***P5.1** (a) The woman's weight is the magnitude of the gravitational force acting on her, given by

$$F_g = mg = 120 \text{ lb} = (4.448 \text{ N/lb})(120 \text{ lb}) = \boxed{534 \text{ N}}$$

(b) Her mass is $m = \dfrac{F_g}{g} = \dfrac{534 \text{ N}}{9.80 \text{ m/s}^2} = \boxed{54.5 \text{ kg}}$

***P5.2** We are given $F_g = mg = 900 \text{ N}$, from which we can find the man's mass,

$$m = \frac{900 \text{ N}}{9.80 \text{ m/s}^2} = 91.8 \text{ kg}$$

Then, his weight on Jupiter is given by

$$(F_g)_{\text{on Jupiter}} = 91.8 \text{ kg}(25.9 \text{ m/s}^2) = \boxed{2.38 \text{ kN}}$$

P5.3 We use Newton's second law to find the force as a vector and then the Pythagorean theorem to find its magnitude. The givens are $m = 3.00$ kg and $\vec{\mathbf{a}} = (2.00\hat{\mathbf{i}} + 5.00\hat{\mathbf{j}}) \text{ m/s}^2$.

(a) The total vector force is

$$\sum \vec{\mathbf{F}} = m\vec{\mathbf{a}} = (3.00 \text{ kg})(2.00\hat{\mathbf{i}} + 5.00\hat{\mathbf{j}}) \text{ m/s}^2 = \boxed{(6.00\hat{\mathbf{i}} + 15.0\hat{\mathbf{j}}) \text{ N}}$$

(b) Its magnitude is

$$|\vec{\mathbf{F}}| = \sqrt{(F_x)^2 + (F_y)^2} = \sqrt{(6.00 \text{ N})^2 + (15.0 \text{ N})^2} = \boxed{16.2 \text{ N}}$$

P5.8 The force on the car is given by $\sum \vec{\mathbf{F}} = m\vec{\mathbf{a}}$, or, in one dimension, $\sum F = ma$. Whether the car is moving to the left or the right, since it's moving at constant speed, $a = 0$ and therefore $\sum F = \boxed{0}$ for both parts (a) and (b).

***P5.15** (a) We start from the sum of the two forces:

$$\sum \vec{\mathbf{F}} = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 = (-6.00\hat{\mathbf{i}} - 4.00\hat{\mathbf{j}}) + (-3.00\hat{\mathbf{i}} + 7.00\hat{\mathbf{j}})$$
$$= (-9.00\hat{\mathbf{i}} + 3.00\hat{\mathbf{j}}) \text{ N}$$

The acceleration is then:

$$\vec{\mathbf{a}} = a_x\hat{\mathbf{i}} + a_y\hat{\mathbf{j}} = \frac{\sum \vec{\mathbf{F}}}{m} = \frac{(-9.00\hat{\mathbf{i}} + 3.00\hat{\mathbf{j}}) \text{ N}}{2.00 \text{ kg}}$$
$$= (-4.50\hat{\mathbf{i}} + 1.50\hat{\mathbf{j}}) \text{ m/s}^2$$

and the velocity is found from

$$\vec{\mathbf{v}}_f = v_x\hat{\mathbf{i}} + v_y\hat{\mathbf{j}} = \vec{\mathbf{v}}_i + \vec{\mathbf{a}}t = \vec{\mathbf{a}}t$$

$$\vec{\mathbf{v}}_f = \left[(-4.50\hat{\mathbf{i}} + 1.50\hat{\mathbf{j}}) \text{ m/s}^2\right](10.0 \text{ s})$$
$$= \boxed{(-45.0\hat{\mathbf{i}} + 15.0\hat{\mathbf{j}}) \text{ m/s}}$$

(b) The direction of motion makes angle θ with the x direction.

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(-\frac{15.0 \text{ m/s}}{45.0 \text{ m/s}}\right)$$

$$\theta = -18.4° + 180° = \boxed{162° \text{ from the } +x \text{ axis}}$$

(c) Displacement:

$$x\text{-displacement} = x_f - x_i = v_{xi}t + \frac{1}{2}a_xt^2$$
$$= \frac{1}{2}(-4.50 \text{ m/s}^2)(10.0 \text{ s})^2 = -225 \text{ m}$$

$$y\text{-displacement} = y_f - y_i = v_{yi}t + \frac{1}{2}a_yt^2$$
$$= \frac{1}{2}(+1.50 \text{ m/s}^2)(10.0 \text{ s})^2 = +75.0 \text{ m}$$

$$\Delta\vec{\mathbf{r}} = \boxed{(-225\hat{\mathbf{i}} + 75.0\hat{\mathbf{j}}) \text{ m}}$$

(d) Position: $\vec{\mathbf{r}}_f = \vec{\mathbf{r}}_i + \Delta\vec{\mathbf{r}}$

$$\vec{\mathbf{r}}_f = (-2.00\hat{\mathbf{i}} + 4.00\hat{\mathbf{j}}) + (-225\hat{\mathbf{i}} + 75.0\hat{\mathbf{j}}) = \boxed{(-227\hat{\mathbf{i}} + 79.0\hat{\mathbf{j}}) \text{ m}}$$

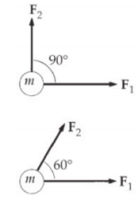
P5.19 We use the particle under a net force model and add the forces as vectors. Then Newton's second law tells us the acceleration.

(a) $\sum \vec{\mathbf{F}} = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 = (20.0\hat{\mathbf{i}} + 15.0\hat{\mathbf{j}}) \text{ N}$

Newton's second law gives, with $m = 5.00$ kg,

$$\vec{\mathbf{a}} = \frac{\sum \vec{\mathbf{F}}}{m} = (4.00\hat{\mathbf{i}} + 3.00\hat{\mathbf{j}}) \text{ m/s}^2$$

or $\boxed{a = 5.00 \text{ m/s}^2 \text{ at } \theta = 36.9°}$



ANS. FIG. P5.19

(b) In this configuration,

$$F_{2x} = 15.0\cos 60.0° = 7.50 \text{ N}$$
$$F_{2y} = 15.0\sin 60.0° = 13.0 \text{ N}$$
$$\vec{\mathbf{F}}_2 = (7.50\hat{\mathbf{i}} + 13.0\hat{\mathbf{j}}) \text{ N}$$

Then,

$$\sum \vec{\mathbf{F}} = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 = \left[20.0\hat{\mathbf{i}} + (7.50\hat{\mathbf{i}} + 13.0\hat{\mathbf{j}})\right] \text{ N}$$
$$= (27.5\hat{\mathbf{i}} + 13.0\hat{\mathbf{j}}) \text{ N}$$

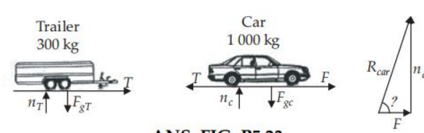
and $\vec{\mathbf{a}} = \dfrac{\sum \vec{\mathbf{F}}}{m} = (5.50\hat{\mathbf{i}} + 2.60\hat{\mathbf{j}}) \text{ m/s}^2 = \boxed{6.08 \text{ m/s}^2 \text{ at } 25.3°}$

P5.21 (a) $\boxed{15.0 \text{ lb up,}}$ to counterbalance the Earth's force on the block.

(b) $\boxed{5.00 \text{ lb up,}}$ the forces on the block are now the Earth pulling down with 15.0 lb and the rope pulling up with 10.0 lb. The forces from the floor and rope together balance the weight.

(c) $\boxed{0,}$ the block now accelerates up away from the floor.

***** Choose the $+x$ direction to be horizontal and forward with the $+y$ vertical and upward. The common acceleration of the car and trailer then has components of $a_x = +2.15 \text{ m/s}^2$ and $a_y = 0$.



ANS. FIG. P5.23

(a) The net force on the car is horizontal and given by

$$\left(\sum F_x\right)_{car} = F - T = m_{car}a_x = (1\,000 \text{ kg})(2.15 \text{ m/s}^2)$$
$$= \boxed{2.15 \times 10^3 \text{ N forward}}$$

(b) The net force on the trailer is also horizontal and given by

$$\left(\sum F_x\right)_{trailer} = +T = m_{trailer}a_x = (300 \text{ kg})(2.15 \text{ m/s}^2)$$
$$= \boxed{645 \text{ N forward}}$$

(c) Consider the free-body diagrams of the car and trailer. The only horizontal force acting on the trailer is $T = 645$ N forward, exerted on the trailer by the car. Newton's third law then states that the force the trailer exerts on the car is $\boxed{645 \text{ N toward the rear}}$.

(d) The road exerts two forces on the car. These are F and n_c shown in the free-body diagram of the car. From part (a), $F = T + 2.15 \times 10^3 \text{ N} = +2.80 \times 10^3 \text{ N}$. Also, $\left(\sum F_y\right)_{car} = n_c - F_{gc} = m_{car}a_y = 0$, so $n_c = F_{gc} = m_{car}g = 9.80 \times 10^3 \text{ N}$. The resultant force exerted on the car by the road is then

$$R_{car} = \sqrt{F^2 + n_c^2} = \sqrt{(2.80 \times 10^3 \text{ N})^2 + (9.80 \times 10^3 \text{ N})^2}$$
$$= 1.02 \times 10^4 \text{ N}$$

at $\theta = \tan^{-1}\left(\dfrac{n_c}{F}\right) = \tan^{-1}(3.51) = 74.1°$ above the horizontal and forward. Newton's third law then states that the resultant force exerted on the road by the car is

$\boxed{1.02 \times 10^4 \text{ N at } 74.1° \text{ below the horizontal and rearward}}$.