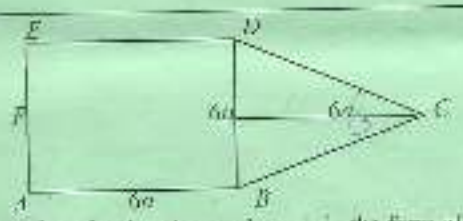
(i) A particle of mass 5 kg moves so that its position vector after t seconds is
$\mathbf{r} = [(\cos 2t)\mathbf{i} + (4\sin 2t + 3)\mathbf{j}]$ m.

Find
(a) the magnitude of the position vector of the particle when $t = \frac{\pi}{6}$,
(b) the speed of the particle when $t = \frac{\pi}{3}$,
(c) the magnitude of the force acting on the particle when $t = \frac{\pi}{2}$.

(ii) The retardation of a particle P moving in a straight line with speed v ms^{-1} is $(2 - v)$ ms^{-2}. Given that the initial speed of the particle is 10 ms^{-1}, find
(a) the time which P takes to come to rest,
(c) the distance covered during this time.

(i)



The uniform lamina shown above is in the form of a square $AEDB$ of side $6a$ and an isosceles triangle BCD of height $6a$.
Find the distance of the centroid of the lamina from AE. If the lamina is folded such that the triangular part lies on the square portion with the vertex C at the point F, where F is the midpoint of AE, Find the distance of the centroid of the resulting lamina from AB.

(ii) A particle moving on the inside smooth surface of a fixed spherical bowl of radius 2 m. It describes a horizontal circle at a distance $\frac{6}{5}$ m below the centre of the bowl.
(a) Prove that the speed of the particle is $3\sqrt{3}$ ms^{-1}.
(b) Find the time taken by the particle to perform a complete revolution.

(Take g as 10 ms^{-2}.)

3. (i) A uniform ladder of length 7 m rests against a vertical wall. It makes an angle of 45° with the wall. The coefficients of friction between the ladder and the wall is $\frac{1}{3}$ and between the ladder and the ground is $\frac{1}{2}$. A girl whose weight is half that of the ladder slowly ascends the ladder. Find how far up along the ladder will she climb before the ladder begins to slip.

(ii) An engine is pumping water from a well 25 m deep. It discharges 0.6 m^3 of water each second with a speed of 12 ms^{-1}. Find the power of the pump given that the density of water is 1000 kg m^{-3}.
(Take g as 10 ms^{-2}.)

4. (i) A particle P of mass 6 kg is attached to the ends of two light inextensible strings PA and PB, where $PA = 3$m. The ends A and B of the strings are attached to two fixed points on a vertical pole, with B 5 m vertically below A. The particle moves in a horizontal circle with constant angular speed, ω, with both strings taut. The tension in the string PA is 120 N.
(a) Show that $\omega^2 = \frac{25}{24}$
(b) Calculate the kinetic energy of P.

(ii) Given that the forces $(3\mathbf{i} + 6\mathbf{j})$ N, $(\mathbf{i} - 4\mathbf{j})$ N and $(-5\mathbf{i} + \mathbf{j})$ N act through the points, $(2\mathbf{i} + 3\mathbf{j})$ m, $(3\mathbf{i} - \mathbf{j})$ m, $(-\mathbf{i} - \mathbf{j})$ m and $(-3\mathbf{i} + 4\mathbf{j})$ m respectively, show that this system of forces reduces to a couple and find magnitude of the couple.
(Take g as 10ms^{-2}.)

A projectile is fired from the origin O with initial velocity $(5\mathbf{i} + 20\mathbf{j})$ ms^{-1}. The projectile just clears a wall of height 20 m which is at a horizontal distance x from O. The plane of the wall is perpendicular to the vector $\mathbf{i}$. Find the possible values of x. Find, also, the corresponding values of the velocity of the projectile when it is just passing over the wall.

(Take g as 10 ms^{-2})

6. A car is moving with a constant acceleration along a straight level road. The car is observed to cover two consecutive 150 m stretches in 20 seconds and 10 seconds respectively.

Find

(a) the acceleration of the car.

(b) velocity of the car 3 seconds before it entered the first stretch.

At the end of the second stretch, the car is subjected to a retardation of magnitude $2x$ ms^{-2}, where x is the distance of the car from the end of the second stretch. Find the further distance travelled by the car before coming to rest.

A small smooth sphere P, of mass $2m$, moves with speed u on a horizontal table and strikes another smooth sphere Q, of mass m, lying at rest on the table at a distance x metres from a vertical wall, the impact being along the lines of centres and perpendicular to the wall. Q subsequently strikes the wall and comes back to strike P again. The coefficient of restitution for all impacts is $\frac{2}{3}$.

Find the speeds P and Q after impact. Find, also, the distance in terms of x from the wall where the second impact has taken place.

(i) A financial institution in a certain town has three branches A, B and C. On the average the branches receive 100, 150 and 120 customers respectively per day.

The probability that a customer will carry out a transaction of more than one million CFA francs at A, B and C are 0.2, 0.6 and 0.4 respectively.

A customer is chosen at random, find the probability that

(a) the customer will carry out a banking transaction of more than one million CFA francs

(b) the customer carried out a transaction less than one million CFA francs given that he went to the second branch.

(c) the customer went to C given that he carried out a transaction of more than one million CFA francs

(ii) An experiment consists of drawing four cards at random from a pack of 52 playing cards, one at a time with replacement.

Find the probability that:

(d) no diamond is drawn.

(e) exactly two diamonds are drawn and the other two cards of different suits.

(f) one card of each suit is drawn.