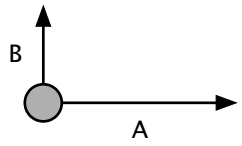
ABRHS PHYSICS (H) NAME: KEY

Newton's Laws - Vectors

1. In the diagram, there are two forces acting on a 3 kg object. Force A is 6 N to the right and force B is 3 N up.



   a. What is the acceleration of the object?

$\vec{F}_1 = 6\hat{i}$ N

$\vec{F}_2 = 3\hat{j}$ N

$\Sigma \vec{F} = m\vec{a}$

$\vec{F}_1 + \vec{F}_2 = m\vec{a}$

$6\hat{i} + 3\hat{j} = 3\vec{a}$

$\boxed{\vec{a} = 2\hat{i} + \hat{j} \ \text{m/s}^2}$

   b. What third force would cause the acceleration to be zero?

$\Sigma \vec{F} = 0$

$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$

$6\hat{i} + 3\hat{j} + \vec{F}_3 = 0$

$\boxed{\vec{F}_3 = -6\hat{i} - 3\hat{j} \ \text{N}}$

   c. If instead, a third force of $-4\mathbf{i} + 1\mathbf{j}$ N acted on the object, what would be its acceleration?

$\vec{F}_3 = -4\hat{i} + \hat{j}$ N

$\Sigma \vec{F} = m\vec{a}$

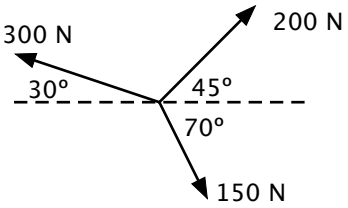
$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = m\vec{a}$

$(6\hat{i}) + (3\hat{j}) + (-4\hat{i} + \hat{j}) = 3\vec{a}$

$2\hat{i} + 4\hat{j} = 3\vec{a}$

$\boxed{\vec{a} = \frac{2}{3}\hat{i} + \frac{4}{3}\hat{j} \ \text{m/s}^2}$

2. Three forces act on a 2.5 kg object as shown. What is the acceleration of the object?



$\vec{F}_1 = -300\cos 30\,\hat{i} + 300\sin 30\,\hat{j}$ N

(or $\vec{F}_1 = 300\cos 150\,\hat{i} + 300\sin 150\,\hat{j}$ N)

$\vec{F}_1 = -260\hat{i} + 150\hat{j}$

$\vec{F}_2 = 200\cos 45\,\hat{i} + 200\sin 45\,\hat{j}$

$\vec{F}_2 = 141\hat{i} + 141\hat{j}$

$\vec{F}_3 = 150\cos 70\,\hat{i} - 150\sin 70\,\hat{j}$

$\vec{F}_3 = 51.3\hat{i} - 141\hat{j}$

So Finally:

$\Sigma \vec{F} = m\vec{a}$ $\quad \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = m\vec{a}$

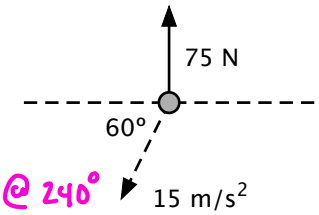
$(-260\hat{i} + 150\hat{j}) + (141\hat{i} + 141\hat{j}) + (51.3\hat{i} - 141\hat{j}) = (2.5)\vec{a}$

$-67.7\hat{i} + 150\hat{j} = (2.5)\vec{a}$

$\boxed{\vec{a} = -27\hat{i} + 60\hat{j} \ \text{m/s}^2}$

Newton's Laws - Vectors

3. A 10 kg object has two forces acting on it and has an acceleration of 15 m/s^2. The diagram shows the acceleration (dotted arrow), and one of the forces acting on the object. What is the second force?



$m = 10$ kg

$\vec{F}_1 = 75\hat{j}$

$\vec{a} = 15$ m/s^2 @ 240° (180+60)

$\vec{F}_1 = 75\hat{j}$ $\quad \vec{a} = -15\cos60\hat{i} - 15\sin60\hat{j}$

$\vec{a} = -7.5\hat{i} - 13\hat{j}$

$\Sigma\vec{F} = m\vec{a}$

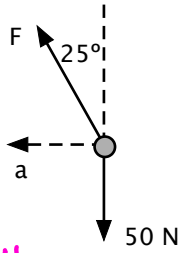
$\vec{F}_1 + \vec{F}_2 = m\vec{a}$

$(75\hat{j}) + \vec{F}_2 = (10)(-7.5\hat{i} - 13\hat{j})$

$75\hat{j} + \vec{F}_2 = -75\hat{i} - 130\hat{j}$

$\vec{F}_2 = -75\hat{i} - 205\hat{j}$ N

4. A 5 kg object has two forces acting on it. The diagram shows one of the forces and the directions of the second force and the direction of the acceleration of the object. What are the magnitudes of the acceleration and second force?



$m = 5$ kg

$\vec{F}_1 = F$ @ 115° (90+25)

$\vec{F}_2 = -50\hat{j}$ N

$\vec{a} = -a\hat{i} + 0\hat{j}$

$\vec{F}_1 = -F\sin25\hat{i} + F\cos25\hat{j}$

$F_2 = 0\hat{i} - 50\hat{j}$

$\Sigma\vec{F} = m\vec{a}$ $\quad \vec{F}_1 + \vec{F}_2 = m\vec{a}$

$(-F\sin25\hat{i} + F\cos25\hat{j}) + (-50\hat{j}) = (5)(-a\hat{i})$

$\hat{i}$) $-F\sin25 = -5a$

$\hat{j}$) $F\cos25 - 50 = 0$

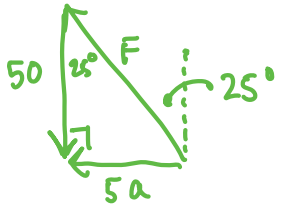
$F = 55.2$ N

So $-(55.2)\sin25 = -5a$

$a = 4.66$ m/s^2

OR diagram!

$\vec{F}_1 + \vec{F}_2 = m\vec{a}$



So

$F\cos25 = 50$

$\tan25 = \frac{5a}{50}$

Answers:

*1. a) 2**i** + **j** m/s² b) –6**i** – 3**j** N c) 0.67**i** + 1.33**j** m/s²*

*2) –27**i** + 60**j** m/s²*

*3) –75**i** – 205**j** N*

4) F = 55.2 N & a = 4.66 m/s²