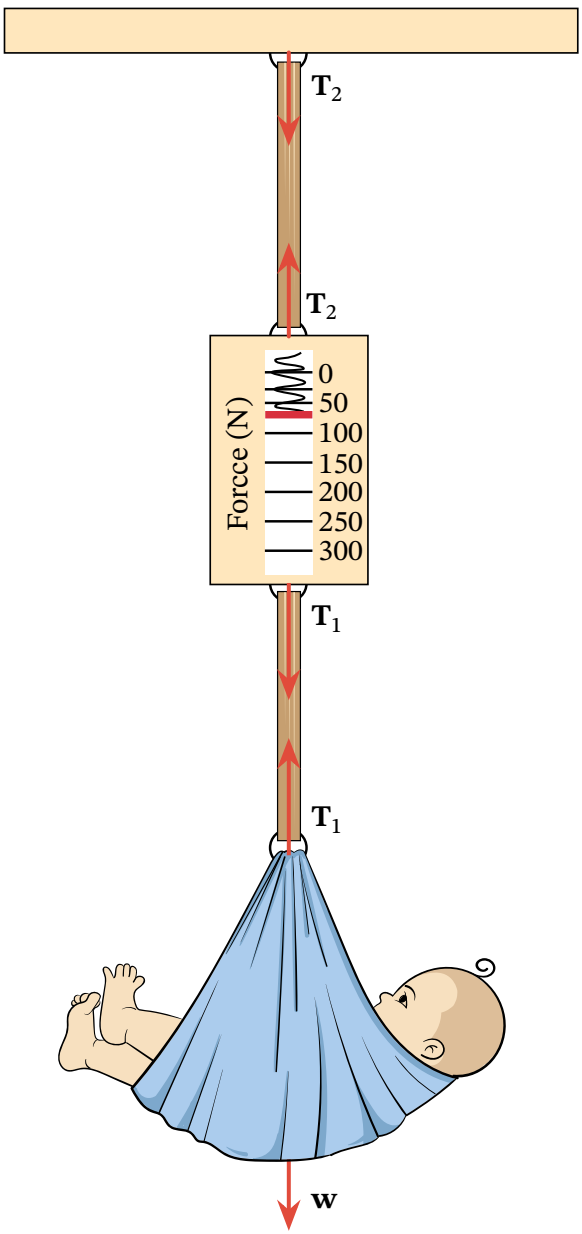
Worksheet: Tension

In this worksheet, we will practice calculating resultant forces in systems involving strings, ropes, and wires under tension.

Q1: Consider the baby being weighed in the shown figure.

Question Video



What is the mass of the infant and basket if a scale reading of 55 N is observed?

A 5.6 kg

B 6.6 kg

C 6.3 kg

D 5.8 kg

E 6.1 kg

What is tension $\mathbf{T}_1$ in the cord attaching the baby to the scale?

A 55 N

B 64 N

C 60 N

D 53 N

E 58 N

What is tension $\mathbf{T}_2$ in the cord attaching the scale to the ceiling, if the scale has a mass of 0.500 kg?

A 60 N

B 74 N

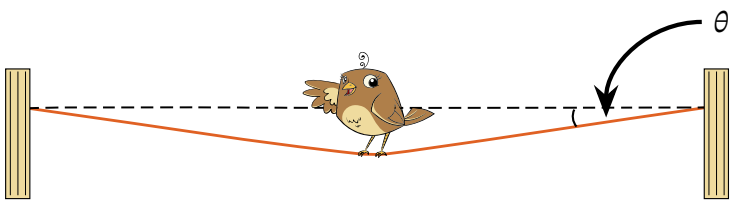
C 70 N

D 55 N

E 64 N

Q2: A bird has a mass of 26 g and perches in the middle of a stretched telephone line. Assume that each half of the line is straight.

Question Video



Determine the tension in each half of the string when $\theta = 5.0°$.

A 2.0 N

B 1.2 N

C 1.5 N

D 1.7 N

E 1.4 N

- Determine the tension in each half of the string when $\theta = 0.50°$.

A 17 N

B 9.7 N

C 15 N

D 13 N

E 11 N

Q3: Two teams of nine members each engage in tug-of-war. The members of one team have an average mass of 68 kg and exert an average horizontal force of 1 350 N. The members of the other team have an average mass of 73 kg and exert an average horizontal force of 1 365 N.

- What is magnitude of the acceleration of the two teams?

A $0.14\ m/s^2$

B $0.089\ m/s^2$

C $0.11\ m/s^2$

D $0.16\ m/s^2$

E $0.19\ m/s^2$

What is the tension in the section of rope between the teams?

A 1.1×10^4 N

B 1.0×10^4 N

C 1.2×10^4 N

D 1.3×10^4 N

E 1.5×10^4 N

Q4: An elevator filled with passengers has a mass of 1.70×10^3 kg. Initially, the elevator accelerates vertically upward at 1.20 m/s^2 for 1.50 s. After accelerating, the elevator moves with constant velocity for 8.50 s, and then decelerates at 0.600 m/s^2 for 3.00 s.

What is the magnitude of the tension in the cable holding the elevator during the elevator's initial acceleration?

A 2.19×10^4 N

B 2.05×10^4 N

C 1.78×10^4 N

D 1.66×10^4 N

E 1.87×10^4 N

What is the magnitude of the tension in the cable holding the elevator while the elevator is moving at constant velocity?

A 2.11×10^4 N

B 1.98×10^4 N

C 1.83×10^4 N

D 1.48×10^4 N

E 1.67×10^4 N

What is the magnitude of the tension in the cable holding the elevator during the elevator's deceleration?

A 1.46×10^4 N

B 1.38×10^4 N

C 1.28×10^4 N

D 1.19×10^4 N

E 1.56×10^4 N

What is the vertical upward displacement of the elevator from the point where its acceleration began to the point where its deceleration finished?

A 20.4 m

B 19.8 m

C 19.1 m

D 18.7 m

E 19.4 m

What is the elevator's final velocity?

A −1.00 m/s

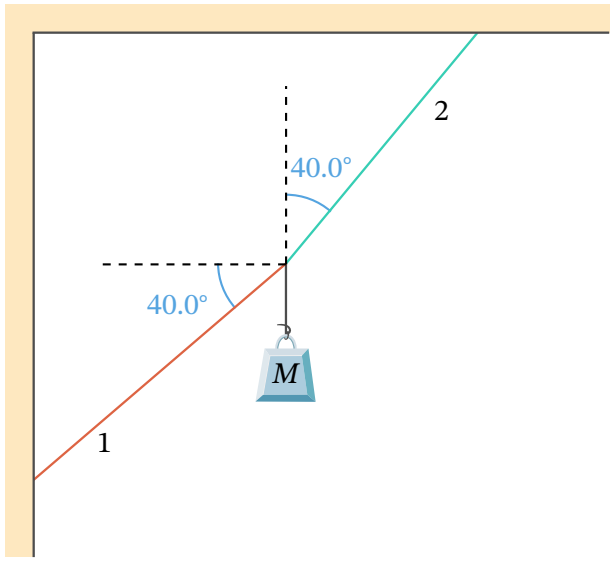
B −0.870 m/s

C 0.957 m/s

D 1.06 m/s

E 0.00 m/s

Q5: As shown in the figure, if $M = 5.50$ kg what is the tension in string 1?



A 189 N

B 200 N

C 183 N

D 177 N

E 194 N

Q6: A ball of mass 11.5 g hangs from the roof of a freight car by a string. While the freight car accelerates, the string makes an angle of 22.7° with the vertical.

What is the magnitude of the acceleration of the freight car?

A $4.10\ m/s^2$

B $23.4\ m/s^2$

C $15.8\ m/s^2$

D $31.6\ m/s^2$

E $9.80\ m/s^2$

What is the magnitude of the tension in the string?

A 0.122 N

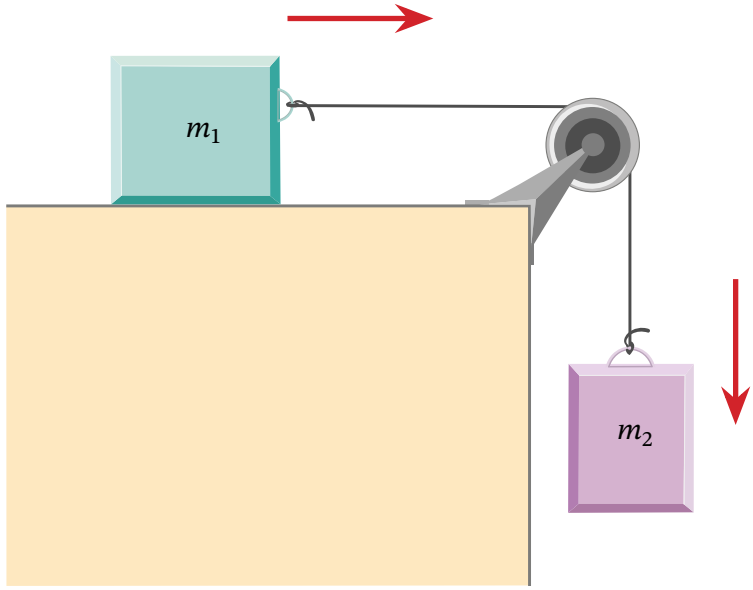
B 0.305 N

C 0.266 N

D 0.341 N

E 0.111 N

Q7: Two blocks are connected across a pulley by a rope as shown. The mass m_1 of the block on the table is 4.0 kg and the mass m_2 of the hanging block is 1.0 kg. The mass of the rope is negligible. The table and the pulley are both frictionless.



Find the acceleration of the system.

A 2.2 m/s^2

B 2.6 m/s^2

C 2.8 m/s^2

D 3.0 m/s^2

E 2.0 m/s^2

Find the tension in the rope.

A 6.3 N

B 6.6 N

C 7.1 N

D 7.5 N

E 7.8 N

Find the speed of the hanging block when it hits the floor. Assume that the hanging block is initially at rest and located 1.0 m vertically above the floor.

A 1.1 m/s

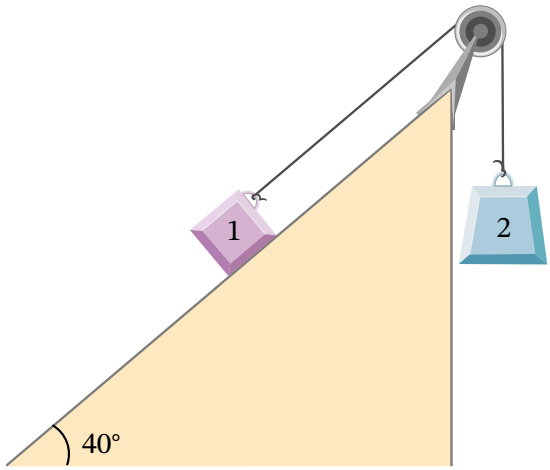
B 1.7 m/s

C 2.3 m/s

D 2.9 m/s

E 2.0 m/s

Q8: A 2.00 kg block (mass 1) and a 4.00 kg block (mass 2) are connected by a light string as shown; the inclination of the ramp is 40.0°. Friction is negligible.



What is the magnitude of the acceleration of each block (these magnitudes are equal to each other).

A $0.977\ m/s^2$

B $0.839\ m/s^2$

C $0.933\ m/s^2$

D $0.780\ m/s^2$

E $1.04\ m/s^2$

What is the magnitude of the tension in the string?

A 23.1 N

B 22.8 N

C 21.5 N

D 22.1 N

E 23.6 N

Q9: One end of a 24.5-m-long rope is tied to a tree, while the other end is tied to a car stuck in mud. The motorist pulls on the midpoint of the rope, displacing the rope by 2.0 m perpendicularly to its length. If he exerts a force of 92 N, determine the force exerted on the car.

A 140 N

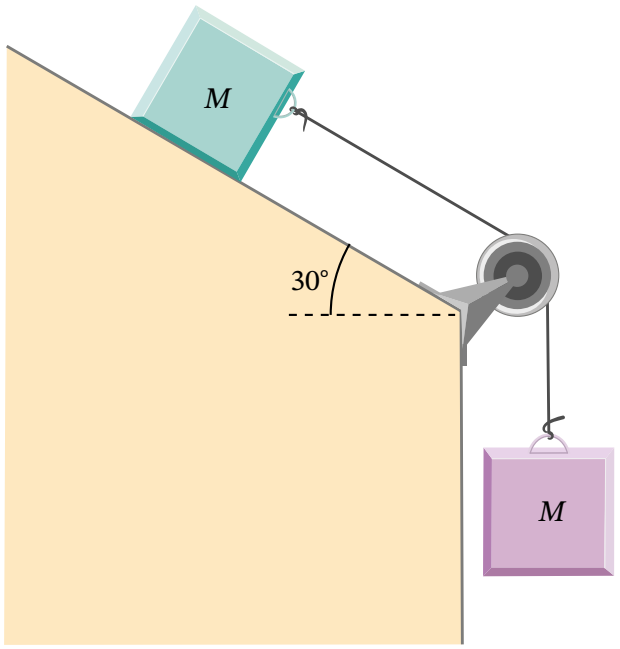
B 560 N

C 720 N

D 280 N

E 850 N

Q10: An object with mass $M = 6.0$ kg is connected to another object of the same mass, as shown. What is the tension in the string connecting the objects? Assume the pulley and surface of the slope are frictionless.



A 15 N

B 17 N

C 14 N

D 12 N

E 19 N

Q11: A 0.0502-kg pair of fuzzy dice is attached to the rearview mirror of a car by a short string. The car accelerates at constant rate, and the dice hang at an angle of 3.20° from the vertical because of the car's acceleration. What is the magnitude of the acceleration of the car?

A $0.548\ m/s^2$

B $0.540\ m/s^2$

C $0.560\ m/s^2$

D $0.553\ m/s^2$

E $0.565\ m/s^2$

Q12: A 30.0-kg-mass girl on a swing is held at rest by a horizontally acting force **F**. The swing's two ropes are at an angle of 30.0° with respect to the vertical.

- Calculate the magnitude of the tension in both of the ropes supporting the swing.

A 88.6 N

B 257 N

C 285 N

D 170 N

E 170 N

- Calculate the magnitude of **F**

A 200 N

B 161 N

C 144 N

D 170 N

E 183 N

Q13: A 62.2-kg gymnast climbs a rope.

- The gymnast climbs the rope at a constant speed. What tension is produced in the rope?

A 7.10×10^2 N

B 0 N

C 9.10×10^2 N

D 6.10×10^2 N

E 8.10×10^2 N

The gymnast accelerates while climbing at a rate of 0.36 m/s^2. What tension is produced in the rope?

A 609 N

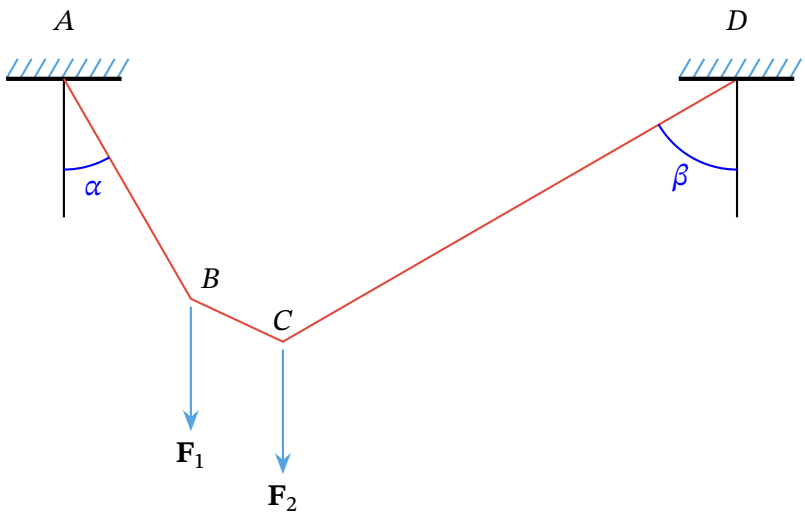
B 587 N

C 851 N

D 632 N

E 445 N

Q14: A wire is suspended from a ceiling at the point A and the point D. The wire bears the two loads $\mathbf{F}_1 = 20.0$ kN and $\mathbf{F}_2 = 25.0$ kN at the points B and C respectively. The counterclockwise angle α made by the wire from the vertical at point A is 30.0° and the clockwise angle β made by the wire from the vertical at point D is 60.0°. Calculate the tension in the wire segment CD.



A 475 kN

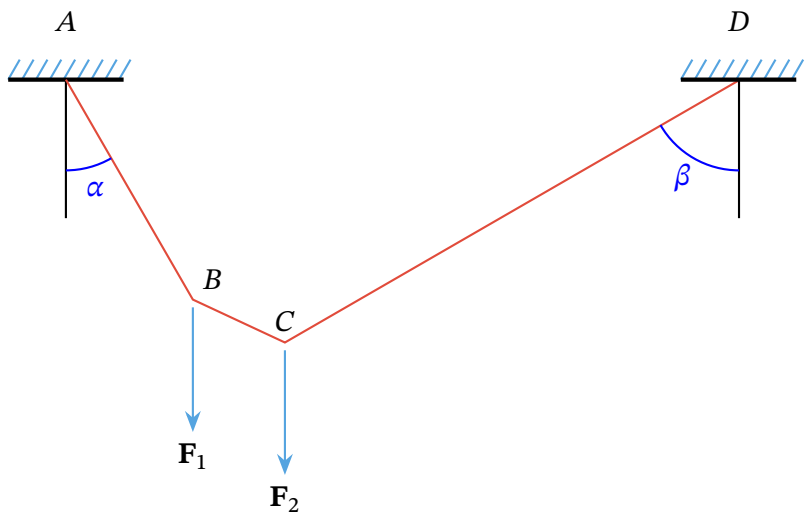
B 238 kN

C 225 kN

D 190 kN

E 390 kN

Q15: A wire is suspended from a ceiling at the point A and the point D. The wire bears the two loads $\mathbf{F}_1 = 20.0$ kN and $\mathbf{F}_2 = 25.0$ kN at the points B and C respectively. The counterclockwise angle α made by the wire from the vertical at point A is 30.0° and the clockwise angle β made by the wire from the vertical at point D is 60.0°. Calculate the tension in the wire segment BC.



A 475 kN

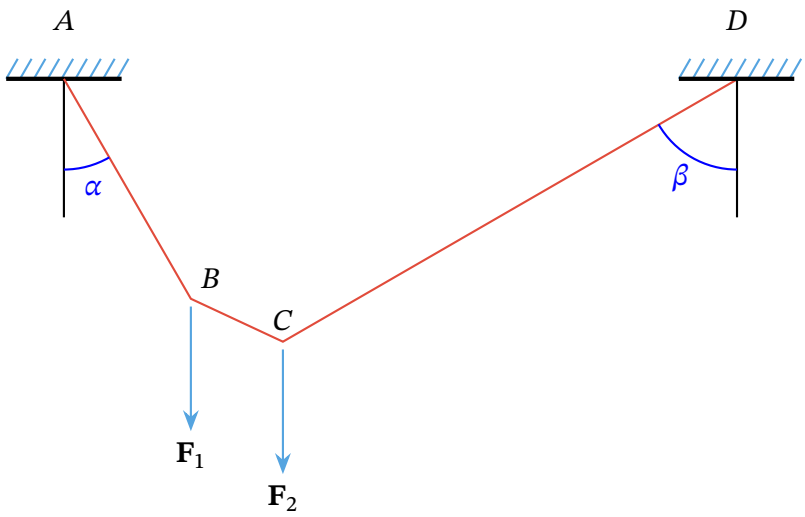
B 390 kN

C 238 kN

D 190 kN

E 225 kN

Q16: A wire is suspended from a ceiling at the point A and the point D. The wire bears the two loads $\mathbf{F}_1 = 20.0$ kN and $\mathbf{F}_2 = 25.0$ kN at the points B and C respectively. The counterclockwise angle α made by the wire from the vertical at point A is 30.0° and the clockwise angle β made by the wire from the vertical at point D is 60.0°. Calculate the tension in the wire segment AB.



A 190 kN

B 225 kN

C 475 kN

D 390 kN

E 427 kN

Q17: The coefficient of static friction between a belt and a circular pulley is 0.57. The contact length between the belt and the pulley subtends an angle of 120 degrees. What is the ratio of belt tensions on the tight side (the side that pulls) to the loose side of the pulley that can be accommodated without the belt slipping?

A 3.3

B 4.4

C 0.57

D 2.6

E 1.5

Q18: A rod is used to carry a tensile load of 44.48 kN. The ultimate tensile stress of the material used in the rod is 1.0 GPa. What should be the minimum diameter of the rod to safely carry the load?

A 20 mm

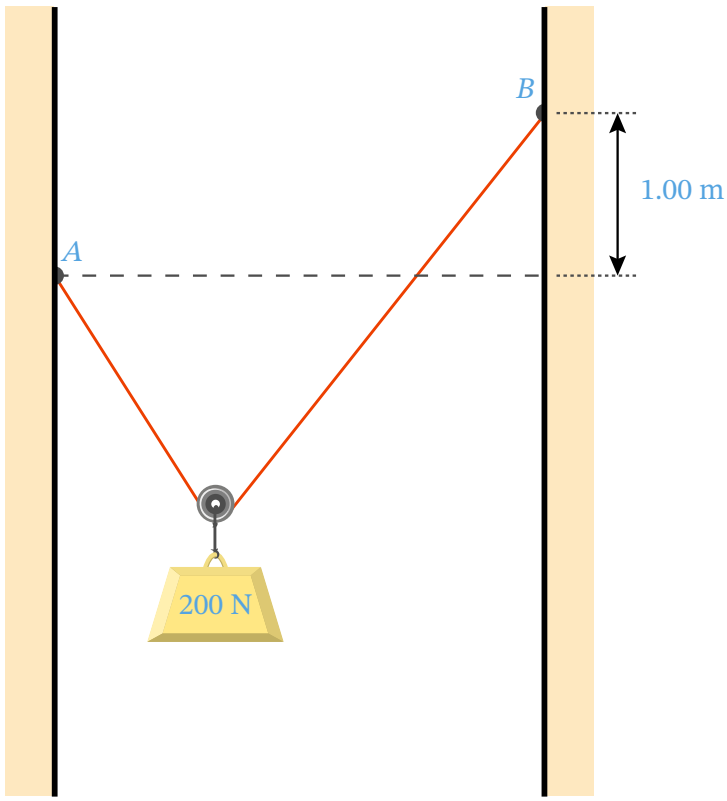
B 50 mm

C 25 mm

D 2.0 mm

E 7.5 mm

Q19: A rope with a length of 5.00 m runs from point A to point B, as shown in the accompanying diagram. The horizontal distance between the walls is 3.00 m, and so the rope sags. Point B is 1.00 m vertically above Point A. Between the points A and B along the rope, a frictionless pulley suspends a load that has a weight of 0.200 kN. Calculate the tension in the rope when the system is at equilibrium.



A 75.0 N

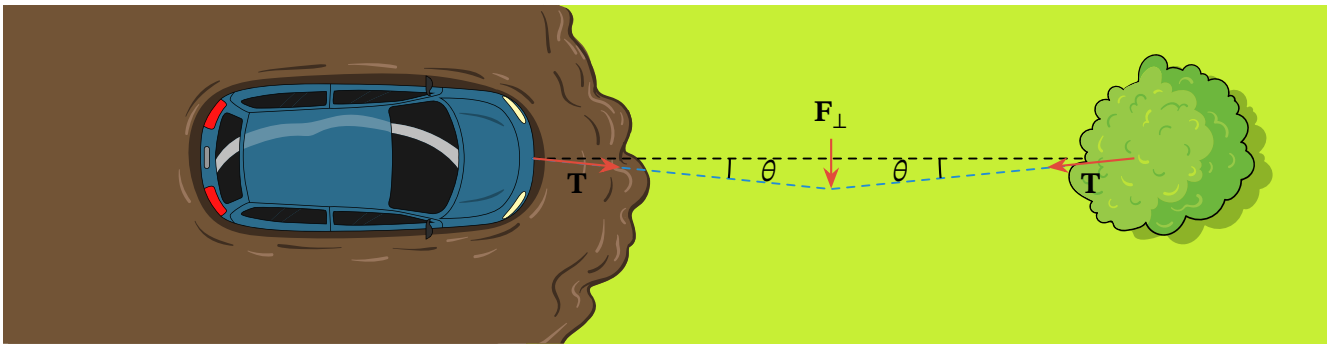
B 175 N

C 50.0 N

D 250 N

E 125 N

Q20: Suppose your car was mired deeply in themud and you wanted to use the method illustrated in the figure to pull it out.



What force would you have to exert perpendicular to the center of the rope to produce a force of 14,000 N on the car if the angle is 3.00°?

A 2,160 N

B 1,470 N

C 1,280 N

D 2,930 N

E 733 N

Real ropes stretch under such forces. What force would be exerted on the car if the angle increases to 5.00° while you are still applying the force found in the first question to its center?

A 10,700 N

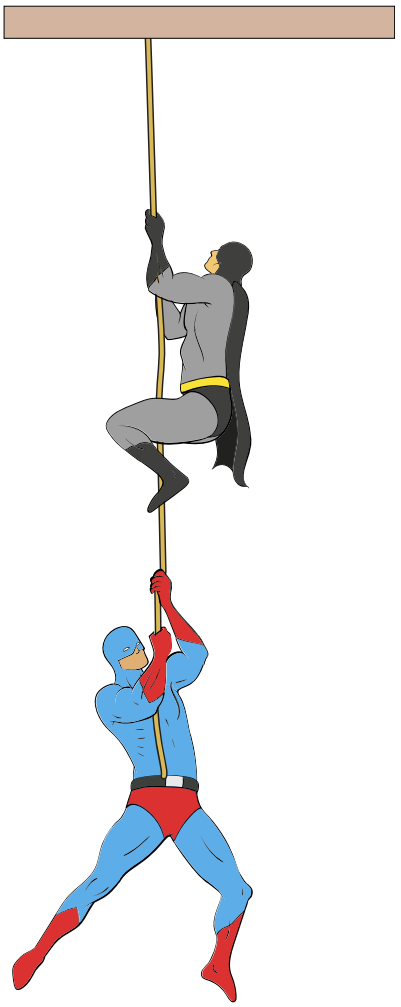
B 8,430 N

C 6,850 N

D 12,800 N

E 16,900 N

Q21: The figure shows two superheroes, Gnatman and Sparrow, hanging motionless from a rope. Gnatman is above Sparrow on the rope. Gnatman's mass is 95.0 kg, Sparrow's mass is 65.0 kg, and the mass of the rope is negligible.



Find the tension in the rope above Gnatman.

A 931 N

B 1,570 N

C 1,490 N

D 1,670 N

E 1,240 N

- Find the tension in the rope betweenGnatman and Sparrow.

A 931 N

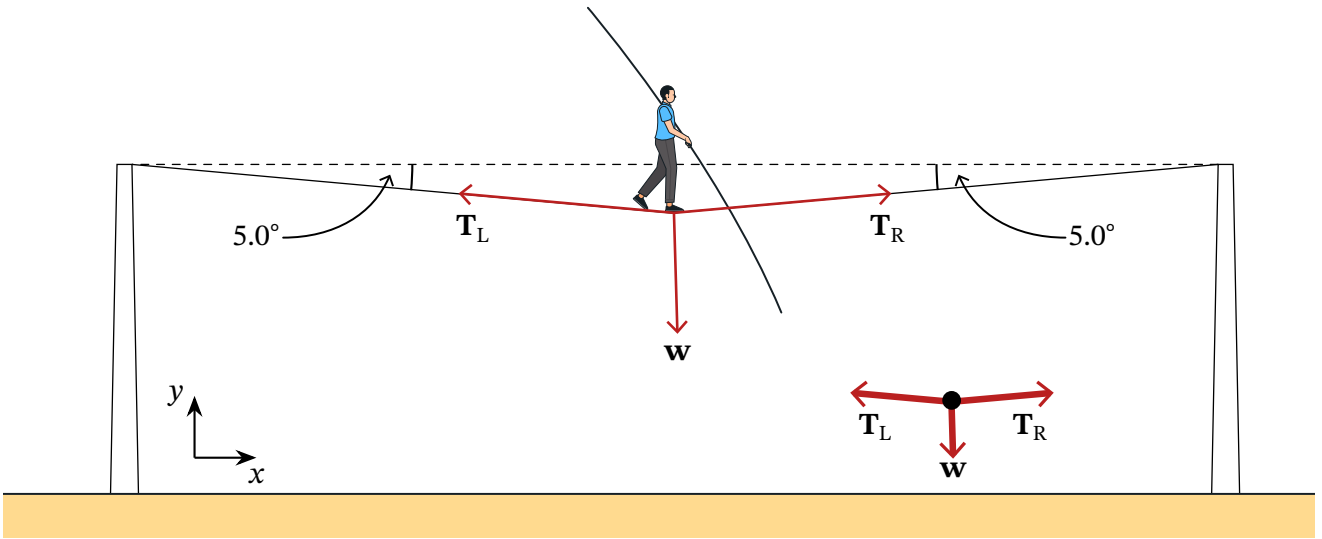
B 637 N

C 554 N

D 401 N

E 787 N

Q22: A tightrope walker with a mass of 70 kg stands at the center of a high wire, as shown in the diagram. The wire is supported at its ends and is directed at an angle of 5.0° below the horizontal. What is the magnitude of the tension in the wire?



A 400 N

B 690 N

C 3,900 N

D 7,900 N

E 4,000 N