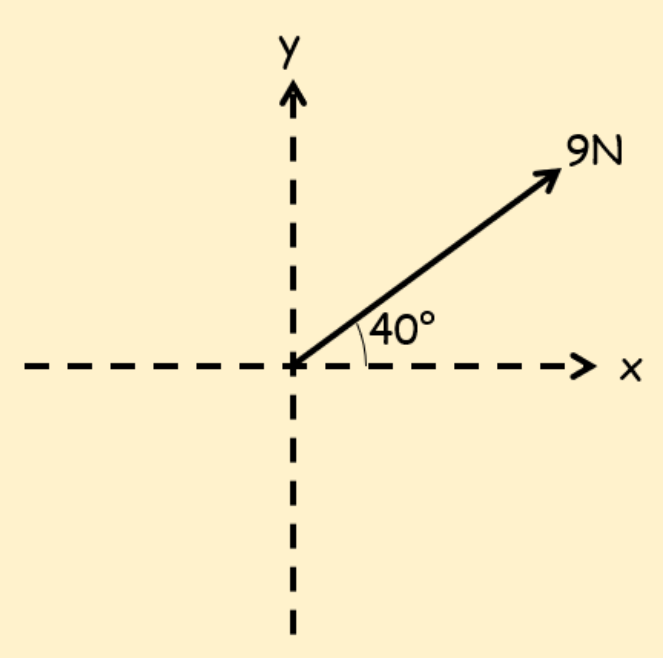
5A Forces at Angles

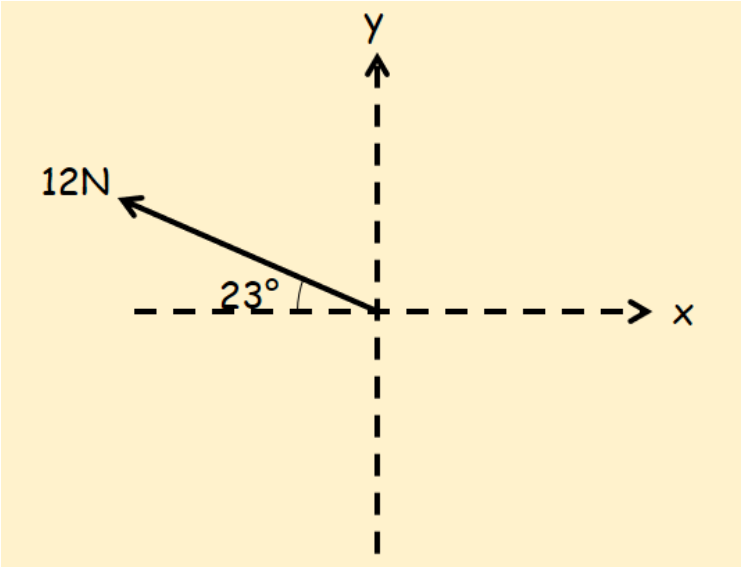
1. Find the component of each force in the x and y-directions.

   Hence, write each force in the form $(p\boldsymbol{i} + q\boldsymbol{j})N$

a)



b)

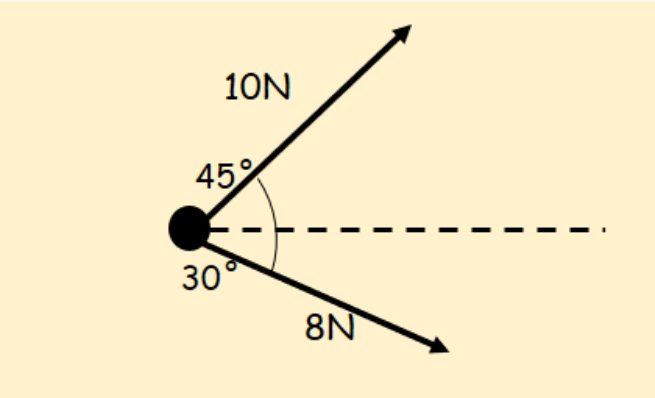


2. A box of mass 8kg lies on a smooth horizontal floor. A force of 10N is applied at an angle of 30˚ causing the box to accelerate horizontally across the floor.

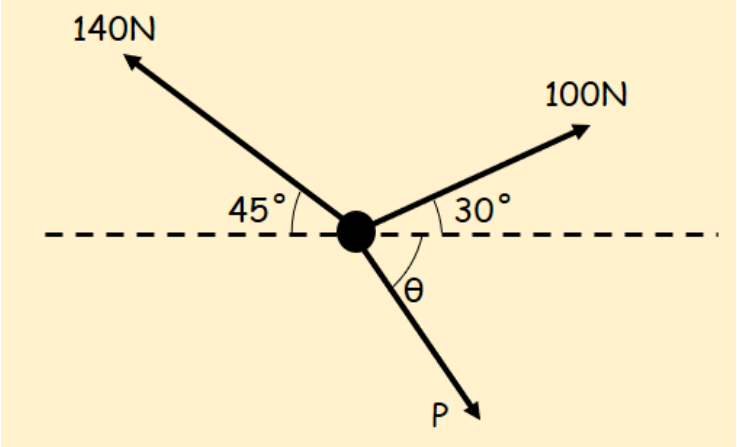
a) Work out the acceleration of the box

b) Calculate the normal reaction between the box and the floor

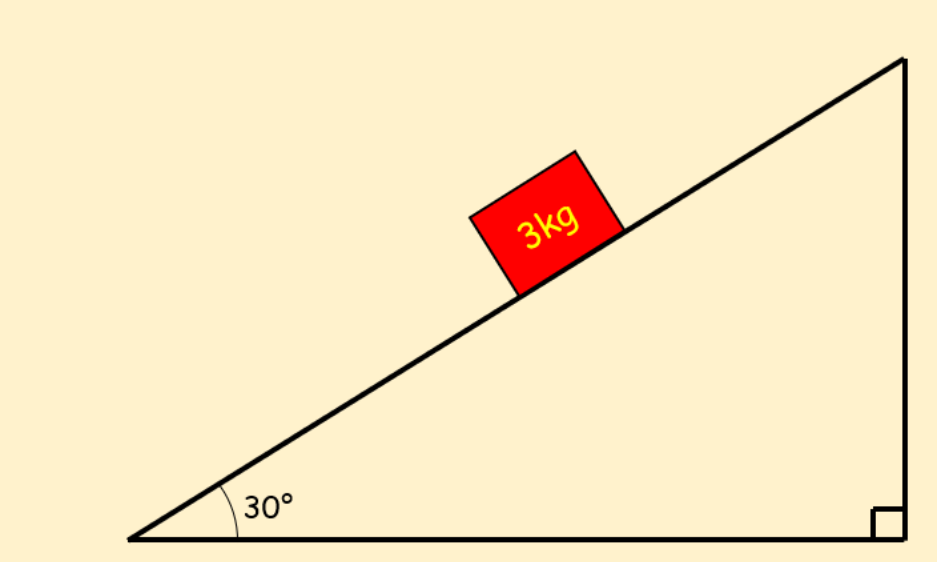
3. Two forces, P and Q, act upon a particle as shown in the diagram. Work out the magnitude and direction of the resultant force.



4. Three forces act on a particle as shown. Given that the particle is in equilibrium, calculate the magnitude of P and the value of θ.



5B Slopes on a Plane



1. A box of mass 2kg is resting on a smooth plane inclined at an angle of 20° to the horizontal. It meets resistance of 2N as it travels down the slope

   a) Calculate the acceleration of the box down the slope

   b) If the box starts 10m up the plane, calculate the velocity of the box at the bottom of the plane

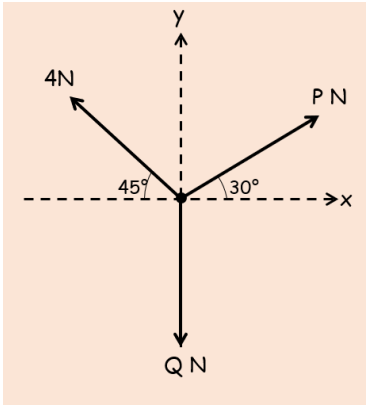
   c) Find the normal reaction between the box and the plane

2. A particle P of mass 2kg is moving on a smooth slope and is being acted on by a force of 4N that acts parallel to the slope as shown.
   The slope is inclined at an angle α to the horizontal, where $tan\alpha = \frac{3}{4}$. Work out the acceleration of the particle.

3. A particle of mass m is pushed up a smooth slope by a force of magnitude 5g acting at an angle of 60˚ to the slope. This causes the particle to accelerate up the slope at 0.5ms^{-2}. Show that the mass of the particle is $\left(\frac{5g}{1+g}\right)\ kg$

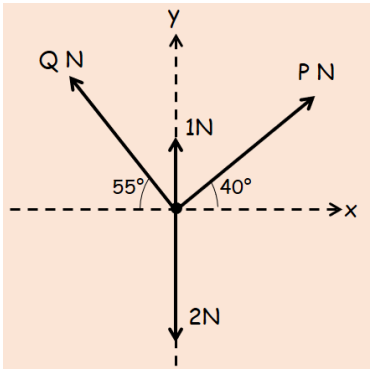
7A Static Diagrams

1. The particle in the diagram is in equilibrium. Calculate the magnitude of the forces P and Q.



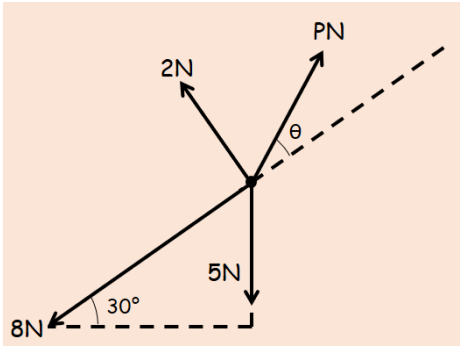
2. The diagram shows a particle in equilibrium under a number of forces.

   Calculate the magnitudes of the forces P and Q



3. The diagram shows a particle in equilibrium on an inclined plane under the effect of the forces shown.

   Find the size of angle θ and the value of force P.



7B Static Models & Tension

1. A smooth bead, Y, is threaded on a light inextensible string. The ends of the string are attached to two fixed points X and Z on the same horizontal level. The bead is held in equilibrium by a horizontal force of 8N acting in the direction ZX. Bead Y hangs vertically below X and angle XZY = 30°.

   Find:

a) The tension in the string

b) The weight of the bead

2. A Particle P with mass 8kg is suspended from two strings at point A and B. The angle PAB is 30° and the angle ABP is 50°.
   Find the Tension in the two strings

3. A mass of 3kg rests on the surface of a smooth plane inclined at an angle of 45° to the horizontal. The mass is attached to a cable which passes up the plane and passes over a smooth pulley at the top. The cable carries a mass of 1kg which hangs freely at the other end. There is a force of PN acting horizontally on the 3kg mass and the system is in equilibrium.

   By modelling the cable as a light inextensible string and the masses as particles, calculate:

a) The magnitude of P

b) The normal reaction between the mass and the plane

5C (Part 1) Friction

1. A block of mass 5kg is lying at rest on rough horizontal ground. The coefficient of friction between the block and the ground is 0.4. A horizontal force, P, is applied to the block. Find the magnitude of the frictional force acting on the block and its acceleration when:

4. P = 10N

5. P = 19.6N

6. P = 30N

2. A 5kg box lies at rest on a rough horizontal floor. The coefficient of friction between the box and the floor is 0.5. A force P is applied to the box. Calculate the value of P required to cause the box to accelerate if:

a) P is applied horizontally

b) P is applied at an angle of θ above the horizontal, where $\tan\theta = {}^{3}/_{4}$

7C Limiting Friction

1. A block of mass 3kg rests on a rough horizontal plane. The coefficient of friction between the block and the plane is 0.4. When a horizontal force P N is applied to the block, the block remains in equilibrium.

a) Find the value for P for which the equilibrium is limiting

b) Find the value of F when P = 8N

2. A mass of 8kg rests on a rough horizontal plane. The mass may be modelled as a particle, and the coefficient of friction between the mass and the plane is 0.5.

   Find the magnitude of the maximum force PN, which acts on this mass without causing it to move if P acts at an angle of 60° above the horizontal.

5C (Part 2) Friction on Slopes

1. A particle of mass 2kg is sliding down a rough slope that is inclined at 30˚ to the horizontal. Given that the acceleration of the particle is $1ms^{-2}$, find the coefficient of friction, μ, between the particle and the slope.

7C Limiting Friction on Slopes

1. A box of mass 10kg rests in limiting equilibrium on a rough plane inclined at 20° above the horizontal. Find the coefficient of friction between the box and the plane.

2. A horizontal force of magnitude P N is applied to the box. Given that the box remains in equilibrium, find the maximum value of P.

   It is very important to notice that this force will be attempting to push the box up the slope

7E Additional Forces on Slopes

3. A box of mass 10kg rests in limiting equilibrium on a rough plane inclined at 20° above the horizontal. Find the coefficient of friction between the box and the plane.

4. A horizontal force of magnitude P N is applied to the box. Given that the box remains in equilibrium, find the maximum value of P.

   It is very important to notice that this force will be attempting to push the box up the slope

7F Pulleys on Slopes

1. Two particles, P and Q, of masses 5kg and 10kg are connected by a light inextensible string. The string passes over a small smooth pulley which is fixed at the top of a plane inclined at an angle of 25° to the horizontal. P is resting on the plane and Q hangs freely with the string vertical and taut. The coefficient of friction between P and the plane is 0.2.

a) Find the acceleration of the system

b) Find the tension in the string

2. One end of a light inextensible string is attached to a block A of mass 2kg. The block A is held at rest on a smooth fixed plane which is inclined to the horizontal at an angle of 30˚. The string lies along the line of greatest slope of the plane (ie – up the plane), and passes over a smooth light pulley which is fixed at the top of the plane. The other end of the string is attached to a block B of mass 5kg. The system is released from rest. By modelling the blocks as particles and ignoring air resistance:

   a) i) Show that the acceleration of block B is $\frac{4}{7}g$

      ii) Find the tension in the string

b) State how you have used the fact that the string is inextensible in your calculations

c) Calculate the magnitude of the force exerted on the pulley by the string