Answers to selected problems from Essential Physics, Chapter 1

1. (a) 1 mile (b) 20 miles (c) 80 km

3. (a) 256 cm (b) 2000 cm^2

5. You agree on (a) and (b), but you disagree on (c), (d), and (e).

7. 4 m in the positive y-direction.

11. (a) 3.16×10^7 s (b) 9.46×10^{15} m (c) 1600 m (d) 180 kg (e) 42195 m

13. 10 grams

15. (a) 1 hectare (b) 100 m (c) 500 m

17. (a) 6.3 L/s. US gallons are smaller than imperial gallons, and we assume we use US gallons in this situation.

19. First, we use the inverse tangent to find that vector A makes an angle of 21.8° with the x-axis. Second, we know that vector B makes an angle of 63.8° with the x-axis, so we can determine that the angle between the vectors A and B is 63.8° – 21.8° = 42.0°. Third, we can determine that the magnitude of vector A is $\sqrt{29}$ m. At this point, we can use the cosine law to find the magnitude of vector C:

$$C^2 = A^2 + B^2 - 2AB\cos\theta_C$$
$$= (29 \text{ m}^2) + (16 \text{ m}^2) - 2\times(\sqrt{29} \text{ m})\times(4 \text{ m})\times\cos(42.0°)$$

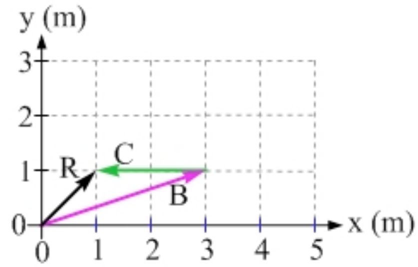
This gives the magnitude of C as 3.60 m.
Now, we can use the sine law to determine θ_B, the angle between the vectors A and C.

$$\frac{\sin\theta_B}{B} = \frac{\sin\theta_C}{C} \quad \Rightarrow \quad \theta_B = \sin^{-1}\left(\frac{B\sin\theta_C}{C}\right) = \sin^{-1}\left(\frac{(4.00 \text{ m})\sin(42.0°)}{3.60 \text{ m}}\right) = 48.0°$$

Finally, we can find the angle between C and the x-axis, which is 48.0° – 21.8° = 26.2°. So, the vector C has a magnitude of 3.60 m and is at an angle of 26.2° below the x-axis.

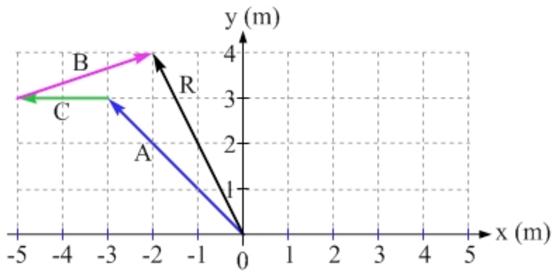
21. (a) 30 m at an angle of 53.1° above the positive x-axis.
(b) 52 m at an angle of 87.8° above the negative x-axis.
(c) 52 m at an angle of 87.8° below the positive x-axis.

23. (a) 4.2 m at an angle of 45° above the negative x-axis.
(b) 3.2 m at an angle of 18.4° above the positive x-axis.
(c) 2.0 m in the negative x direction.

25. 

(a) (b) $+(1.0\text{ m})\hat{x}+(1.0\text{ m})\hat{y}$

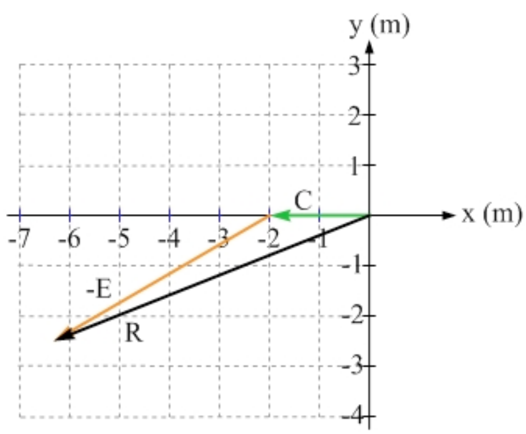
27. (a) + (b) (c) + (d)



Vector	x-component	y-component
A	–3 m	+3 m
B	+3 m	+1 m
C	–2 m	0
R=A+B+C	–2 m	+4 m

(e) 4.5 m at an angle of 63.4° above the negative x-axis.

29. (a) + (b) (c) + (d)



Vector	x-component	y-component
C	–2 m	0
–E	–4.33 m	–2.5 m
R=C–E	–6.33 m	–2.5 m

(e) 6.81 m at an angle of 21.6° below the negative x-axis.

31. (a) + (b) (c) + (d)

Vector	x-component	y-component
B	$+\sqrt{10}$ m	0
D	$-\sqrt{40}$ m	0
R=B+D	–3.16 m	0

(e) 3.16 m in the negative x-direction.

35. 425 m at an angle of 41.7° north of west

37. 62.5 miles is awfully precise – it has three significant figures, which seems like far too many. Most likely, Nike said that the shoe was good up to 100 km (note that this has 1 significant figure), and somewhere along the line the distance was converted to miles using the approximation that 1 km is 5/8 of a mile, with three significant figure (way too many) being kept in the number printed in the paper.

41. (a) Anya could first travel $+(3 \text{ blocks})\hat{x} + 0\hat{y}$, followed by $0\hat{x} + (4 \text{ blocks})\hat{y}$ (or the reverse order). (b) As the crow flies, her net displacement has a magnitude of 5 blocks, but she traveled a distance of 7 blocks. (c) $(+2.4 \text{ blocks})\hat{x} + (1.8 \text{ blocks})\hat{y}$, followed by $(-2.4 \text{ blocks})\hat{x} + (3.2 \text{ blocks})\hat{y}$ (or the reverse order). (d) $0\hat{x} + (5 \text{ blocks})\hat{y}$.

43. (a) 4500 m (b) 2800 m (c) She did not travel in a straight-line path between her starting point and her current location. Her route could have done a lot of zig-zagging, for instance.

45. (a) $x = 4$ (b) $x = 2$

47. (a) Equation 1 is incorrect. It has units of length on the left, and inverse length on the right. A valid equation has the same units on both sides. Equation 2 is dimensionally correct, with units of length on the right and left. Equation 3 is incorrect – in the numerator on the right side, units of length are being subtracted from units of length squared. This is not allowed – quantities that are added or subtracted must have the same units. (b) No, dimensional analysis alone does not guarantee that Equation 2 is correct (although, as we will see in the optics section, it is correct). By simply doing dimensional analysis, we cannot be sure of the + and – signs, and we also don't know if there are any numerical factors missing from the equation. For example, the following equation is also dimensionally correct, but it is not the correct equation:

$$d_i = \frac{3d_o f}{d_o + f}.$$