Physics 20 - Lesson 12
Relative Motion – Answer Key

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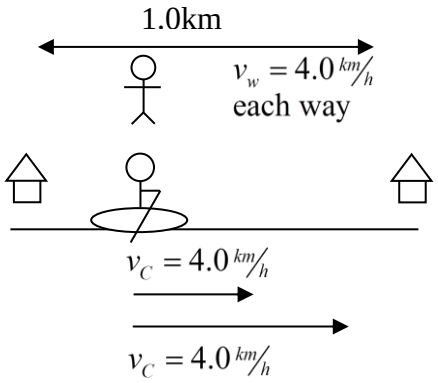
1) /10

a) $-1.5\ ^{m}/_{s}$
b) $-2.0\ ^{m}/_{s}$
c) $-1.3\ ^{m}/_{s}$
d) $-5.0\ ^{m}/_{s}$
e) $+7.0\ ^{m}/_{s}$
f) $+4.8\ ^{m}/_{s}$
g) $+1.3\ ^{m}/_{s}$
h) $-5.5\ ^{m}/_{s}$
i) $0\ ^{m}/_{s}$
j) $-6.8\ ^{m}/_{s}$

2) /4

a) $28.5\ ^{m}/_{s}$ east
b) $35.0\ ^{m}/_{s}$ east
c) $1.5\ ^{m}/_{s}$ east
d) $5.0\ ^{m}/_{s}$ west

3) /5



a)

$$\Delta t = t_{walk} - t_{canoe}$$

$$\Delta t = \frac{\Delta d}{v_w} - \frac{\Delta d}{v_C} = \frac{1.0km}{4.0\ ^{km}/_{h}} - \frac{1.0km}{6.0\ ^{km}/_{h}} = \boxed{0.083h\ (5\text{min})}$$

b)

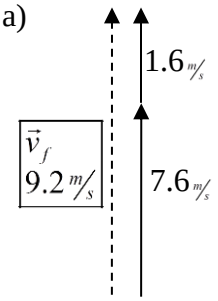
walker: $\Delta t = \dfrac{\Delta d}{\Delta v} = \dfrac{2 \times 1.0km}{4.0\ ^{km}/_{h}} = \boxed{30\,\text{min}}$

canoeist:

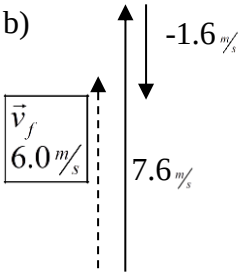
$$\Delta t = \frac{\Delta d}{\Delta v_{up}} + \frac{\Delta d}{\Delta v_{down}} = \frac{1.0km}{6.0\ ^{km}/_{h}} + \frac{1.0km}{2.0\ ^{km}/_{h}} = \boxed{40\,\text{min}}$$

4) /4

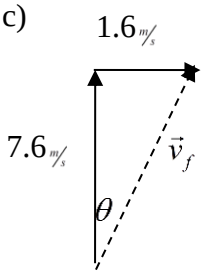
a)



b)



c)



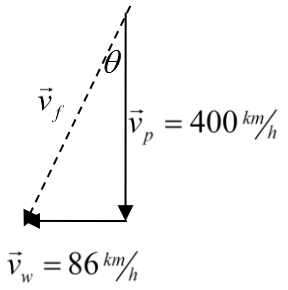
$$v_f = \sqrt{1.6^2 + 7.6^2}$$

$$v_f = 7.8\ ^{m}/_{s}$$

$$\tan\theta = \frac{1.6}{7.6} \quad \theta = 12°\text{ E of N}$$

$$\boxed{\vec{v}_f = 7.8\ ^{m}/_{s}\ [12°\text{ E of N}]}$$

5)



$\vec{v}_f = \sqrt{400^2 + 86^2}$

$\vec{v}_f = 409\,{}^{km}/_{h}$

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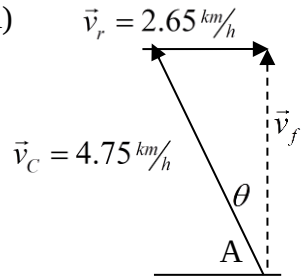
$\tan\theta = \dfrac{86}{400}$ θ=12° W of S

$\boxed{\vec{v}_f = 409\,{}^{km}/_{h}\ [12°\text{ W of S}]}$

6)

A)



$\sin\theta = \dfrac{2.65}{4.75}$

$\theta = 34°$

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$A = 90° - 34°$

$\boxed{A = 56°}$

B)

$\vec{v}_f = \sqrt{4.75^2 - 2.65^2}$

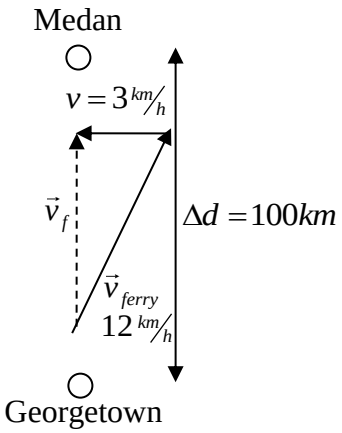
$\vec{v}_f = \dfrac{\Delta\vec{d}}{\Delta t}$

$\Delta t = \dfrac{\Delta\vec{d}}{\vec{v}_f} = \dfrac{0.50km}{3.94km/h}$

$\boxed{\Delta t = 0.13h}$

$\boxed{\Delta t = 7.6\,\text{min}}$

7)



$\sin\theta = \dfrac{3}{12}$

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$\boxed{\theta = 14.5°\text{ E of N}}$

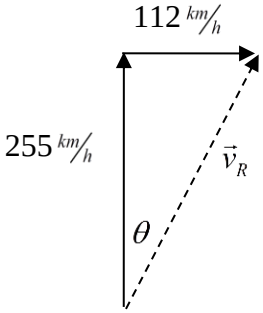
$\vec{v}_f = \sqrt{12^2 - 3^2}$

$\vec{v}_f = 11.6\,{}^{km}/_{h}$

$\vec{v}_f = \dfrac{\Delta\vec{d}}{\Delta t}$

$\Delta t = \dfrac{\Delta\vec{d}}{\vec{v}_f} = \dfrac{100km}{11.6\,{}^{km}/_{h}} = \boxed{8.6h}$

8)



$v_R = \sqrt{112^2 + 255^2}$

$v_R = 279\,{}^{km}/_{h}$

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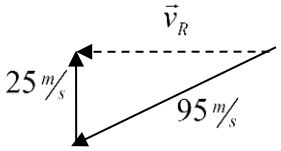
$\tan\theta = \dfrac{112}{255}$

θ=23.7° E of N

$\boxed{\vec{v}_R = 279\,{}^{km}/_{h}\ [23.7°\text{ E of N}]}$

9)



a) $\sin\theta = \frac{25}{95}$ $\boxed{\theta = 15.3°\text{ S of W}}$

b) $\vec{v}_R = \sqrt{95^2 - 25^2}$

$\boxed{\vec{v}_R = 91.7\ ^m/_s}$

c) $\Delta d = v_R \cdot \Delta t = 91.7\ ^m/_s\,(8100\text{s})$

$\boxed{\Delta d = 743 km(west)}$

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10) a) fastest $\rightarrow$ aim straight across and let the current carry you

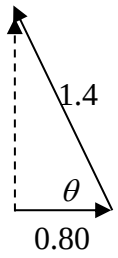
$\Delta t = \frac{\Delta d}{\Delta v} = \frac{70m}{1.4\ ^m/_s}$

$\Delta t = \boxed{50s}$

b) $\Delta\vec{d} = v_R \times \Delta t = 0.8\ ^m/_s\,(50\text{s})$

$\boxed{\Delta\vec{d} = 40m}$

c)



$\theta = \cos^{-1}\left(\frac{0.80}{1.4}\right)$

$\theta = 55°$

d) $v_R = \sqrt{1.4^2 - 0.80^2}$

$v_R = 1.15\ ^m/_s$

$\Delta t = \frac{\Delta d}{\Delta v} = \frac{70m}{1.15\ ^m/_s} = \boxed{61s}$

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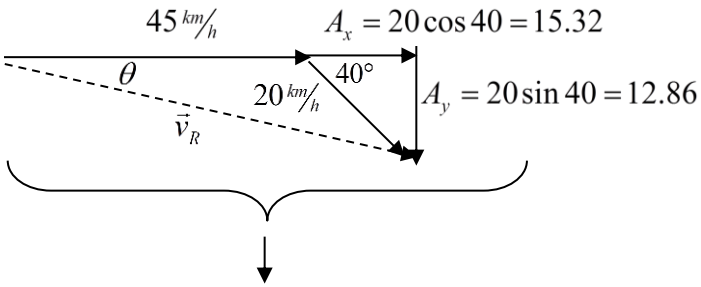
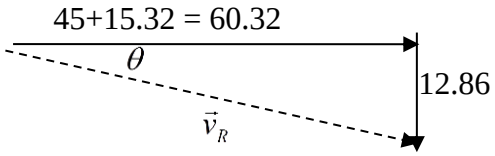
11)





$v_R = \sqrt{60.32^2 + 12.86^2}$

$v_R = 61.7\ ^{km}/_h$

$\tan\theta = \frac{12.86}{60.32}$

$\theta = 12.0°$ S of E

$\boxed{\vec{v}_R = 61.7\ ^{km}/_h\ [12.0°\text{ S of E}]}$

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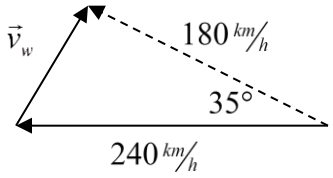
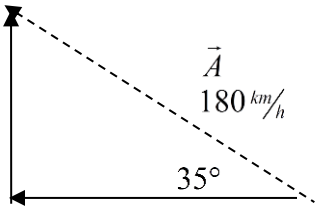
12)



$A_y = 180\sin 35$
$A_y = 103.24$



$A_x = -180\cos 35$
$A_x = -147.45$

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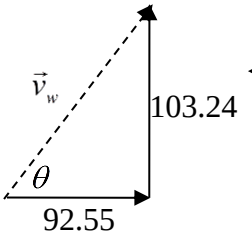

$v_{wx} = +(240 - 147.45)$
$= 92.55$
$v_{wy} = 103.24$
$v_w = \sqrt{92.55^2 + 103.24^2}$
$v_w = 138.7$
$\tan\theta = \dfrac{103.24}{92.55}$ θ=48.1° N of E
$\boxed{\vec{v}_w = 138.7\ km/h\ [48.1°\text{ N of E}]}$