Phy-107

Assignment

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① Two vectors are given by $\vec{a} = (9.0m)\hat{i} + (2.0m)\hat{j}$ and $\vec{b} = (2.0m)\hat{i} + (1.0m)\hat{j} + (3.0m)\hat{k}$ in unit vector notation find

ⓐ $\vec{a} + \vec{b}$

$$a+b = (9.0m + 2.0m)\hat{i} + (2.0m + 1.0m)\hat{j} + (3.0m)\hat{k}$$
$$= (11.0m)\hat{i} + (3.0m)\hat{j} + (3.0m)\hat{k}$$

ⓑ $\vec{a} - \vec{b}$

$$\vec{a} - \vec{b} = (9.0m - 2.0m)\hat{i} + (2.0m - 1.0m)\hat{j} - (3.0m)\hat{k}$$
$$= (7.0m)\hat{i} + (1.0m)\hat{j} - (3.0m)\hat{k}$$

ⓒ a third vector $\vec{c}$ such that $\vec{a} + \vec{b} - \vec{c} = 0$

w.k,

$$\vec{a+b} = (11.0m)\hat{i} + (3.0m)\hat{j} + (3.0m)\hat{k}$$

So, $\vec{c}$ will be $-(11.0m)\hat{i} - (3.0m)\hat{j} - (3.0m)\hat{k}$

(2) Vectors $\vec{A}$ and $\vec{B}$ lie in an xy plane. $\vec{A}$ has magnitude 5.00 and angle 150°, $\vec{B}$ has components $B_x = -6.50$ and $B_y = -9.20$. What are the angles between the negative direction of the y axis and (a) the direction of $\vec{A}$

(a) $\vec{A} = 5.00(\cos 150°\,\hat{i} + \sin 150\,\hat{j})$

$= -4.3\hat{i} + 2.5\hat{j}$

$\vec{B} = B_x\hat{i} + B_y\hat{j}$

$= -6.50\hat{i} - 9.20\hat{j}$

(b) $\vec{A}(-\hat{j}) = A\cos\theta$

$\theta = \cos^{-1}\left(\frac{\vec{A}(-\hat{j})}{A}\right)$

$= \cos^{-1}\left(\frac{-2.5}{\sqrt{(-4.3)^2 + (2.5)^2}}\right)$

$= \cos^{-1}\left(\frac{-2.5}{4.97}\right)$

$= 120.2°$

(b) $\vec{A}\times\vec{B}$ is perpendicular to the y axis

So, answer will be $90°$

(c) $\bar{A}\times(\bar{B}+7.00\hat{k})$

$= (-4.3\hat{i}+2.5\hat{j})\times(-6.50\hat{i}-9.20\hat{j}+7.00\hat{k})$

Now,

$$\bar{A}\times\bar{B} = \begin{vmatrix} \hat{i} & \hat{j} & k \\ -4.3 & 2.5 & 0 \\ -6.50 & -9.2 & 7 \end{vmatrix}$$

$= 17.5\hat{i} + 30.1\hat{j} + 55.81\hat{k}$

$|\vec{A}\times\bar{B}| = \sqrt{(17.5)^2+(30.1)^2+(55.81)^2}$

$= 65.78$

$\therefore \theta = \cos^{-1}\left(\frac{-30.1}{65.78}\right)$

$= 117.23°$

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(3) An iphone is shot from the ground into the air. At a height of 7.6 m, its velocity is $\vec{v} = (6.7\hat{i} + 5.2\hat{j})\,ms^{-1}$, with $\hat{i}$ horizontal and $\hat{j}$ upward.

(a) To what maximum height does the iphone rise?

$$v_y^2 = (v_{oy})^2 - 2gh$$

$$v_{oy} = \sqrt{v_y^2 + 2gh}$$

$$= \sqrt{5.2^2 + (2 \times 9.8 \times 7.6)}$$

$$= 13.41$$

So, at the maximum height of the phone, the vertical component of the velocity is 0

Now,

$$v_y^2 = (v_{oy})^2 - 2gH$$

$$H = -\frac{v_y^2 - v_{oy}^2}{2g} \qquad | v_y = 0$$

$$= \frac{13.41^2}{2 \times 9.8}$$

$$= 9.1 \text{ m}$$

(b) What total horizontal distance does the iphone travel?

WK,

$$R = \frac{2 V_{x} V_{oy}}{g}$$

$$= \frac{2 \times 6.7 \times 13.41}{9.8}$$

$$= 18.33 \text{ m}$$

(d) What are the magnitude and angle of the iphone's velocity just before it hits the ground?

$$V^2 = (V_x)^2 + (V_{oy})^2$$

$$V = \sqrt{(V_x)^2 + (V_{oy})^2}$$

$$= \sqrt{(6.7)^2 + (13.41)^2}$$

$$= 14.99 \text{ ms}^{-1}$$

Now, $\theta = \tan^{-1}\left(\frac{V_y}{V_x}\right)$

$$= \tan^{-1}\left(\frac{13.41}{6.7}\right) = 63.45°$$

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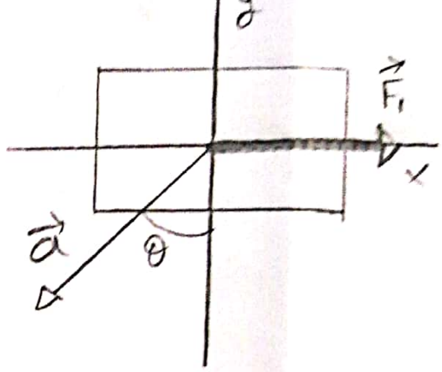
(4) There are two forces on the 500kg box in the overhead ~~view~~ view of the figure, but only one is shown. for $F_1 = 25.0N$, $a = 17.0 ms^{-2}$ and $\theta = 30°$, Find the second force



(a) in unit vector notation

Here,

$$F = -(ma\sin\theta)\hat{i} - (ma\cos\theta)\hat{j}$$

$$= -(5 \times 17 \times \sin 30)\hat{i} - (5 \times 17 \times \cos 30)\hat{j}$$

$$= -42.5\hat{i} - 73.6\hat{j}$$

(b) a magnitude

Here $F_2 = (-25.0 - 42.5)\hat{i} - 73.6\hat{j}$

$$= -67.5\hat{i} - 73.6\hat{j}$$

$$|\vec{F_2}| = \sqrt{(-67.5)^2 + (-73.6)^2}$$

$$= 99.87 \text{ N}$$

(c) an angle relative to the positive direction of the x axis

$$\theta = \tan^{-1}\left(\frac{-73.6}{-67.5}\right)$$

$$= 47.47 - 180$$

So, -132.53 from positive x axis

(5) A labor drags a crate accross a factory floor by pulling on a rope tied to the crate. The labor exerts a force of magnitude $F = 470\,N$ on the rope. which is inclined at an upward angle $\theta = 43°$ to the horizontal and the floor exerts a horizontal force of magnitude $f = 125\,N$ that opposses the motion. Calculate the magnitude of the accelaration of the crade if

(a) mass is 360 kg

$$F_x = F\cos\theta$$
$$= (470N)\cos 43°$$
$$= 343.73\,N$$

Now, $F_x - f = ma$

$$\Rightarrow a = \frac{F_x - f}{m}$$
$$= \frac{343.73 - 125}{360}$$
$$= 0.6\ ms^{-2}$$

(b) WK,

$$W = mg$$
$$m = \frac{W}{g} = \frac{360}{9.8} = 36.73$$

Now,

$$F_x - f = ma$$

$$a = \frac{F_x - f}{m}$$

$$= \frac{343.73 - 125}{36.73}$$

$$= 5.95 \ ms^{-2}$$