UNIVERSITY OF NAIROBI
DEPARTMENT OF PHYSICS

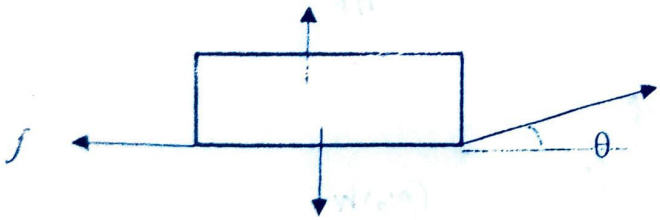
CAT I: SPH 101 – MECHANICS I Date: 4/11/2019

1. Give a concise definition of the following terms;
   (i) Isotropy of space.
   (ii) Non-inertial frame of reference (3 marks)
2. A particle of mass m_1 moving with velocity u_1 collides head on with another particle of mass m_2 at rest. After collision the particles travel with velocities v_1 and v_2 respectively. Given that the collision is perfectly elastic, show that

$$v_2 = \frac{2m_1u_1}{m_1+m_2}$$ (3 marks)

3. Three bodies of masses 2g, 5g and 10g have position vectors; $R_1 = 3i + 2j - k$ $R_2 = i - j + 3k$ and $R_3 = 2i + 3j - k$ respectively, determine the position and magnitude of the centre of mass from the origin. (3 marks)
4. a). State Newton's second law of motion, hence demonstrate how it enhances conservation of linear momentum. (3 marks)

   b). A block of mass m is pulled by a force T at angle θ moving in the positive x-axis on the surface with frictional force f as shown below;



   Show that the force T is given by $T = \frac{\mu_k mg}{Cos\,\theta+\mu_k Sin\,\theta}$ (4 marks)
5. The frequency of vibration f of a mass m at the end of a spring that has a stiff constant k is directly proportional to m and k and is given by the relation; $f \alpha m^a k^b$
   Use dimensional analysis to find the values of a and b. (2 marks)
6. a) Vector C is perpendicular to both vectors A and B, determine the Cartesian components of vector C given that $A = 2i - j - 4k$ and $B = 3i - 2j - k$. (2 marks)
   b) If vector $A = 2i + j + k$, $B = i + 2j - 2k$ and $C = i - 3j - 2k$ find the magnitude and direction cosines of the vector $R = A + B + C$. (3 marks)
   c) A particle is acted upon by the forces $F_1 = 5i - 10j + 15k$, $F_2 = 10i + 25j - 20k$ and $F_3 = 15i - 20j + 10k$. Find the force needed to keep it in equilibrium. (2 marks)