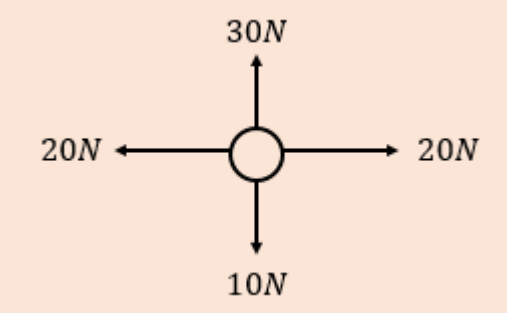
10A Diagrams & Resultant Forces

1. The diagram shows the forces acting on a particle.

a) Calculate the resultant force



b) Describe the motion of the particle

10B Forces as Vectors

1. The forces $2\boldsymbol{i} + 3\boldsymbol{j}$, $4\boldsymbol{i} - \boldsymbol{j}$, $-3\boldsymbol{i} + 2\boldsymbol{j}$ and $x\boldsymbol{i} + y\boldsymbol{j}$ act on an object which is in equilibrium. Find the values of x and y.

2. In this question i represents the unit vector due east, and j represents the unit vector due north. A particle begins at rest at the origin. It is acted on by three forces $(2\boldsymbol{i} + \boldsymbol{j})N$, $(3\boldsymbol{i} - 2\boldsymbol{j})N$ and $(-\boldsymbol{i} + 4\boldsymbol{j})N$.

a) Find the resultant force in the form $p\boldsymbol{i} + q\boldsymbol{j}$

b) Work out the magnitude and bearing of the resultant force

c) Describe the motion of the particle

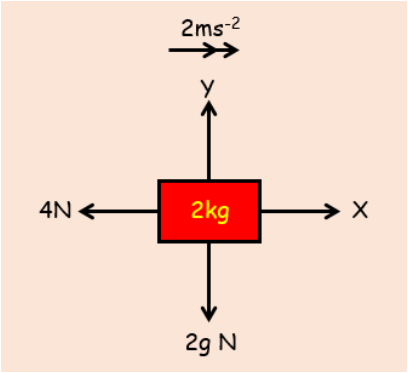
10C F=ma

1. Find the weight in Newtons, of a particle of mass 12kg.

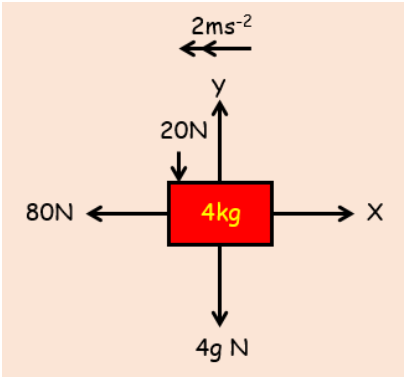
2. Find the acceleration when a particle of mass 1.5kg is acted on by a force of 6N

3. Find the values of the missing forces acting on the object in the diagram below

a)



b)



4. A particle of mass 5kg is pulled along a rough horizontal table by a force of 20N, with a frictional force of 4N acting against it. Given that the particle is initially at rest, find:

a) The acceleration of the particle

b) The distance travelled by the particle in the first 4 seconds

c) The magnitude of the normal reaction between the particle and the table

10D F=ma with Vectors

1. A force of $(\mathbf{3}\boldsymbol{i} + \mathbf{8}\boldsymbol{j})\ N$ acts upon a particle of mass 0.5kg.

a) Find the acceleration of the particle in the form $(p\boldsymbol{i} + q\boldsymbol{j})\ ms^{-2}$.

b) Find the magnitude and bearing of the acceleration of the particle

2. The following forces:

   $\mathbf{F}_1$ = (2**i** + 4**j**) N

   $\mathbf{F}_2$ = (-5**i** + 4**j**) N

   $\mathbf{F}_3$ = (6**i** – 5**j**) N

   all act on a particle of mass 3kg. Find the acceleration of the particle.

3. A boat is modelled as a particle of mass 60kg being acted on by 3 forces:

$$F_1 = \begin{pmatrix} 80 \\ 50 \end{pmatrix} N \qquad F_2 = \begin{pmatrix} 10p \\ 20q \end{pmatrix} N \qquad F_3 = \begin{pmatrix} -75 \\ 100 \end{pmatrix} N$$

Given that the boat is accelerating at a rate of $\begin{pmatrix} 0.8 \\ -1.5 \end{pmatrix} ms^{-2}$, find the values of p and q

4. Given that:

   $\mathbf{a} = 3\mathbf{i} - \mathbf{j}$

   $\mathbf{b} = \mathbf{i} + \mathbf{j}$

   Find μ if $\mathbf{a} + \mu\mathbf{b}$ is parallel to $3\mathbf{i} + \mathbf{j}$

10E Connected Particles

1. Two particles, P and Q, of masses 5kg and 3kg respectively, are connected by a light inextensible string. Particle P is pulled by a horizontal force of magnitude 40N along a rough horizontal plane. Particle P experiences a frictional force of 10N and particle Q experiences a frictional force of 6N.

a) Find the acceleration of the particles

b) Find the tension in the string

c) Explain how the modelling assumptions that the string is light and inextensible have been used

2. A light scale-pan is attached to a vertical light inextensible string. The scale pan carries two masses, A and B. The mass of A is 400g and the mass of B is 600g. A rests on top of B.

   The scale pan is raised vertically with an acceleration of $0.5ms^{-2}$.

a) Find the Tension in the string

b) Find the force exerted on mass B by mass A

c) Find the force exerted on mass B by the scale pan

C Alt (Consider particles as one)

10F Pulleys

1. Particles P and Q, of masses 2m and 3m, are attached to the ends of a light inextensible string. The string passes over a small, smooth, fixed pulley and the masses hang with the string taut. The system is released from rest.

a) Find the acceleration of each mass

b) Find the tension in the string, in terms of m

c) Find the force exerted on the pulley by the string, in terms of m

d) Find the distance travelled by Q in the first 4 seconds, assuming that P does not reach the pulley

e) Comment on any modelling assumptions used

2. Two particles A and B of masses 0.4kg and 0.8kg respectively are connected by a light inextensible string. Particle A lies on a rough horizontal table 4.5m from a small smooth fixed pulley which is attached to the end of the table. The string passes over the pulley and B hangs freely, with the string taut, 0.5m above the ground. The frictional force has a magnitude 0.08g.The system is released from rest. Find:

a) The acceleration of the system

b) The velocity at which B hits the ground

c) The total distance travelled by A before it comes to rest

d) (Bonus Question) The Force exerted on the pulley and the direction the force is in.