Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Solutions Manual

Engineering Mechanics: Statics

2nd Edition

Michael E. Plesha
University of Wisconsin–Madison

Gary L. Gray
The Pennsylvania State University

Francesco Costanzo
The Pennsylvania State University

With the assistance of:
Chris Punshon
Andrew J. Miller
Justin High
Chris O'Brien
Chandan Kumar
Joseph Wyne
Jonathan Fleischmann

Version: May 11, 2012

The McGraw-Hill Companies, Inc.

Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Copyright © 2002–2012
Michael E. Plesha, Gary L. Gray, and Francesco Costanzo

This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must be surrendered upon request of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Important Information about this Solutions Manual

We encourage you to occasionally visit

`http://www.mhhe.com/pgc2e`

to obtain the most up-to-date version of this solutions manual.

Contact the Authors

If you find any errors and/or have questions concerning a solution, please do not hesitate to contact the authors and editors via email at:

`plesha@engr.wisc.edu`, and
`stat_solns@email.esm.psu.edu`

We welcome your input.

This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must not be copied, in whole or part, without the permission of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Accuracy of Numbers in Calculations

Throughout this solutions manual, we will generally assume that the data given for problems is accurate to 3 significant digits. When calculations are performed, all intermediate numerical results are reported to 4 significant digits. Final answers are usually reported with 3 or 4 significant digits. If you verify the calculations in this solutions manual using the rounded intermediate numerical results that are reported, you should obtain the final answers that are reported to 3 significant digits.

This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must not be copied, in whole or part, without the permission of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

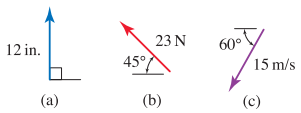
Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Chapter 2 Solutions

Problem 2.1

For each vector, write two expressions using polar vector representations, one using a positive value of θ and the other a negative value, where θ is measured counterclockwise from the right-hand horizontal direction.



Solution

Part (a)

$$\vec{r} = 12\,\text{in. @ } 90^\circ\measuredangle \quad \text{or} \quad \vec{r} = 12\,\text{in. @ } -270^\circ\measuredangle. \tag{1}$$

Part (b)

$$\vec{F} = 23\,\text{N @ } 135^\circ\measuredangle \quad \text{or} \quad \vec{F} = 23\,\text{N @ } -225^\circ\measuredangle. \tag{2}$$

Part (c)

$$\vec{v} = 15\,\text{m/s @ } 240^\circ\measuredangle \quad \text{or} \quad \vec{v} = 15\,\text{m/s @ } -120^\circ\measuredangle. \tag{3}$$

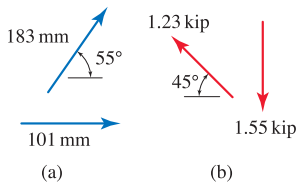
This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must be surrendered upon request of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

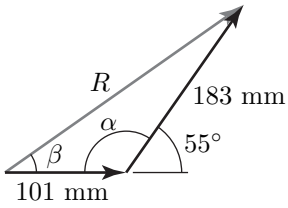
Problem 2.2

Add the two vectors shown to form a resultant vector $\vec{R}$, and report your result using polar vector representation.



Solution

Part (a) The vector polygon shown at the right corresponds to the addition of the two position vectors to obtain a resultant position vector $\vec{R}$. Note that α is given by $\alpha = 180° - 55° = 125°$. Knowing this angle, the law of cosines may be used to determine R



$$R = \sqrt{(101\,\text{mm})^2 + (183\,\text{mm})^2 - 2(101\,\text{mm})(183\,\text{mm})\cos 125°} = 254.7\,\text{mm}. \tag{1}$$

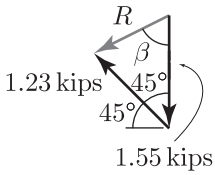
Next, the law of sines may be used to determine the angle β:

$$\frac{R}{\sin\alpha} = \frac{183\,\text{mm}}{\sin\beta} \quad \Rightarrow \quad \beta = \sin^{-1}\left(\frac{183\,\text{mm}}{254.7\,\text{mm}}\sin 125°\right) = 36.05°. \tag{2}$$

Using these results, we may report the vector $\vec{R}$ using polar vector representation as

$$\boxed{\vec{R} = 255\,\text{mm} \;@\; 36.0°\measuredangle.} \tag{3}$$

Part (b) The vector polygon shown at the right corresponds to the addition of the two force vectors to obtain a resultant force vector $\vec{R}$. The law of cosines may be used to determine R



$$R = \sqrt{(1.23\,\text{kip})^2 + (1.55\,\text{kip})^2 - 2(1.23\,\text{kip})(1.55\,\text{kip})\cos 45°} = 1.104\,\text{kip}. \tag{4}$$

Using the law of sines, we find that

$$\frac{R}{\sin 45°} = \frac{1.23\,\text{kip}}{\sin\beta} \quad \Rightarrow \quad \beta = \sin^{-1}\left(\frac{1.23\,\text{kip}}{1.104\,\text{kip}}\sin 45°\right) = 51.97°. \tag{5}$$

The direction of $\vec{R}$ measured from the right-hand horizontal direction is $-90° - 51.97° = -142°$. Using these results, we may report $\vec{R}$ using polar vector representation as

$$\boxed{\vec{R} = 1.10\,\text{kip} \;@\; -142°\measuredangle.} \tag{6}$$

This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must be surrendered upon request of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Part (d)

$$\vec{R} = [(200\,\hat{\imath} + 480\,\hat{\jmath}) - (150\,\hat{\imath} - 200\,\hat{\jmath})]\ \text{lb} = (50\,\hat{\imath} + 680\,\hat{\jmath})\ \text{lb} \tag{10}$$

$$R = \sqrt{(50)^2 + (680)^2}\,\text{lb} = 681.8\,\text{lb}. \tag{11}$$

The unit vector in the direction of $\vec{R}$ is $\hat{R}$, and it is given by

$$\boxed{\hat{R} = \frac{\vec{R}}{R} = \frac{(50\,\hat{\imath} + 680\,\hat{\jmath})\ \text{lb}}{681.8\,\text{lb}} = 0.0733\,\hat{\imath} + 0.997\,\hat{\jmath}.} \tag{12}$$

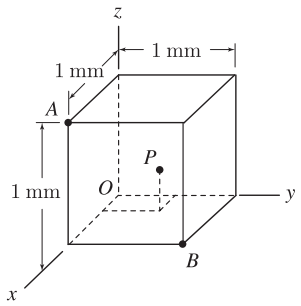
This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must be surrendered upon request of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Problem 2.81

A cube of material with 1 mm edge lengths is examined by a scanning electron microscope, and a small inclusion (i.e., a cavity) is found at point P. It is determined that the direction cosines for a vector from points A to P are $\cos\theta_x = -0.485$, and $\cos\theta_y = 0.485$, and $\cos\theta_z = -0.728$; and the direction cosines for a vector from points B to P are $\cos\theta_x = -0.667$, $\cos\theta_y = -0.667$, and $\cos\theta_z = 0.333$. Determine the coordinates of point P.



Solution

The distance between points A and P and points B and P is r_{AP} and r_{BP}, respectively. If $\vec{r}_{BA}$ is the position vector from point B to point A, given by

$$\vec{r}_{BA} = (-1\,\hat{\jmath} + 1\,\hat{k})\,\text{mm}, \tag{1}$$

then we may write

$$\vec{r}_{BA} + \vec{r}_{AP} = \vec{r}_{BP} \tag{2}$$

$$(-1\,\hat{\jmath} + 1\,\hat{k})\,\text{mm} + r_{AP}(-0.485\,\hat{\imath} + 0.485\,\hat{\jmath} - 0.728\,\hat{k}) = r_{BP}(-0.667\,\hat{\imath} - 0.667\,\hat{\jmath} + 0.333\,\hat{k}). \tag{3}$$

Equation (3) may be rewritten as

$$\begin{aligned}(-0.485\,r_{AP} + 0.667\,r_{BP})\,\hat{\imath} + (-1\,\text{mm} + 0.485\,r_{AP} + 0.667\,r_{BP})\,\hat{\jmath} \\ + (1\,\text{mm} - 0.728\,r_{AP} - 0.333\,r_{BP})\,\hat{k} = \vec{0}.\end{aligned} \tag{4}$$

For Eq. (4) to be satisfied, each term multiplying $\hat{\imath}$, $\hat{\jmath}$, and $\hat{k}$ must be zero. Furthermore, Eq. (4) contains only two unknowns, thus we use the equations corresponding to the $\hat{\imath}$ and $\hat{\jmath}$ terms to solve for r_{AP} and r_{BP} as follows

$$-0.485\,r_{AP} + 0.667\,r_{BP} = 0 \quad \Rightarrow \quad r_{AP} = 1.375\,r_{BP}, \tag{5}$$

$$-1\,\text{mm} + 0.485(1.375\,r_{BP}) + 0.667\,r_{BP} = 0 \quad \Rightarrow \quad r_{BP} = 0.7496\,\text{mm}. \tag{6}$$

Note that the above solutions for r_{AP} and r_{BP} also satisfy the equation corresponding to the $\hat{k}$ term.

To determine the coordinates of point P, we consider the vector $\vec{r}_{OP}$, which may be written as

$$\vec{r}_{OP} = \vec{r}_{OB} + \vec{r}_{BP}. \tag{7}$$

In Eq. (7), $\vec{r}_{OP} = x_P\,\hat{\imath} + y_P\,\hat{\jmath} + z_P\,\hat{k}$, the vector $\vec{r}_{BP}$ is known from the direction cosines given in the problem statement and Eq. (6), and $\vec{r}_{OB} = (1\,\hat{\imath} + 1\,\hat{\jmath})\,\text{mm}$. Thus, Eq. (7) becomes

$$x_P\,\hat{\imath} + y_P\,\hat{\jmath} + z_P\,\hat{k} = (1\,\hat{\imath} + 1\,\hat{\jmath})\,\text{mm} + (0.7496\,\text{mm})(-0.667\,\hat{\imath} - 0.667\,\hat{\jmath} + 0.333\,\hat{k})\,\text{mm} \tag{8}$$

$$= \left(0.500\,\hat{\imath} + 0.500\,\hat{\jmath} + 0.250\,\hat{k}\right). \tag{9}$$

Therefore, the coordinates of point P are

$$\boxed{(0.500, 0.500, 0.250)\,\text{mm}.} \tag{10}$$

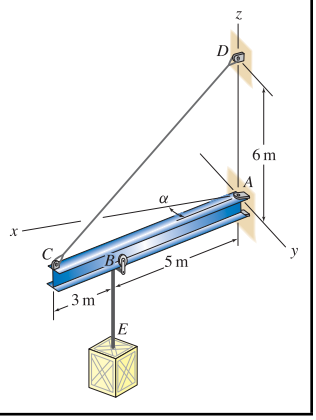
This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must be surrendered upon request of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Problem 2.97

A wall-mounted jib crane consists of an I beam that is supported by a pin at point A and a cable at point C, where A and C lie in the xy plane. A crate at E is supported by a cable that is attached to a trolley at point B where the trolley may move along the length of the I beam. The forces supported by cables CD and BE are 3 kN and 5 kN, respectively. For the value of angle α given below, determine expressions for the forces the two cables apply to the I beam. $\alpha = 40°$.



Solution

The coordinates of point D are (0, 0, 6) m, and with $\alpha = 40°$, the coordinates of point C are (8 m cos 40°, 8 m sin 40°, 0). Hence, the position vector from point C to point D is

$$\vec{r}_{CD} = (-6.128\,\hat{\imath} - 5.142\,\hat{\jmath} + 6\,\hat{k})\ \text{m}. \tag{1}$$

The force that cable CD applies to the I beam is

$$\vec{F}_{CD} = 3\,\text{kN}\,\frac{\vec{r}_{CD}}{r_{CD}} = 3\,\text{kN}\,\frac{-6.128\,\hat{\imath} - 5.142\,\hat{\jmath} + 6\,\hat{k}}{10.00} \tag{2}$$

$$= \boxed{(-1.839\,\hat{\imath} - 1.543\,\hat{\jmath} + 1.800\,\hat{k})\ \text{kN}.} \tag{3}$$

By inspection, the force that cable BE applies to the I beam is

$$\boxed{\vec{F}_{BE} = -5\,\text{kN}\,\hat{k}.} \tag{4}$$

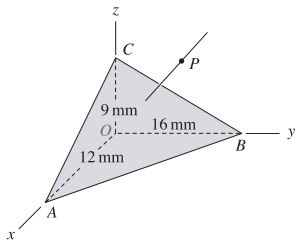
This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must be surrendered upon request of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

Download full file from answersun.com

Full file at https://answersun.com/download/solutions-manual-engineering-mechanics-statics-2nd-edition-by-plesha-gray-costanzo/

Problem 2.164

Determine the smallest distance between point O and the infinite plane containing points A, B, and C.



Solution

To determine the smallest distance between point O and the infinite plane containing points A, B, and C, we will use a position vector between any convenient point on the plane and point O, or vice versa. We will use $\vec{r}_{AO}$, although $\vec{r}_{BO}$ and $\vec{r}_{CO}$ are equally good choices. Thus,

$$\vec{r}_{AO} = -12\,\text{mm}\,\hat{\imath}. \tag{1}$$

The normal direction to the plane is needed, and will be determined by taking the cross product between two vectors that lie in the plane, and among the many possible choices, we will use

$$\vec{r}_{AB} = (-12\,\hat{\imath} + 16\,\hat{\jmath})\,\text{mm}, \quad \text{and} \quad \vec{r}_{AC} = (-12\,\hat{\imath} + 9\,\hat{k})\,\text{mm}. \tag{2}$$

The normal direction $\vec{n}$ to the plane is

$$\vec{n} = \vec{r}_{AB} \times \vec{r}_{AC} \tag{3}$$

$$= \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ -12 & 16 & 0 \\ -12 & 0 & 9 \end{vmatrix} \text{mm}^2 = \left\{[(16)(9) - 0]\,\hat{\imath} - [(-12)(9) - 0]\,\hat{\jmath} + [0 - (16)(-12)]\,\hat{k}\right\} \text{mm}^2 \tag{4}$$

$$= (144.0\,\hat{\imath} + 108.0\,\hat{\jmath} + 192.0\,\hat{k})\,\text{mm}^2, \tag{5}$$

$$n = \sqrt{(144.0)^2 + (108.8)^2 + (192.0)^2}\,\text{mm}^2 = 263.2\,\text{mm}^2. \tag{6}$$

The dot product of $\vec{r}_{AO}$ with the unit vector normal to the plane is the smallest distance between point O and the plane. Hence,

$$d = \vec{r}_{AO} \cdot \frac{\vec{n}}{n} = (-12\,\text{mm})\,\hat{\imath} \cdot \frac{(144.0\,\hat{\imath} + 108.0\,\hat{\jmath} + 192.0\,\hat{k})\,\text{mm}^2}{263.2\,\text{mm}^2} = -6.566\,\text{mm}. \tag{7}$$

The negative sign in Eq. (7) is irrelevant, thus smallest distance between point O and the plane is **6.57 mm.**

This solutions manual, in any print or electronic form, remains the property of McGraw-Hill, Inc. It may be used and/or possessed only by permission of McGraw-Hill, and must be surrendered upon request of McGraw-Hill. Any duplication or distribution, either in print or electronic form, without the permission of McGraw-Hill, is prohibited.

Download full file from answersun.com