33. Diego and Mika are trying to fix a tire on Diego's car, but they are having trouble getting the tire loose. When they pull together, Mika with a force of 23 N and Diego with a force of 31 N, they just barely get the tire to budge. What is the magnitude of the strength of the force between the tire and the wheel?

Identify the tire as the system and the direction of pulling as positive.

$$F_{net} = F_{wheel\ on\ tire} - F_{Mika\ on\ tire} - F_{Diego\ on\ tire}$$

$$= ma = 0$$

$$F_{wheel\ on\ tire} = F_{Mika\ on\ tire} + F_{Diego\ on\ tire}$$

$$= 23\ N + 31\ N$$

$$= 54\ N$$

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34. Force Hold a book motionless in your hand in the air. Identify each force and its interaction pair on the book.

The forces on the book are downward force of gravity due to the mass of Earth and the upward force of the hand. The force of the book on Earth and the force of the book on the hand are the other halves of the interaction pairs.

35. Force Lower the book from problem 34 at increasing speed. Do any of the forces or their interaction-pair partners change? Explain.

Yes, the force of the hand on the book becomes smaller so there is a downward acceleration. The force of the book also becomes smaller; you can feel that. The interaction pair partners remain the same.

36. Tension A block hangs from the ceiling by a massless rope. A second block is attached to the first block and hangs below it on another piece of massless rope. If each of the two blocks has a mass of 5.0 kg, what is the tension in each rope?

For the bottom rope with the positive direction upward:

$$F_{net} = F_{bottom\ rope\ on\ bottom\ block} - F_{Earth's\ mass\ on\ bottom\ block}$$

$$= ma = 0$$

$$F_{bottom\ rope\ on\ bottom\ block} = F_{Earth's\ mass\ on\ bottom\ block}$$

$$= mg$$

$$= (5.0\ kg)(9.80\ m/s^2)$$

$$= 49\ N$$

For the top rope, with the positive direction upward:

$$F_{net} = F_{top\ rope\ on\ top\ block} - F_{bottom\ rope\ on\ top\ block} - F_{Earth's\ mass\ on\ top\ block}$$

$$= ma = 0$$

$$F_{top\ rope\ on\ top\ block} = F_{Earth's\ mass\ on\ top\ block} + F_{bottom\ rope\ on\ top\ block}$$

$$= mg + F_{bottom\ rope\ on\ top\ block}$$

$$= (5.0\ kg)(9.80\ m/s^2) + 49\ N$$

$$= 98\ N$$

37. Tension If the bottom block in problem 36 has a mass of 3.0 kg and the tension in the top rope is 63.0 N, calculate the tension in the bottom rope and the mass of the top block.

For the bottom rope with the positive direction upward:

$$F_{net} = F_{bottom\ rope\ on\ bottom\ block} - F_{Earth's\ mass\ on\ bottom\ block}$$

$$= ma = 0$$

$$F_{bottom\ rope\ on\ bottom\ block} = F_{Earth's\ mass\ on\ bottom\ block}$$

$$= (3.0\ kg)(9.80\ m/s^2)$$

$$= -29\ N$$