniform cube of side 1 m, resting on a rough floor. F is

slowly increased until the cube is just about to tilt. The cube has weight W = 10 N.

(i) Sketch a diagram of one side of the cube on the floor. Draw and label all the forces acting on the cube.

(ii) Find F.

(iii) Draw the directions and positions of the other two forces acting on the box.

(iv) Which pair(s) of forces are equal and opposite?

(v) Which pair(s) of forces form couple(s)?

(i) use a vector triangle to represent forces in equilibrium

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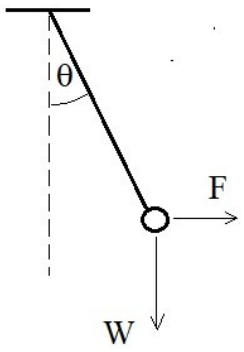
7. The figure shows a bob of weight W, hanging on a spring. It is pulled to one side by a force F, and stays at equilibrium there. The W is 1 N and θ is 30°.



(i) What is the remaining force? Label it T.

(ii) Draw a vector triangle to show the equlibrium of the 3 forces.

(iii) Find T.

(j) derive, from the definitions of pressure and density, the equation $p = \rho gh$

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8. Find the formula for liquid pressure in terms of density ρ and depth h.

Hint: consider a measuring cylinder containing a height h of the liquid.

(k) solve problems using the equation $p = \rho gh$

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9. The water in a swimming pool is 1 m deep. What is the water pressure at the bottom of the pool. (Density of water is 1 g/m^3.)

(l) show an understanding of the origin of the force of upthrust acting on a body in a fluid

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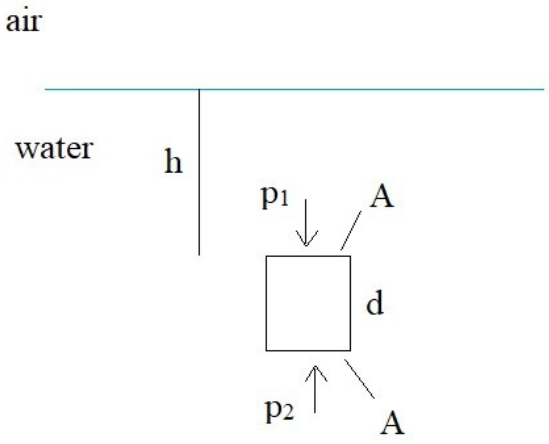
10. A rectangular box has height d and cross-section A. It is immersed in a liquid with density ρ , with the top surface at depth h.



(i) Write down the expressions for liquid pressures p_1 and p_2 in terms of h, d and ρ.

(ii) The pressure at the bottom of the box is higher than pressure at the top. This should be the reason

for the upthrust. Check that is the case by :

- writing down the forces at top and bottom in terms of h, d, ρ and A.

- subtracting them and showing that the answer is equal to weight of the water displaced.

(m) state that upthrust is equal in magnitude and opposite in direction to the weight of the fluid displaced by a submerged or floating object

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(n) calculate the upthrust in terms of the weight of the displaced fluid

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9. A metal has density 2.7 g/cm^3. 10 cm^3 of this metal immersed in water (density 1 g/cm^3) is found to become lighter. Find the upthrust it experiences.

(o) recall and apply the principle that, for an object floating in equilibrium, the upthrust is equal in magnitude and opposite in direction to the weight of the object to new situations or to solve related problems.

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10. What is the mass of water displaced by a 100 ton ship?

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