Projectile Motion

① (a)

if final velocity is horizontal then final velocity in the y direction is 0.

x	y
$v = 2.3\cos\theta$	$v_i = 2.3\sin\theta$
$d = ?$	$a = -9.8\ m/s^2$
$t = ?$	$d = 0.03\ m$
	$V_f = 0$

$$V_f^2 = V_i^2 + 2ad$$
$$0 = (2.3\sin\theta)^2 + 2(-9.8)(.03)$$
$$5.29\sin^2\theta = 0.0588$$
$$\sqrt{\sin^2\theta} = \sqrt{0.0111}$$
$$\sin\theta = .1054$$
$$\underline{\theta = 6.05^\circ}$$

(b) y

$V_i = 2.3\sin(6.05) = 0.2424$
$a = -9.8\ m/s^2$
$d = 0.03\ m$
$V_f = 0$

$$V_f = V_i + at$$
$$0 = .2424 - 9.8t$$
$$\underline{t = 0.02\ s}$$

(c) x

$V = 2.3\cos(6.05) = 2.2872$
$d = ?$
$t = 0.02\,s$

$V = \frac{d}{t}$ $\qquad 2.2872 = \frac{d}{0.02}$ $\qquad \underline{d = 0.046\ m}$

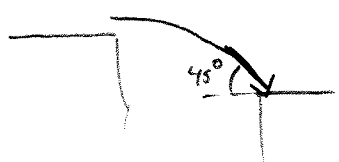
(2)

x	y
$v = 3.60$ m/s	$v_i = 0$
$d = ?$	$a = -9.8\ m/s^2$
$t = ?$	$d = -108$ m
	$v_f = ?$

$$v_f^2 = v_i^2 + 2ad$$
$$= 2(-9.8)(-108)$$
$$\sqrt{v_f^2} = \sqrt{2116.8}$$
$$v_f = 46$$

but the water is falling, so $\underline{v_f = -46\ m/s}$

(3)



(a)

x	y
$V = 8$ m/s	$v_i = 0$
$d = 3.0$m	$a = -9.8\ m/s^2$
$t =$	$d = ?$
	$t = .375$s

$$V = \frac{d}{t}$$
$$8 = \frac{3}{t}$$
$$t = .375\text{s}$$

$$d = v_i t + \tfrac{1}{2} a t^2$$
$$= \tfrac{1}{2}(-9.8)(.375)^2$$
$$d = -.689$$

height difference is 0.689 m.

(b) The climber lands on the edge of the other side. of the crevasse.

④ (a) maximum $\theta = 45°$

$\underline{x}$

$v_i = 30 \cos 45 = 21.21$
$d = ?$
$t = ?$

$v = \frac{d}{t}$

$21.21 = \frac{d}{4.33}$

$\underline{d = 91.8\,m}$

$\underline{y}$

$v_i = 30 \sin 45 = 21.21$
$a = -9.8\ m/s^2$
$d = 0$ (starts and ends on the ground)
$t = ?$

$d = v_i t + \frac{1}{2} a t^2$
$0 = 21.21\,t + \frac{1}{2}(-9.8)t^2$

$4.9\,t^{\cancel{2}} = 21.21\,\cancel{t}$
$t = 4.33\,s$

(b) minimum speed would be when the vertical speed was zero at the top of the path.
If vertical speed is zero, then the only speed will be the horizontal at 21.21 m/s.

(c) maximum height when velocity in y-direction is 0.

$\underline{y}$

$v_i = 21.21\ m/s$
$a = -9.8\ m/s^2$
$d = ?$
$v_f = 0$

$v_f^2 = v_i^2 + 2ad$
$0 = (21.21)^2 + 2(-9.8)d$
$19.6\,d = 449.86$
$\underline{d = 23\,m}$

(5) (a) people on the ground will see the cork travel $5.0 + 2.0 = \underline{7.0\ m/s}$

(b) $\underline{\quad y \quad}$

$v_i = 7.0\ m/s$
$a = -9.8\ m/s^2$
$d = ?$
$v_f = 0$

$v_f^2 = v_i^2 + 2ad$
$0 = 7^2 + 2(-9.8)d$
$19.6d = 49$
$\underline{d = 2.5\ m}$

(c) $v_i = 7.0\ m/s$
$a = -9.8\ m/s^2$
$d = -6.0m$ (distance to ground)
$t = ?$

$d = v_i t + \frac{1}{2}at^2$
$-6 = 7t + \frac{1}{2}(-9.8)t^2$

$4.9t^2 - 7t - 6 = 0$

$t = \frac{7 \pm \sqrt{(-7)^2 - 4(4.9)(-6)}}{2(4.9)}$

$t = \frac{7 \pm 12.9}{9.8}$

$\underline{t = 2.03\ s}$

6 (a)

x	y
$V = 2.5\ m/s$	$V_i = 0$
$d = 1.96\ m$	$a = -9.8\ m/s^2$
$t = ?$	$d = ?$
	$t = ?$

$$V = \frac{d}{t}$$

$$2.5 = \frac{1.96}{t}$$

$$t = 0.784$$

$$d = V_i t + \frac{1}{2} a t^2$$

$$= \frac{1}{2}(-9.8)(.784)^2$$

$$d = -6.02$$

diving board is 6.02 m high

(b) The horizontal speed of the ronner will not change the amount of time to reach the water, only how far away from the diving board the swimmer lords.

7 (a)

x	y
$V = 5\ m/s$	$V_i = 0$
$d = ?$	$a = -9.8\ m/s^2$
$t = 2.94\ s$	$d = -169.16\ m$
	$t = ?$

$$V = \frac{d}{t}$$

$$5 = \frac{d}{2.94}$$

$$d = 14.7$$

$$d = V_i t + \frac{1}{2} a t^2$$

$$-169.16 = \frac{1}{2}(-9.8)t^2$$

$$\sqrt{t^2} = \sqrt{8.63}$$

$$t = 2.94\ s$$

The ball landed 14.7 m away from the base of the monumant.

(b) $\underline{\quad y \quad}$

$v_i = 0$

$a = -9.8\ m/s^2$

$d = -169.16\ m$

$t = 2.94\ s$

$v_f = ?$

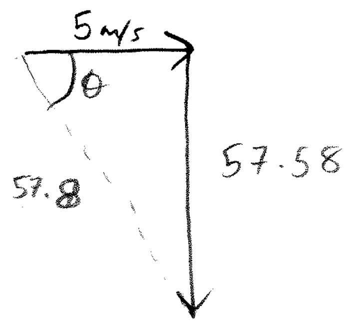
$$v_f^2 = v_i^2 + 2ad$$

$$= 2(-9.8)(-169.16)$$

$$\sqrt{v_f^2} = \sqrt{3315.54}$$

$$v_f = -57.58\ m/s$$

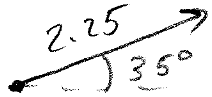
The final speed combines both horizontal and vertical velocities. so...



57.8 m/s 85° below the horizontal.

$$\tan\theta = \frac{57.58}{5}$$

(8)

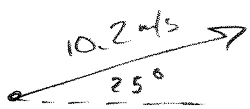


x	y
$V = 2.25 \cos 35 =$	$v_i = 2.25 \sin 35 = 1.29$ m/s
	$a = -9.8$ m/s^2
	$d = ?$
	$t = 1.6$ s

$$d = v_i t + \frac{1}{2} a t^2$$
$$= 1.29(1.6) + \frac{1}{2}(-9.8)(1.6)^2$$
$$= -10.48$$

10.48 m above the water.

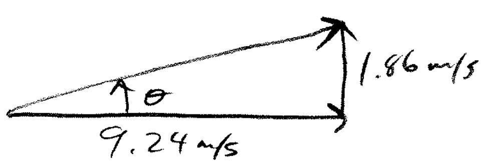
(9)



(a)

x	y
$V = 10.2 \cos 25 = 9.24$ m/s	$V_i = 10.2 \sin 25 = 4.31$
	$a = -9.8$ m/s^2
	$t = .25$ s
	$V_f = ?$

$$V_f = V_i + at$$
$$= 4.31 - 9.8(.25)$$
$$= 1.86 \text{ m/s}$$



$$\tan\theta = \frac{1.86}{9.24} =$$
$$\theta = 11.38$$

9.43 m/s 11.4° above the horizontal

(b) velocity in x-direction is the same (constant)

$\underline{y}$

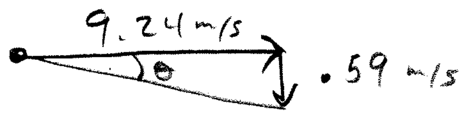
$v_i = 4.31$ m/s

$a = -9.8$ m/s^2

$t = 0.5$ s

$v_f = ?$

$$v_f = v_i + at$$
$$= 4.31 - 9.8(.5)$$
$$= -.59 \text{ m/s}$$



$$\tan\theta = \frac{.59}{9.24}$$
$$\theta = 3.7^\circ$$

9.26 m/s 3.7° below the horizontal

(c) The ball is at its greatest height between .25 and .5 s. At .25 s the velocity in the y-direction is positive indicating that the ball is going up. At .5 s the velocity in the y-direction is negative indicating that the ball is going down. At its maximum height, the velocity of the ball in the y-direction would be zero, it would only be changing direction.