Kinematics 2D -Solutions

1. (a) $r = 53m$ $C = \pi r = 166.5m$

$D = \bar{v}t = 25t = 166.5$

$\boxed{t = 6.66s}$ (a) 5

$v_0 = 32$, $v_f = 18$ $\quad a = \frac{\Delta v}{\Delta t}$

$\bar{v} = \frac{18+32}{2} = 25$

(b) $v = at + v_0$

$18 = a(6.66) + 32$

$-14 = a(6.66)$

$a = \boxed{-2.10 m/s^2 \text{ WEST}}$ (b) 4

(c) $D = \frac{1}{2}at^2 + v_0 t = \frac{-2.1}{2}t^2 + 32t = \frac{166.5}{2}$

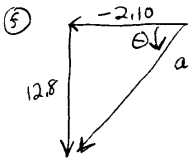
$-1.05t^2 + 32t - 83.25 = 0$

$t = 2.87, 27.6s$

$v = at + v_0 = -2.1(2.87) + 32 = 25.97 = \boxed{26.0 \text{ m/s EAST}}$ (c)

(d) $a_c = \frac{v^2}{r} = \frac{26^2}{53} = 12.76 = \boxed{12.8 m/s^2 \text{ SOUTH}}$ (d) 4

(e) SAME AS B

(f) 

$a = \sqrt{12.8^2 + 2.1^2} = \boxed{12.93 m/s^2 \text{ at } 80.7° \text{ SW OR } 201°}$ (f) 4

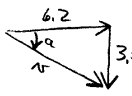
at

$\tan\theta = \frac{12.8}{2.1} \Rightarrow \theta = 80.7° \text{ SW}$

2. (a) $D = \bar{v}t$

$310 = 6.2t$

$\boxed{t = 50s}$ (a) 5

(b) 

$v = \sqrt{6.2^2 + 3.5^2} = \boxed{7.12 m/s \text{ at } 29.4° \text{ DOWNSTREAM}}$ (b)

$\tan a = \frac{3.5}{6.2} \Rightarrow a = 29.4°$

OR

$v = (6.2\hat{i} - 3.5\hat{j}) m/s$

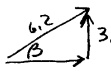
(c) $7.12 \text{ at } 29.4° \times 50s = \boxed{356m \text{ at } 29.4° \text{ DOWNSTREAM}}$ (c) 4

OR

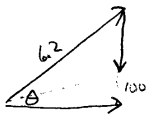
OR

$(6.2\hat{i} - 3.5\hat{j}) m/s \times 50s = (310\hat{i} - 175\hat{j}) m$

(d) $D_0 = \frac{310}{6.2+3.5} + \frac{310}{6.2-3.5} = 31.96s + 114.8s = 146.8s = \boxed{147s}$ (d) 4

(e) 

$\sin\beta = \frac{3.5}{6.2} = \boxed{34.4° \text{ UPSTREAM}}$ (e) 4

(f) 

$t = \frac{310}{6.2\cos\theta} \Rightarrow t\cos\theta = 50$

$100 = (6.2\sin\theta - 3.5)t$

$\frac{100 = 6.2t\sin\theta - 3.5t}{50 = t\cos\theta}$

$2 = 6.2\tan\theta - \frac{3.5}{\cos\theta} = \frac{6.2\sin\theta}{\cos\theta} - \frac{3.5}{\cos\theta} = \frac{6.2\sin\theta - 3.5}{\cos\theta}$

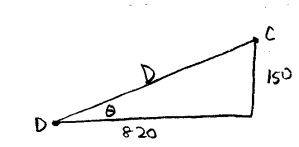
$\underbrace{2\cos\theta}_{1.29} = \underbrace{6.2\sin\theta - 3.5}$

$\boxed{\theta = 50.9°}$ (.25) (f) 4

$127.5 \overset{\checkmark}{=} 127.7$

Kinematics 2D -Solutions

3.



(a) $D = \sqrt{820^2 + 150^2} = 833.6$ miles

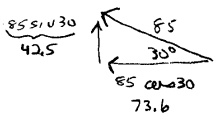
$\tan\theta = \frac{150}{820} = 10.37°$ NE

OR $\frac{820}{1.5}\hat{i} + \frac{150}{1.5}\hat{j} = (547\hat{i} + 100\hat{j})$ mph

10:15 − 8:45 = 1:30

$\frac{833.6 \text{ mi}}{1.5 \text{ h}} =$ **556 mph at 10.4° NE** (a)

(b)



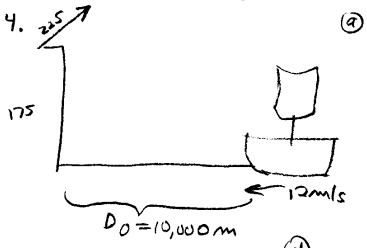
$v_{wind} = -73.6\hat{i} + 42.5\hat{j}$

$+547\hat{i} + 100\hat{j} = (473\hat{i} + 142.5\hat{j})$ m/s = **494 mph at 16.8° N** (b)

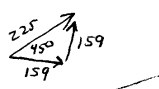
(c) $(-73.6\hat{i} + 42.5\hat{j})\,1.5\text{ hrs} = (-110\hat{i} + 63.8\hat{j})$ miles OR **127 miles at 30.1° NW** (c) 5

(d) $547\hat{i} + 100\hat{j} - (-73.6\hat{i} + 42.5\hat{j}) = 620.6\hat{i} + 57.5\hat{j} =$ **623 at 5.3° mph** (d) 5

4.



(a)



$0 = -4.9t^2 + 159t + 175$

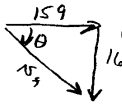
$t =$ **33.55** (b) 5

$D_H = v_H t$

$= 159(33.5) =$ **5327 m**

(b)

(c)



$v_y = -9.8(33.5) + 159$

$v = \sqrt{159^2 + 169.3^2} =$ **232 m/s at 46.8° DOWN**

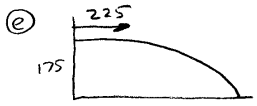
OR $(159\hat{i} - 169\hat{j})$ m/s

$\tan\theta = \frac{169}{159} = 46.8°$

(d)

10,000 − 5327 = 4673 m ÷ 12 = 389.4 s − 33.5 s = **356 s** (d) 5

(e)

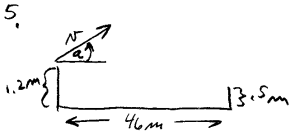


$0 = -4.9t^2 + 0 + 175$

$t = 5.98$ s

$R = 225(5.98) =$ **1345 m** (e) 5

5.



$(v\cos a)t = 46$

$t = 5$ s

$v\cos a = \frac{46}{5}$

$v\cos a = 9.2$

$D_y = \frac{1}{2}at^2 + v_0 t + D_0$

$.5 = -4.9(5)^2 + v\sin a\,(5) + 1.2$

$\frac{v\sin a = 24.36}{v\cos a = 9.2} = 2.648 = \tan a$

$a =$ **69.3°** (d) 5

$v\sin(69.3) = 24.36$

$v = 26.0$ m/s

$v = at + v_0$

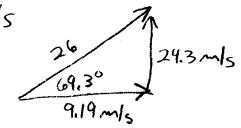
$0 = -9.8t + 24.3$

$t = 2.48$ s

$D_y = \frac{1}{2}at^2 + v_0 t + D_0$

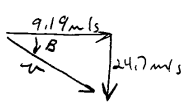
$= -4.9(2.48)^2 + 24.3(2.48) + 1.2$

$H =$ **31.3 m** (a) 5



$9.19\hat{i}$ m/s, 5 + $24.3\hat{j}$ m/s, 5 (b)

(c)



$v = -9.8(5) + 24.3$

$\sqrt{24.7^2 + 9.19^2} =$ **26.4 m/s** (c) 5 at 69.6°

$\tan^{-1}\left(\frac{24.7}{9.19}\right) = 69.6°$