ANSWERS

CHAPTER 1: GRAVITY AND MOTION

1.1 SECTION REVIEW

REMEMBERING

1 Tip-to-tail; parallelogram

2 Careful scale drawing and measurement using ruler and protractor.

3 a Magnitude increases

b Magnitude decreases

c Change of direction

4 a $A_x = |\vec{A}|\cos\theta;\ A_y = |\vec{A}|\sin\theta;\ \theta$ relative to positive x-axis

b $\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$

UNDERSTANDING

5 Tip-to-tail addition produces a triangle – resultant completes the triangle from tail of first addend to tip of second addend; parallelogram addition produces a parallelogram: both tails start at same point – resultant is diagonal from start to completion of parallelogram; both methods require careful measurements using ruler and protractor.

6 Subtraction is the addition of the negative.

7 Without a consistent scale, resultant length and angle cannot be measured correctly.

8 All triangles used in calculations must be right-angled.

APPLYING

9 a $\vec{C} = \vec{A} + \vec{B}$

b $\vec{C} = \vec{B} - \vec{A}$

c $\vec{A} = \vec{C} - \vec{B}$

d $\vec{C} = 2\vec{A} + 3\vec{B}$

ANALYSING

10 a $R_x = P_x + Q_x;\ R_y = P_y + Q_y$

b $R_x = P_x - Q_x;\ R_y = P_y - Q_y$

c $R_x = 2P_x - 3Q_x;\ R_y = 2P_y - 3Q_y$

1.2 SECTION REVIEW

REMEMBERING

1 See pages 10–11

2 See pages 11–12

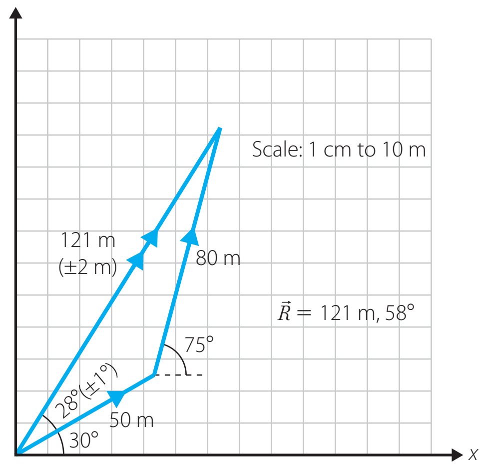
3 See pages 12–13

UNDERSTANDING

4 See Figure 1.1.6, page 9

APPLYING

5 a



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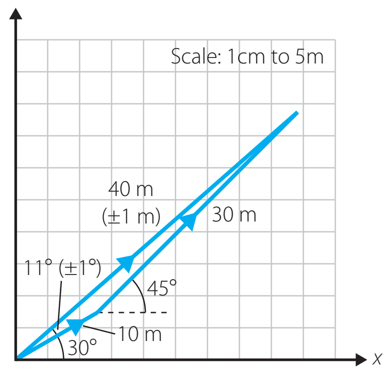
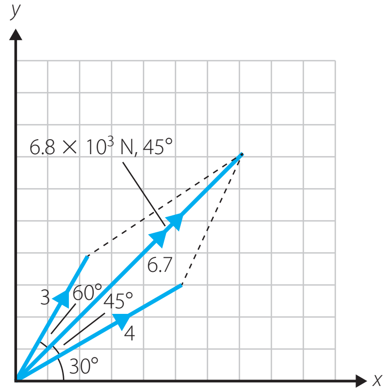


6 a



Scale: 1cm represents 1000 N

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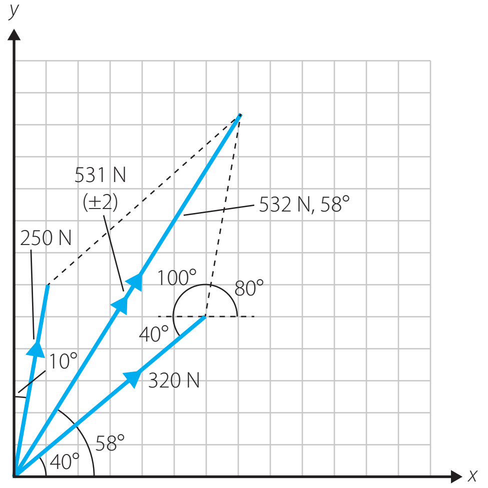
b



Scale: 1cm represents 50 N

ANALYSING

7 a $R_x = 2A_x - B_x$

$R_x = 2 \times 15\,\mathrm{m\,s^{-1}} \times \cos 30° - 25\,\mathrm{m\,s^{-1}} \times \cos 60°$

$R_x = 12.48\,\mathrm{m\,s^{-1}}$

$R_y = 2A_y - B_y$

$R_y = 2 \times 15\,\mathrm{m\,s^{-1}} \times \sin 30° - 25\,\mathrm{m\,s^{-1}} \times \sin 60°$

$R_y = {}^{-}6.65\,\mathrm{m\,s^{-1}}$

$R = \sqrt{R_x^2 + R_y^2}$

$R = \sqrt{\left(13.48\,\mathrm{m\,s^{-1}}\right)^2 + \left({}^{-}6.65\,\mathrm{m\,s^{-1}}\right)^2}$

$R = 15\,\mathrm{m\,s^{-1}}$

$\theta = \tan^{-1}\left(\dfrac{R_y}{R_x}\right)$

$\theta = \tan^{-1}\left(\dfrac{{}^{-}6.65\,\mathrm{m\,s^{-1}}}{13.48\,\mathrm{m\,s^{-1}}}\right)$

$\theta = {}^{-}26.3°$

$\theta = 360° - 26.3°$

$\theta = 334°$

b $R_x = 2A_x - B_x$

$R_x = 2 \times 35\,\mathrm{N} \times \cos 120° - 25\,\mathrm{N} \times \cos 45°$

$R_x = {}^{-}52.7\,\mathrm{N}$

$R_y = 2A_y - B_y$

$R_y = 2 \times 35\,\mathrm{N} \times \sin 120° - 25\,\mathrm{N} \times \sin 45°$

$R_y = 42.9\,\mathrm{N}$

$R = \sqrt{R_x^2 + R_y^2}$

$R = \sqrt{\left({}^{-}52.7\,\mathrm{N}\right)^2 + \left(42.9\,\mathrm{N}\right)^2}$

$R = 68\,\mathrm{N}$

$\theta = \tan^{-1}\left(\dfrac{R_y}{R_x}\right)$

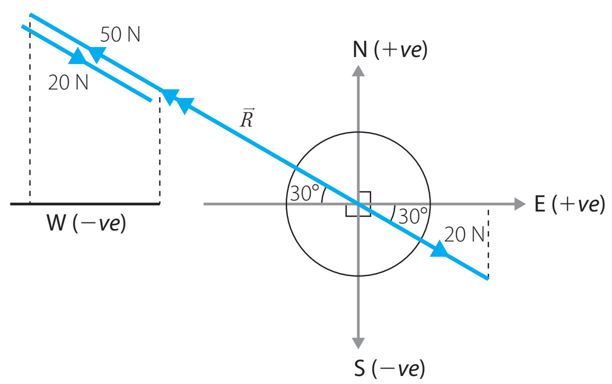
$\theta = \tan^{-1}\left(\dfrac{42.9\,\mathrm{N}}{{}^{-}52.7\,\mathrm{N}}\right)$

$\theta = {}^{-}39.2°$

$\theta = 180° - 39.2°$

$\theta = 141°$

8 a



Scale: 1 cm represents 5 N

Take north and east as positive:

$R_x = P_x + Q_x$

$R_x = 20\,\mathrm{N} \times \cos 30° + {}^{-}50\,\mathrm{N} \times \cos 30°$

$R_x = {}^{-}26\,\mathrm{N}$

$R_y = P_y + Q_y$

$R_y = {}^{-}20\,\mathrm{N} \times \sin 30° + 50\,\mathrm{N} \times \sin 30°$

$R_y = 15\,\mathrm{N}$

$R = \sqrt{R_x^2 + R_y^2}$

$R = \sqrt{\left({}^{-}26\,\mathrm{N}\right)^2 + \left(15\,\mathrm{N}\right)^2}$

$R = 30\,\mathrm{N}$

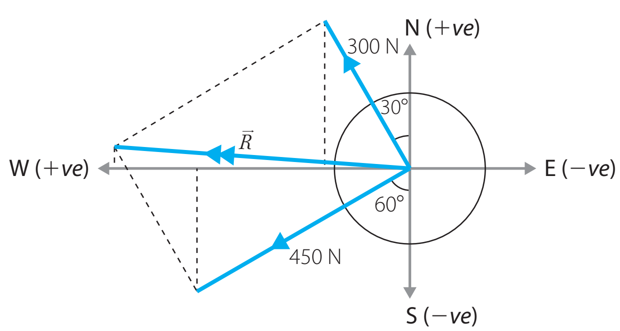
$\theta = \tan^{-1}\left(\dfrac{R_y}{R_x}\right)$

$\theta = \tan^{-1}\left(\dfrac{15\,N}{{}^{-}26\,N}\right)$

$\theta = {}^{-}30°$

$\theta_{\mathrm{true}} = 300°$

b



Scale: 1 cm represents 50 N

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Take north and west as positive:

$R_x = P_x + Q_x$

$R_x = 300\,\text{N} \times \cos 60° + 450\,\text{N} \times \cos 30°$

$R_x = 540\,\text{N}$

$R_y = P_y + Q_y$

$R_y = 300\,\text{N} \times \sin 60° + {}^{-}450\,\text{N} \times \sin 30°$

$R_y = 34.8\,\text{N}$

$R = \sqrt{R_x^2 + R_y^2}$

$R = \sqrt{(540\,\text{N})^2 + (34.8\,\text{N})^2}$

$R = 541\,\text{N}$

$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)$

$\theta = \tan^{-1}\left(\frac{34.8\,\text{N}}{541\,\text{N}}\right)$

$\theta = 3.7°$

$\Rightarrow$ N86°W

CHAPTER REVIEW QUESTIONS

DETAIL QUESTIONS

1 a Distance and time (speed and acceleration are derived from distance and time)

b Mass, distance and time (speed and acceleration, hence force, work-energy, impulse-momentum are derived from distance and time combined with the effect of mass)

2 Kinematics: velocity (change of displacement) and (vector) acceleration (change of velocity)

Dynamics: the sum of forces in different directions causes acceleration.

3 Motion can be resolved into rectangular components. These are independent of each other.

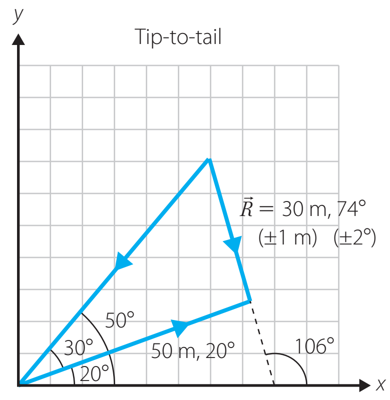
CATEGORY QUESTIONS

4 a Use a Cartesian grid. Tip-to-tail (direct addition) is simplest; parallelogram (easier to place addends but must produce tip-to-tail construction); method of components (use tip-to-tail or parallelogram on axis system, then add resolutes – diagram can become quite complex)

b $\vec{R} = \vec{C} - 2\vec{D}$

$\vec{R} = (50\,\text{m}, 20°) - 2 \times (30\,\text{m}, 50°)$

$\vec{R} = (50\,\text{m}, 20°) + 2 \times ({}^{-}30\,\text{m}, 50°)$



c Use trigonometrical ratios to find *x*- and *y*-resolutes, add corresponding resolutes to find *x*- and *y*-components of the resultant; use Pythagoras to calculate magnitude; use trigonometry to find angle.

d $\vec{R} = \vec{C} - 2\vec{D}$

$\vec{R} = (50\,\text{m}, 20°) - 2 \times (30\,\text{m}, 50°)$

$\vec{R} = (50\,\text{m}, 20°) + 2 \times ({}^{-}30\,\text{m}, 50°)$

$R_x = C_x - 2D_x$

$R_x = 50\,\text{m} \times \cos 20° + {}^{-}60\,\text{m} \times \cos 50°$

$R_x = 8.42\,\text{m}$

$R_y = C_y + Q_y$

$R_y = 50\,\text{m} \times \sin 20° + {}^{-}60\,\text{m} \times \sin 50°$

$R_y = {}^{-}28.9\,\text{m}$

$R = \sqrt{R_x^2 + R_y^2}$

$R = \sqrt{(8.42\,\text{m})^2 + ({}^{-}28.9\,\text{m})^2}$

$R = 30\,\text{m}$

$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)$

$\theta = \tan^{-1}\left(\frac{{}^{-}28.9\,\text{m}}{8.42\,\text{m}}\right)$

$\theta = {}^{-}73.8°$

e The calculational method is more likely to be accurate. Where the number of significant figures in the data exceeds the number of significant figures it is possible to draw using a ruler and protractor.

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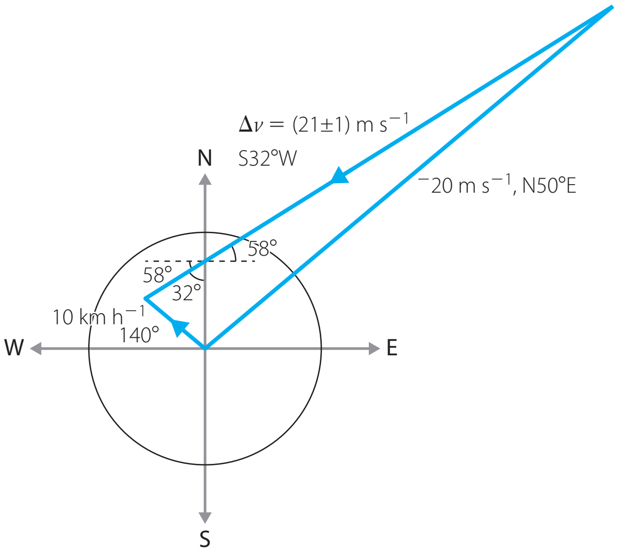
ELABORATION QUESTIONS

5 By scale drawing:



then:

$$a_{av} = \frac{\Delta v}{\Delta t}$$

$$a_{av} = \frac{(21 \pm 1)\text{ms}^{-1}}{25\text{s}}$$

$$a_{av} = (0.84 \pm 0.04)\text{ms}^{-2}$$

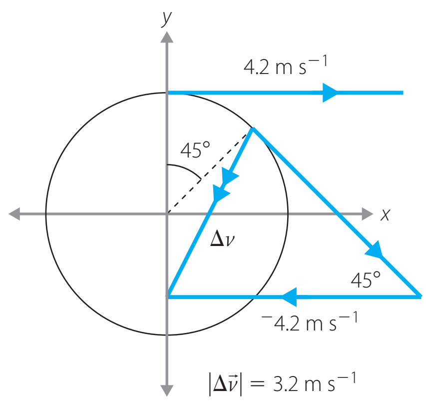
6 a $v = \dfrac{2\pi r}{T}$

$$T = \frac{2\pi r}{v}$$

$$T = \frac{2\pi \times 10\text{m}}{4.2\text{ms}^{-1}}$$

$$T = 15\text{ms}^{-1}$$

b



c $a_{av} = \dfrac{\Delta v}{\Delta t}$

$$a_{av} = \frac{3.2\text{ms}^{-1}}{\left(\frac{15\text{ms}^{-1}}{8\text{s}}\right)}$$

$$a_{av} = 1.7\text{ms}^{-2}$$

EVIDENCE QUESTIONS

7 a Student answers will vary.

b Student answers will vary.

8 Student answers will vary.

END-OF-CHAPTER EXAM

1 B

2 C

3 A

4 C

5 D

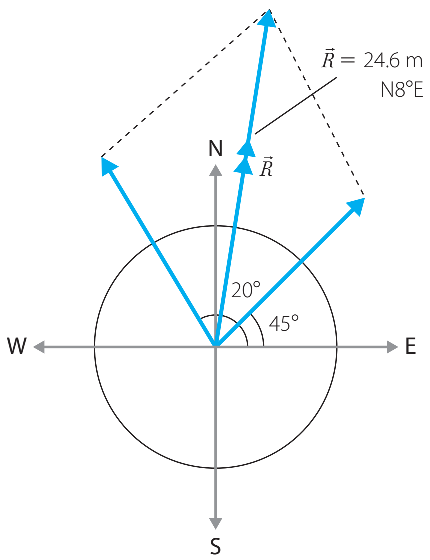
6 Rectangular

7 Positive

8 Add x-components of the addends; add y-components of the addends

9 Magnitude × 4 and direction reversed

10



Scale: 1 cm represents 5 cm

11 a $a_{\parallel} = g\sin\theta$

$$a_{\parallel} = 9.8\text{ms}^{-2} \times \sin 30°$$

$$a_{\parallel} = 4.9\text{ms}^{-2}$$

b $a_{\perp} = g\cos\theta$

$$a_{\perp} = 9.8\text{ms}^{-2} \times \cos 30°$$

$$a_{\perp} = 8.5\text{ms}^{-2}$$

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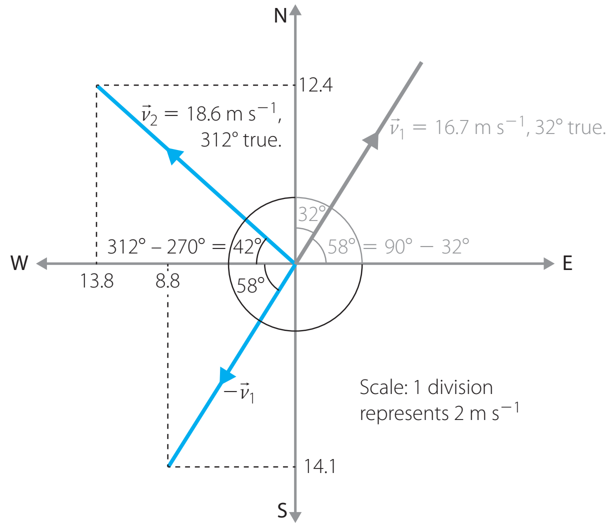
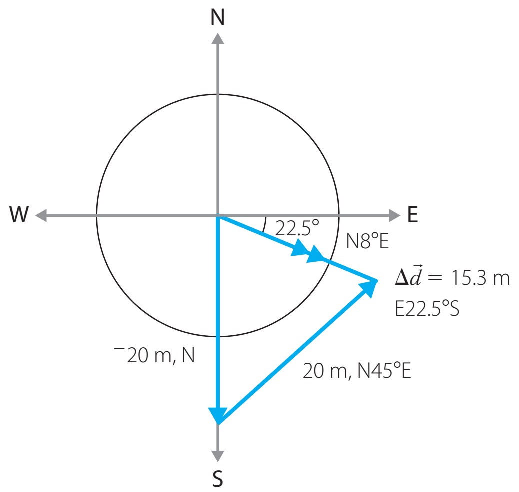


13 $\vec{v}_{av} = \dfrac{\Delta \vec{x}}{\Delta t} = k \times \Delta \vec{x}$, $k = \dfrac{1}{\Delta t}$ = scalar multiplier

14 a $P(20\,\text{m}, \text{N}0°\text{E})$; $P(20\,\text{m}, \text{N}45°\text{E})$

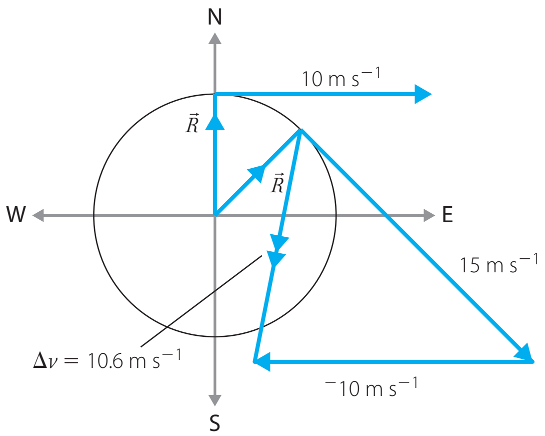
b



$$v_{av} = \frac{\Delta d}{\Delta t} = \frac{15.3\text{ m}}{2\text{s}} = 7.65\text{ m s}^{-1}$$

Scale: 1 cm represents 5 m

c



$$a_{av} = \frac{\Delta v}{\Delta t} = \frac{10.6\text{ m s}^{-1}}{2.0\text{ s}} = 5.3\text{ m s}^{-2}$$

Scale: 1 cm represents 2.5 m s⁻¹

CHAPTER 2: PROJECTILE MOTION

2.1 SECTION REVIEW

REMEMBERING

1 a See Figure 2.1.1, page 20

b $u_x = |\vec{u}|\cos\theta$; $u_y = |\vec{u}|\sin\theta$

2 See key formula boxes, pages 20–1

UNDERSTANDING

3 Field lines are approximately parallel; over relatively small vertical distances the differences in $|\vec{g}|$ are negligible.

4 Perpendicular resolutes have no component in the direction of parallel resolutes.

APPLYING

5 a Horizontal component: $u_x = 17\,\text{m s}^{-1}$; vertical component: $u_y = 10\,\text{m s}^{-1}$

b Horizontal component: $u_x = 11\,\text{m s}^{-1}$; vertical component: $u_y = 11\,\text{m s}^{-1}$

c Horizontal component: $u_x = 1.2\,\text{m s}^{-1}$; vertical component: $u_y = 2.1\,\text{m s}^{-1}$

6 a $|\vec{v}_{top}| = u_x = |\vec{u}|\cos\theta$; horizontal

$|\vec{v}_{top}| = 12\,\text{m s}^{-1} \times \cos 70°$

$|\vec{v}_{top}| = 4.1\,\text{m s}^{-1}$

b $9.8\,\text{m s}^{-2}$

c $y = 4.0\,\text{m}$; $u_y = |\vec{u}|\sin\theta = 12\,\text{m s}^{-1} \times \sin 70° = 11.3\,\text{m s}^{-1}$;

$v_y = 0\,\text{m s}^{-1}$; $g = {}^{-}9.8\,\text{m s}^{-2}$; $t = ?$

$y = \dfrac{1}{2}gt^2 + u_y t$

$4.9t^2 - 11.3t + 4.0 = 0$

$t = -\dfrac{{}^{-}11.3}{2 \times 4.9} \pm \dfrac{\sqrt{(11.3)^2 - 4 \times 4.9 \times 4.0}}{2 \times 4.9}$

$t = 1.15 \pm 0.71\,\text{s}$

$t = 0.44\,\text{s}$ and $1.9\,\text{s}$

7 $R = \dfrac{|\vec{u}|^2 \sin 2\theta}{g}$

$R = \dfrac{(300\,\text{m s}^{-1})^2 \sin(2 \times 35°)}{9.8\,\text{m s}^{-2}}$

$R = 8629\,\text{m} = 8.6\,\text{km}$

ANALYSING

8 *suvat* uses slightly different symbols and are written in a different order. When the order of terms are aligned, the equations are of the same form.

9 $y = 25\,\text{m}$; $u_y = |\vec{u}|\sin\theta = u\sin 60°$;

$v_y = 0\,\text{m s}^{-1}$; $g = {}^{-}9.8\,\text{m s}^{-2}$; $t = ?$

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