18. Many of the operations are done efficiently on most modern graphical calculators using their built-in vector manipulation and rectangular ↔ polar "shortcuts." In this solution, we employ the "traditional" methods (such as Eq. 3-6).

(a) The magnitude of $\vec{a}$ is $\sqrt{4^2 + (-3)^2} = 5.0$ m.

(b) The angle between $\vec{a}$ and the $+x$ axis is $\tan^{-1}(-3/4) = -37°$. The vector is 37° *clockwise* from the axis defined by $\hat{\imath}$.

(c) The magnitude of $\vec{b}$ is $\sqrt{6^2 + 8^2} = 10$ m.

(d) The angle between $\vec{b}$ and the $+x$ axis is $\tan^{-1}(8/6) = 53°$.

(e) $\vec{a} + \vec{b} = (4 + 6)\,\hat{\imath} + ((-3) + 8)\,\hat{\jmath} = 10\,\hat{\imath} + 5\,\hat{\jmath}$, with the unit meter understood. The magnitude of this vector is $\sqrt{10^2 + 5^2} = 11$ m; we rounding to two significant figures in our results.

(f) The angle between the vector described in part (e) and the $+x$ axis is $\tan^{-1}(5/10) = 27°$.

(g) $\vec{b} - \vec{a} = (6 - 4)\,\hat{\imath} + (8 - (-3))\,\hat{\jmath} = 2\,\hat{\imath} + 11\,\hat{\jmath}$, with the unit meter understood. The magnitude of this vector is $\sqrt{2^2 + 11^2} = 11$ m, which is, interestingly, the same result as in part (e) (exactly, not just to 2 significant figures) (this curious coincidence is made possible by the fact that $\vec{a} \perp \vec{b}$).

(h) The angle between the vector described in part (g) and the $+x$ axis is $\tan^{-1}(11/2) = 80°$.

(i) $\vec{a} - \vec{b} = (4 - 6)\,\hat{\imath} + ((-3) - 8)\,\hat{\jmath} = -2\,\hat{\imath} - 11\,\hat{\jmath}$, with the unit meter understood. The magnitude of this vector is $\sqrt{(-2)^2 + (-11)^2} = 11$ m.

(j) The two possibilities presented by a simple calculation for the angle between the vector described in part (i) and the $+x$ direction are $\tan^{-1}(11/2) = 80°$, and $180° + 80° = 260°$. The latter possibility is the correct answer (see part (k) for a further observation related to this result).

(k) Since $\vec{a} - \vec{b} = (-1)(\vec{b} - \vec{a})$, they point in opposite (antiparallel) directions; the angle between them is 180°.