NAME:_____ **SID #**_____

Question 1 :
A pressure transducer measures a value of 300-lb/in^2 (psi). Determine the value of the pressure in Pascal.
One Pascal (Pa) is 1-N/m^2.

Answer: 2.07 x 10^6-Pa or 2.07-MPa

Question 2 :
One horsepower is 550 - ft-lb/s. One watt is 1- N-m/s. Determine the number of watts generated by:
- a- The Wright brothers' 1903 airplane, which had a 12-horsepower engine.
- b- A modern airplane jet with a power of 100,000 horsepower at cruising speed.

Answers: 8,950-watts and 74.6 x 10^6-watts

Question 3 :
The acceleration due to gravity is 13.2-ft/s^2 on the surface of Mars and 32.2-ft/s^2 on the surface of the Earth. If a woman weighs 125-lb on Earth, what would she weigh on Mars ?

Answer: 51.2-lb

Question 4 :
A person weighs 180-lb at sea level. The radius of the Earth is 3,960-miles. What force is exerted on the person by the gravitational attraction of the Earth if he is in a space station in near-orbit 200-miles above the surface of the Earth ?

Answer : 163-lb

Question 5 :
The mass of one cubic meter of water is 1,000-kg. The acceleration due to gravity at sea level is g = 9.81-m/s^2.
The weight of one cubic foot of water at sea level is approximately 62.4-lb. One inch is 25.4-mm.
By using these data determine how many Newton (N) is equal to one pound. ***Do not use conversion table.***

Answer: 4.448 N = 1 lb.

Question 6 :
The acceleration due to gravity at sea level in SI units is g = 9.81-m/s^2 . By converting units, determine the acceleration due to gravity at sea level in U.S. customary units.

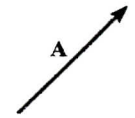
Answer: g = 32.2-ft/s^2

Question 7 :
The "Crawler" developed to transport the Saturn V launch vehicle from the assembly building to the launch pad is the largest land vehicle ever built, weighing 4.9 x 10^6-lbs at sea level.
- a- What is its mass in slugs ?
- b- What is its mass in kilograms ?

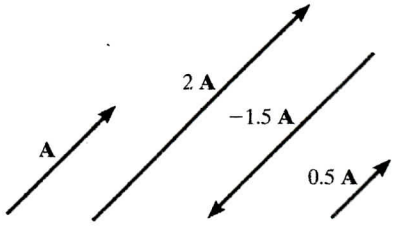
Answers : 0.152 x 10^6-slug and 2.22 x 10^6-kg

A scalar is a positive or negative number; e.g., mass and temperature.

A vector has a magnitude and an arrowhead sense of direction; e.g., force and position.



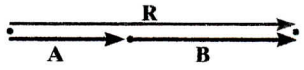
Multiplication or division of a vector by a scalar will change only the magnitude of the vector. If the scalar is negative the sense of the vector will change, so that it acts in the opposite direction.



If vectors are collinear, the resultant is formed by an algebraic or scalar addition.

$$\mathbf{R} = \mathbf{A} + \mathbf{B}$$

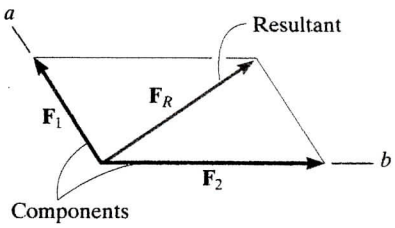
$$R = A + B$$



Parallelogram Law

Two forces add according to the parallelogram law. The *components* form the sides of the parallelogram and the *resultant* is the diagonal.

$$\mathbf{F}_R = \mathbf{F}_1 + \mathbf{F}_2$$

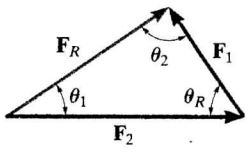


To find the components of a force along any two axes, extend lines from the head of the force, parallel to the axes, to form the components.

To obtain the components or the resultant, show how the forces add by a tip-to-tail addition using the triangle rule, and then use the law of sines and the law of cosines to calculate their values.

$$F_R = \sqrt{F_1^2 + F_2^2 - 2F_1F_2\cos\theta_R}$$

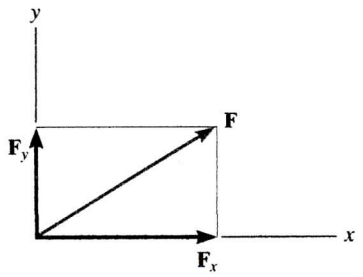
$$\frac{F_1}{\sin\theta_1} = \frac{F_2}{\sin\theta_2} = \frac{F_R}{\sin\theta_R}$$



Rectangular Components: Two Dimensions

Vectors $\mathbf{F}_x$ and $\mathbf{F}_y$ are rectangular components of $\mathbf{F}$.

$$\mathbf{F} = F_x\mathbf{i} + F_y\mathbf{j}$$



The resultant force is determined from the algebraic sum of its components.

$$\mathbf{F}_R = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3$$

$$F_{Rx} = \Sigma F_x$$
$$F_{Ry} = \Sigma F_y$$

$$F_R = \sqrt{(F_{Rx})^2 + (F_{Ry})^2},\ \theta = \tan^{-1}\left|\frac{F_{Ry}}{F_{Rx}}\right|$$

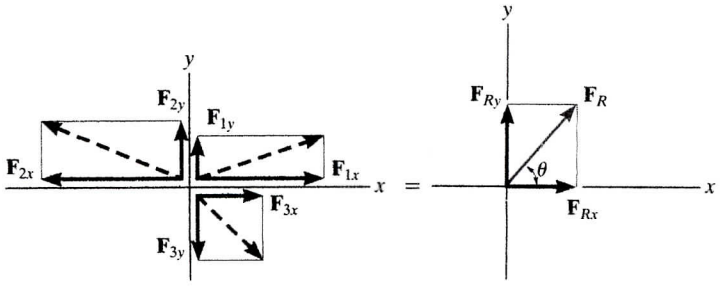


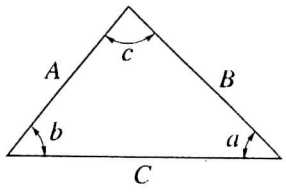
Table A-1 Principal Units Used in Mechanics

Quantity	International System (SI)			U.S. Customary System (USCS)		
	Unit	Symbol	Formula	Unit	Symbol	Formula
Acceleration (angular)	radian per second squared		rad/s^2	radian per second squared		rad/s^2
Acceleration (linear)	meter per second squared		m/s^2	foot per second squared		ft/s^2
Area	square meter		m^2	square foot		ft^2
Density (mass) (Specific mass)	kilogram per cubic meter		kg/m^3	slug per cubic foot		$slug/ft^3$
Density (weight) (Specific weight)	newton per cubic meter		N/m^3	pound per cubic foot	pcf	lb/ft^3
Energy; work	joule	J	N · m	foot-pound		ft-lb
Force	newton	N	$kg \cdot m/s^2$	pound	lb	(base unit)
Force per unit length (Intensity of force)	newton per meter		N/m	pound per foot		lb/ft
Frequency	hertz	Hz	s^{-1}	hertz	Hz	s^{-1}
Length	meter	m	(base unit)	foot	ft	(base unit)
Mass	kilogram	kg	(base unit)	slug		$lb\text{-}s^2/ft$
Moment of a force; torque	newton meter		N·m	pound-foot		lb-ft
Moment of inertia (area)	meter to fourth power		m^4	inch to fourth power		$in.^4$
Moment of inertia (mass)	kilogram meter squared		$kg \cdot m^2$	slug foot squared		$slug\text{-}ft^2$
Power	watt	W	J/s (N·m/s)	foot-pound per second		ft-lb/s
Pressure	pascal	Pa	N/m^2	pound per square foot	psf	lb/ft^2
Section modulus	meter to third power		m^3	inch to third power		$in.^3$
Stress	pascal	Pa	N/m^2	pound per square inch	psi	$lb/in.^2$
Time	second	s	(base unit)	second	s	(base unit)
Velocity (angular)	radian per second		rad/s	radian per second		rad/s
Velocity (linear)	meter per second		m/s	foot per second	fps	ft/s
Volume (liquids)	liter	L	$10^{-3}\ m^3$	gallon	gal.	$231\ in.^3$
Volume (solids)	cubic meter		m^3	cubic foot	cf	ft^3

Notes: 1 joule (J) = 1 newton meter (N·m) = 1 watt second (W·s)
1 hertz (Hz) = 1 cycle per second (cps) or 1 revolution per second (rev/s)
1 watt (W) = 1 joule per second (J/s) = 1 newton meter per second (N·m/s)
1 pascal (Pa) = 1 newton per meter squared (N/m^2)
1 liter (L) = 0.001 cubic meter (m^3) = 1000 cubic centimeters (cm^3)

Table A-3 SI Prefixes

Prefix	Symbol	Multiplication factor
tera	T	$10^{12} = 1\ 000\ 000\ 000\ 000$
giga	G	$10^{9} = 1\ 000\ 000\ 000$
mega	M	$10^{6} = 1\ 000\ 000$
kilo	k	$10^{3} = 1\ 000$
hecto	h	$10^{2} = 100$
deka	da	$10^{1} = 10$
deci	d	$10^{-1} = 0.1$
centi	c	$10^{-2} = 0.01$
milli	m	$10^{-3} = 0.001$
micro	μ	$10^{-6} = 0.000\ 001$
nano	n	$10^{-9} = 0.000\ 000\ 001$
pico	p	$10^{-12} = 0.000\ 000\ 000\ 001$



Sine law:

$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}$$

Cosine law:

$$C = \sqrt{A^2 + B^2 - 2AB\cos c}$$

STEPS TO SUCCESSFUL PROBLEM SOLVING.

A- Formulate the Problem:

1- Read the question carefully.
2- Identify the data (information).
3- Identify the desired outcome (result).
4- Generate ideas for solution (procedure, concept & method to be used).

B- Develop the Solution:

1- Select the procedure that fits the desired outcome (plan).
2- Draw sketches, free-body- diagrams, etc. and tabulate the information.
3- Apply principles and equations; make calculations (carry out the plan).

C- Evaluate the Results.

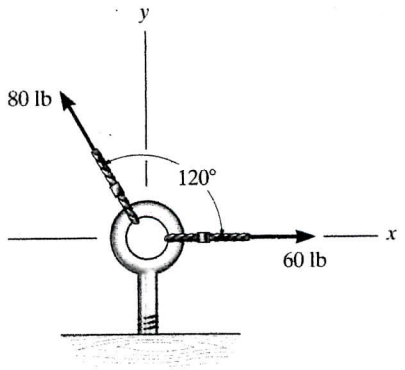
1- Check accuracy of your calculation to be consistent with accuracy of the data (significant digit).
2- Use appropriate units throughout.
3- Check the result to be reasonable and within the acceptable range.

D- Finalize the Solution / Presentation.

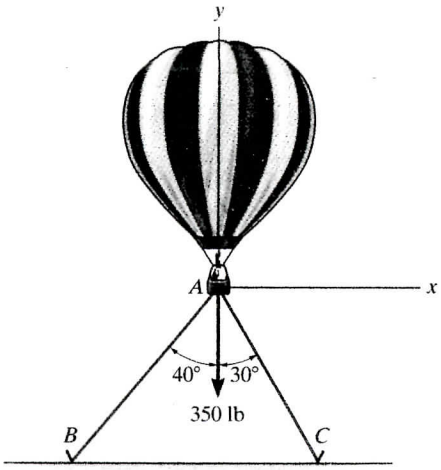
1- Write the solution in neat and orderly format that is easy to follow.
2- Underline the answers or place them in a box with appropriate unit.
3- Use 8 ½" x 11" papers and write only on one side of the papers.
4- Present the result in a package with appropriate cover sheet containing Name, Date, Course No., Assignment No., etc.

Use Parallelogram of the Forces and Trigonometry (Sines and Cosines Rules)

Question 1 :
Determine the magnitude of the resultant force acting on the pin and its direction measured counterclockwise from positive x-axis.

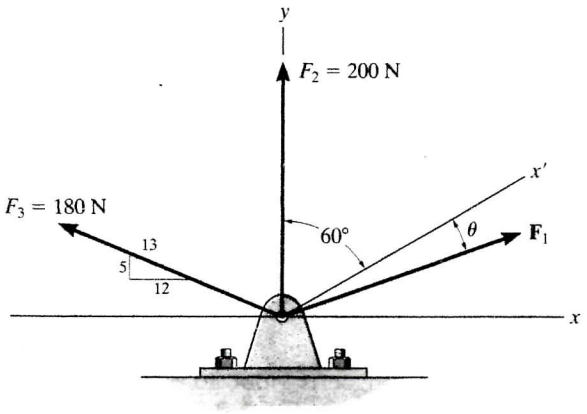


Question 2 :
A resultant vertical force of 350-lb is necessary to hold the balloon in place. Resolve this force into components along the tether lines AB and AC, and compute the magnitude of each component.



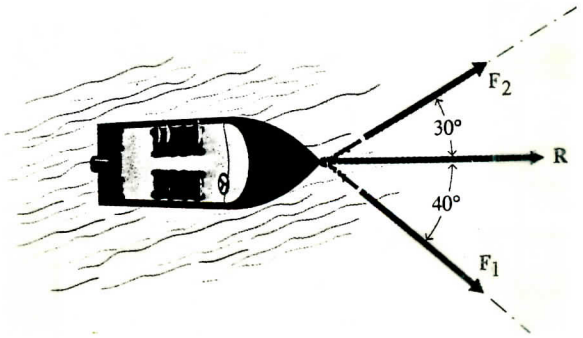
Use Force Components

Question 3 :
Three forces act on the bracket shown. Determine the magnitude and direction θ of force $\mathbf{F}_1$ so that the resultant force is directed along the positive x' axis and has a magnitude of 800-N.



Question 1:
Two ropes are used to tow a boat. The resultant **R** of the rope forces has a magnitude of 1,500-N, and its line of action is along the axis of the boat (horizontal). Determine the magnitudes of the rope forces $\mathbf{F}_1$ and $\mathbf{F}_2$ by constructing the parallelogram of the forces and using laws of sines and cosines.

Answer: $|\mathbf{F}_1| = 798\text{-N}$ $|\mathbf{F}_2| = 1{,}026\text{-N}$



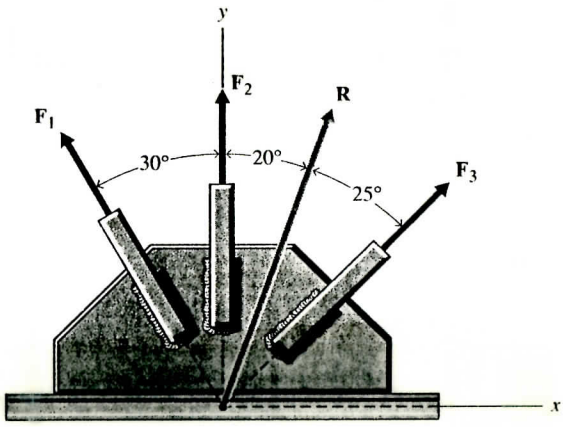
Question 2:
Three forces $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ are applied to a bracket as shown. The magnitude of the resultant **R** of three forces is 5,000-lb. If magnitude of the force $\mathbf{F}_3$ is 3,000-lb :

a- Find the magnitudes of the forces $\mathbf{F}_1$ and $\mathbf{F}_2$.

b- What would be the magnitude and the direction of a fourth force applied to the bracket such as the resultant **R** become vertical ?

Answers: $F_1 = 822\text{-lb}$, $F_2 = 1{,}867\text{-lb}$

$\mathbf{F}_4 = -1{,}700\,\mathbf{i}$ lb or $\mathbf{F}_4 = -1{,}700\,\mathbf{i} + 300\,\mathbf{j}$ lb



Question 3:
A particle is subjected to the four forces shown. Determine the magnitudes of the forces $\mathbf{F}_1$ and $\mathbf{F}_2$ such as the resultant of the four forces :

a- is equal to zero.

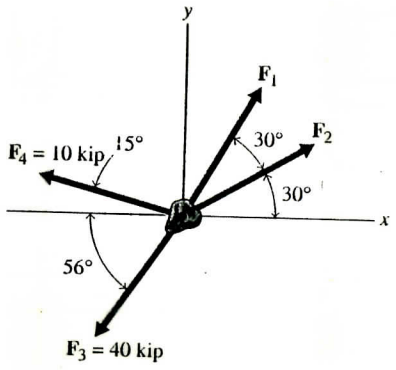
b- is horizontal with magnitude of 12-kips. (1-kip = 1,000-lb)

c- is vertical with magnitude of 18-kips.

Answers: a- $F_1 = 20.9\text{-kip}$, $F_2 = 24.9\text{-kip}$

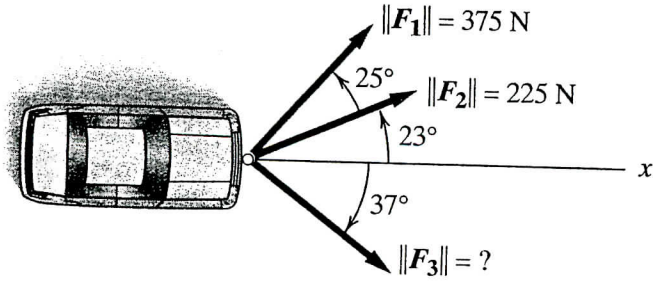
b- $F_1 = 8.9\text{-kip}$, $F_2 = 45.8\text{-kip}$

c- $F_1 = 52.1\text{-kip}$, $F_2 = 7.00\text{-kip}$



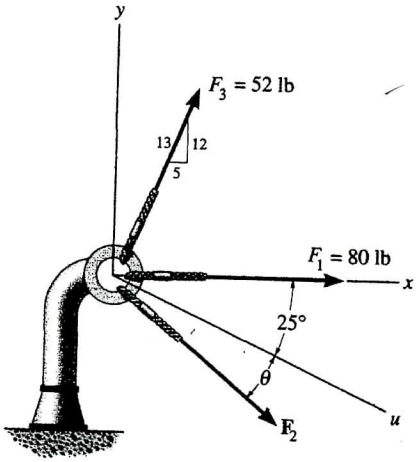
NAME:_____ **SID #**_____

Question 1: (20 Points)
Three ropes attached to a stalled car apply the forces shown. Express each force in Cartesian Vector form and determine the magnitudes of the force $\mathbf{F}_3$ and the resultant force **R** if the line of action of the resultant is along the x-axis.

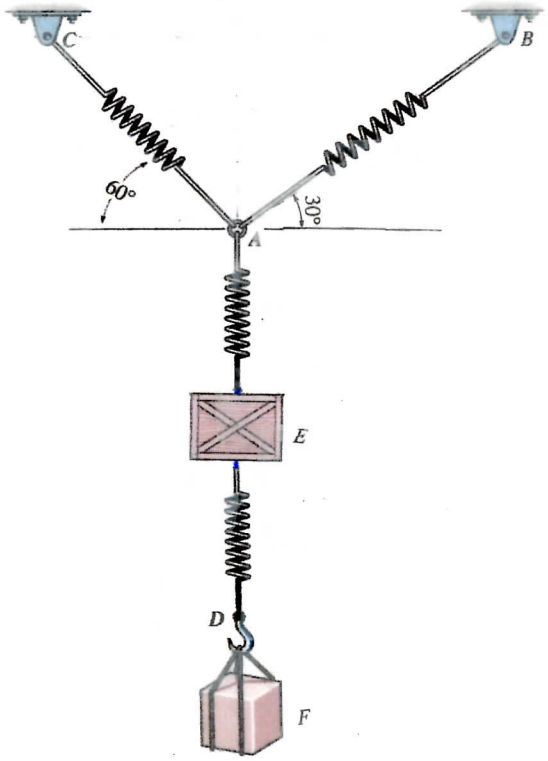


NAME:_____ **SID #**_____

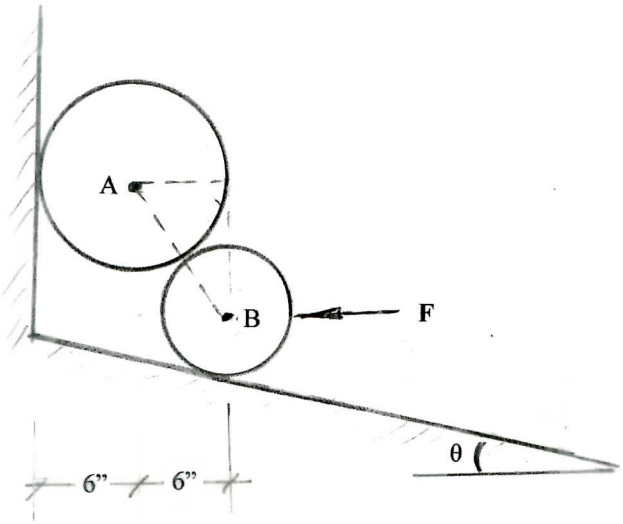
Question 1: (20 Points)
Three forces are applied to a bracket as shown. If the resultant **R** of these three forces is directed along the positive **u** axis, for $\Theta = 15°$ determine the magnitudes of the force $\mathbf{F}_2$ and the resultant **R.**



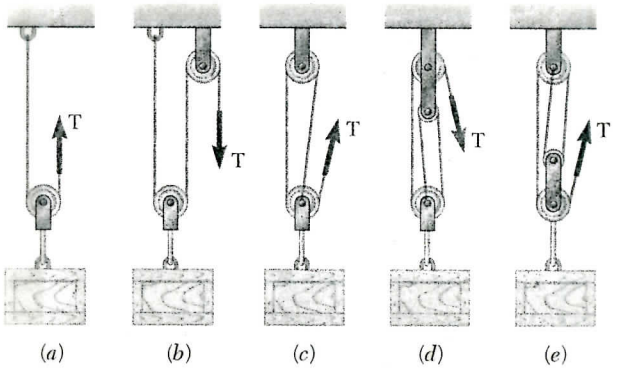
Question 1:
Two crates are held in equilibrium position with the spring system as shown. Given the weight of crates as $W_E = 200$-lb and $W_F = 100$-lb, determine the tension force in each spring.



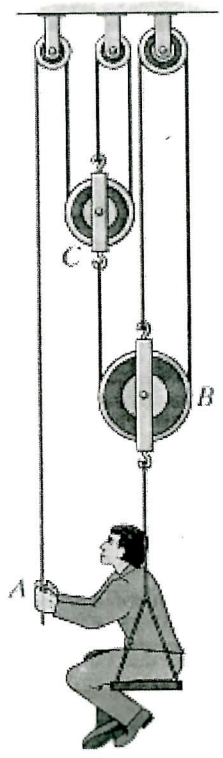
Question 2 :
A 12-in diameter pipe A with the weight of 80-lbs, and an 8-in diameter pipe B with the weight of 60-lbs are held in place with a horizontal force **F**. Find magnitude of the force **F** required to keep the pipes in equilibrium when $\theta = 30^\circ$. Assume smooth contacts.



Question 3:
A crate with the weight of 300-lb is held in equilibrium by several rope and pulley arrangements as shown. Determine for each arrangement the tension T in the rope.

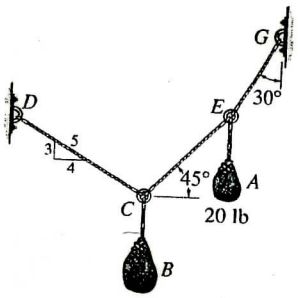


Question 4:
The man of weight W_1 = 150-lb attempts to lift himself and the seat of weight W_2 = 10-lb using the rope pulley system shown. Determine the tension force at A needed to do so, and also find his reaction on the seat.



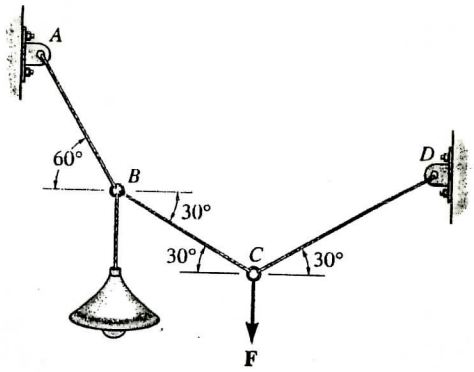
Question 1 :
If the sack A has a weight of 20-lb, determine the weight of sack B and the force in each cord to hold the system in the equilibrium position shown.

Answers:
$T_{CD} = 34.2$-lb
$T_{CE} = 38.6$-lb
$T_{EG} = 54.6$-lb
$W_B = 48.0$-lb



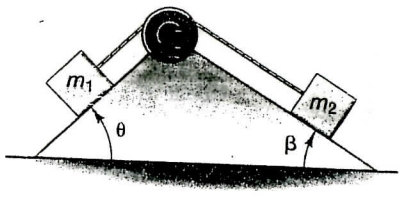
Question 2 :
If the lamp has a mass of 4-kg, determine the force in each cord and the force **F** needed to hold the system in equilibrium position shown.

Answers:
$T_{BA} = 67.9$-N
$T_{BC} = 39.2$-N
$T_{CD} = 39.2$-N
$F = 39.2$-N



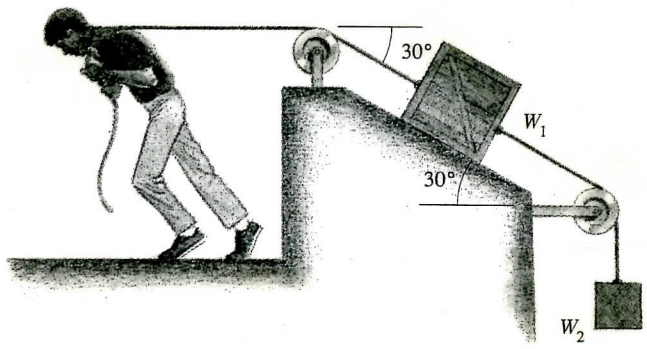
Question 3 :
A pulley and two blocks are held in place as shown. If m_1 =200-kg, m_2 =300-kg, and $\theta = 40^\circ$, determine the required angle β such as the system remains in equilibrium. The pulley and surfaces are frictionless. $g = 9.81$ m/s^2

Answer:
$\beta = 25.4°$



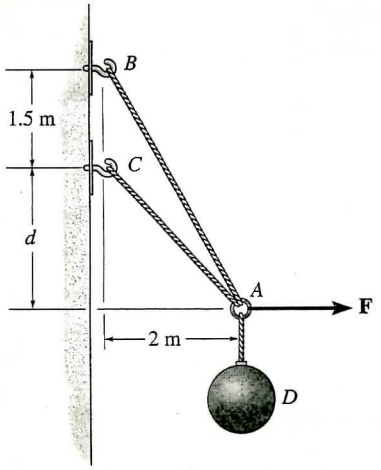
Question 4 :
The weight of the two blocks are W_1 = 200-lb and W_2 = 50-lb.
What force must the man exert on the rope to hold the blocks in place ?
Surface is frictionless.

Answer : T = 150-lb



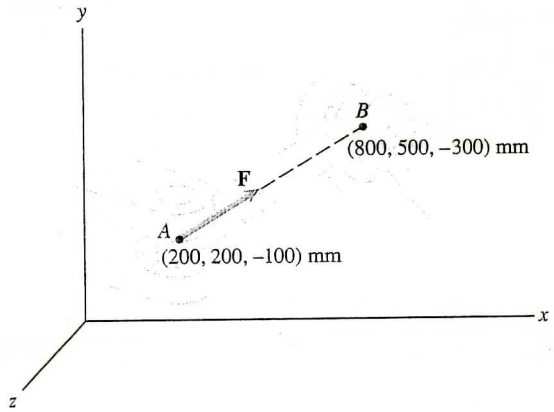
Question 5 :
The ball D has a mass of 20-kg and cable **CAB** passes through ring A.
For d = 1.0-m, find horizontal force **F** required to hold the ball in position shown.

Answer : F = 243-N



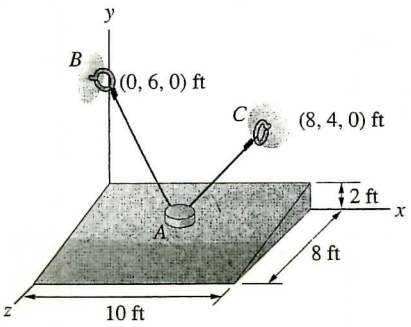
Question 6 :
The force **F** has a magnitude of 140-N.
a- Express force **F** in vector form.
b- Determine the direction cosines of this force with respect to x, y and z axes.

Answers:
$\mathbf{F} = 120\,\mathbf{i} + 60\,\mathbf{j} - 40\,\mathbf{k}$ (N)
$\cos\theta_x = 6/7 \quad \theta_x = 31.0°$
$\cos\theta_y = 3/7 \quad \theta_y = 64.6°$
$\cos\theta_z = -2/7 \quad \theta_z = 106.6°$

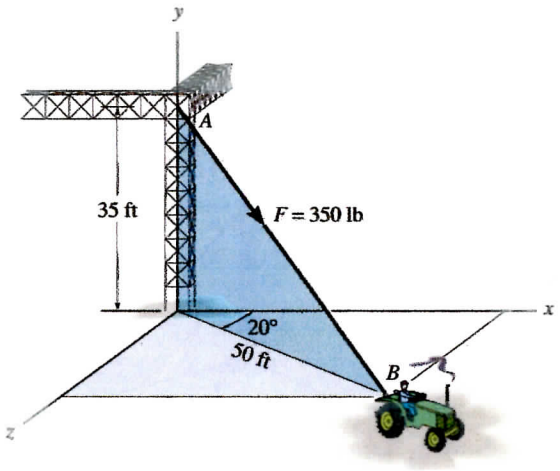


Question 7 :
A metal disk weighs 10-lb. It is held in place at the center of an inclined frictionless surface by the strings AB and AC.
What are the tensions in the strings ?

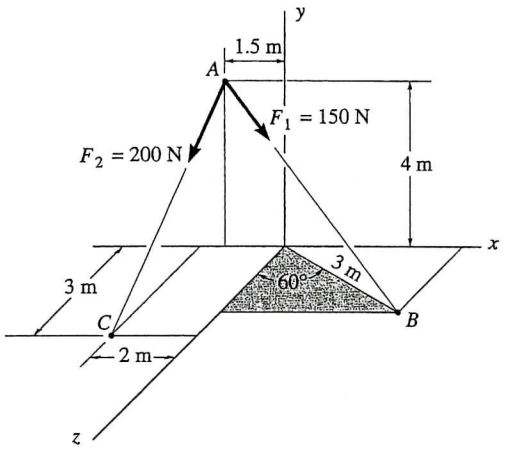
Answers:
T_{AB} = 1.54-lb
T_{AC} = 1.85-lb



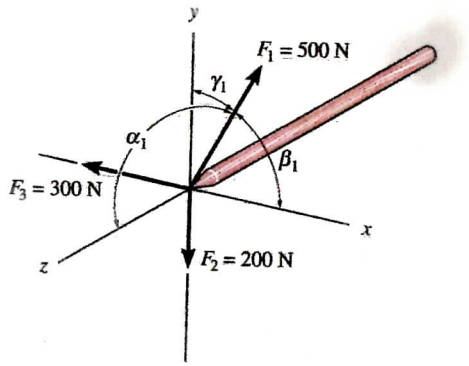
Question 1:
The cable attached to the tractor at B exerts a force of 350-lb on the frame. Express this force as a Cartesian vector, and determine its direction angles.



Question 2:
Determine the magnitude and the direction angles of the resultant force acting at point A.



Question 3:
The mast is subjected to three forces shown. Determine the magnitude and the direction angle of force $\mathbf{F}_1$ so that the resultant force acting on the mass is zero.



Question 4:
Determine the tension in cables AB, AC, and AD required to hold the crate of weight W = 60-lb in equilibrium.