Physics

Chapter 3 Math, Constant Horiz acceleration.

In class practice

Take off distance:

$V = 33 m/s$

$a = 3.100 m/s^2$

We know that $V^2 = u^2 + 2as$ but $u = 0$.

Therefore $V^2 = 2as$

$$s = \frac{V^2}{2a} = \frac{33^2}{2 \times 3} = 181.5 m$$

Emergency stopping distance

$u = 25.0 m/s = 55 mph$

$t = 4 s$

$V = u - at$

$0 = 25 - a(4)$.

$\frac{4a}{4} = \frac{25}{4} \Rightarrow a = 6.25 m/s^2$

$V^2 = u^2 - 2as$ but $v = 0$.

$u^2 = 2as$

$$\frac{25^2}{2a} = s = \frac{25^2}{2 \times 6.25} = 50 m$$

Slowing down

$u = 115 km$ in $m/s = 115 \times 5/18 = 31.944 m/s$

$v = 92 km/h$ in $m/s = 92 \times 5/18 = 25.56 m/s$

$V^2 = u^2 - 2as$

$25.56^2 = 31.944^2 - 2a(75)$.

$25.56^2 = 31.944^2 - 150a$

$$a = \frac{31.944^2 - 25.56^2}{150} = 2.45 m/s^2$$

b) $V = u - at$.

$25.56 = 31.944 - 2.45t$.

$\frac{31.944 - 25.56}{2.45} = t = 2.615$

Homework.

1. $u = 23.0 \text{ m/s}$

$s = 85.0 \text{ m}$

$v = 0$

$$v^2 = u^2 - 2as$$

$$0 = 23^2 - 2(a)85).$$

$$a = \frac{23^2}{2 \times 85} = 3.11 \text{ m/s}^2$$

2. $u = 13.0\ m/s$

$V = 25.0\ m/s$

$t = 6.00\ s$

$$V = u + at$$

$$25 = 13 + a(6)$$

$$25 - 13 = 6a$$

$$\frac{12}{6} = \frac{6a}{6} \Rightarrow a = 2\ m/s^2$$

$$V^2 = u^2 + 2as$$

$$25^2 = 13^2 + 2 \times 2 \times s$$

$$25^2 = 13^2 + 4s$$

$$25^2 - 13^2 = 4s$$

$$\frac{456}{4} = \frac{4s}{4} \Rightarrow s = 114\ m$$

3. $u = 85 km/h$

$u = 85 \times \frac{5}{18} m/s = 23.61 m/s$

$V = 0 m/s$

$s = 0.8 m$

$V^2 = u^2 - 2as$

$0 = 23.61^2 - 2a(0.8)$

$a = \frac{23.61^2}{1.6} = 348.39 m/s^2$

4. $a = 1.6 m/s^2$

$V = 110 km/h = 110 \times \frac{5}{18} m/s = 30.56 m/s$

$u = 80 km/h = 80 \times \frac{5}{18} m/s = 22.22 m/s$

$V = u + at$

$\frac{V-u}{a} = t = \frac{30.56 - 22.22}{1.6} = 6.74 s$

5. $u = 5\ km/h = 5 \times \frac{5}{18}\ m/s = 1.39\ m/s$

$v = 20\ km/h = 20 \times \frac{5}{18}\ m/s = 5.56\ m/s$

$t = 10s$

$$a = \frac{v-u}{t} = \frac{5.56 - 1.39}{10} = 0.417\ s$$

Extra practice

1. $V = 0$

$u = 21 m/s$ $\quad a = \frac{V-u}{t} = \frac{0-21}{6} = -3.5 m/s^2$

$t = 6s$ $\quad = 3.5 m/s^2$ deceleration

$V^2 = u^2 - 2as$

$0 = 21^2 - 2 \times 3.5 \times s$

$\frac{21^2}{7} = s = 63m$

2. $u = 25 km/h = 2.5 \times \frac{5}{18} m/s = 0.694 m/s$

$a = 12.5 m/s^2$

$s = 198$

$V^2 = u^2 + 2as$

$V^2 = 0.694^2 + 2 \times 12.5 \times 198$

$V = \sqrt{0.694^2 + 2 \times 12.5 \times 198} = 70.35 = 70.4 m/s$

3. $u = 15.0 m/s$

$v = 5 m/s$

$t = 5s$

$a = \frac{V-u}{t} = \frac{5-15}{5} = \frac{-10}{5} = -2 m/s^2$

4. $h = 3m$

$h = \frac{1}{2}gt^2$ because the free fall

$t = \sqrt{\frac{2h}{g}}$

$t = \sqrt{\frac{6}{9.81}} = 0.78s$

5. ~~u=u~~ $u = 10 m/s$

$h = 100 m$

$h = ut + \frac{1}{2}gt^2$

$v^2 = u^2 + 2gh$

$v^2 = 10^2 + 2 \times 9.81 \times 100$

$v = \sqrt{2062} = 45.41 m/s$

$h = ut + \frac{1}{2}gt^2$

$100 = 10t + \frac{1}{2} \times 9.81 t^2$

$200 = 20t + 9.81t^2$

$9.81t^2 + 20t - 200 = 0$

$t = -5.65$ or $t = 3.61 s$

$\therefore t = 3.6 s$

6. $u = 8.5 m/s$

$t = 3.20 s$

$h = ut + \frac{1}{2}gt^2$

$h = 8.5(3.2) + \frac{1}{2} \times 9.81 \times 3.2^2$

$h = 27.2 + 50.22 = 77.43 m$

7. $h_{max} = \frac{u^2}{2g} = \frac{22^2}{2 \times 9.81} = 24.67 m$

time of flight $= \frac{2u}{g} = \frac{2 \times 22}{9.81} = 4.49 s$

8. $t = \frac{2u}{g}$ $t = 3s$

$u = \frac{tg}{2} = \frac{3 \times 9.81}{2} = 14.715 m/s$

$h_{max} = \frac{u^2}{2g} = \frac{14.74^2}{2 \times 9.81} = 11.03\ m$

9. a) $h_{max} = \frac{u^2}{2g} = \frac{2000}{2 \times 9.81} = 2038.74\ m$

$v^2 = u^2 + 2gh$ (as the bullet drops $u = 0$)

b) $v^2 = 2gh = 2 \times 9.81 \times 2038.74$

$v^2 = \sqrt{2 \times 9.81 \times 2038.71} = 200\ m/s$

c) $t = \frac{2u}{g} = \frac{2(200)}{9.81} = 40.80\ s$

10. $h = 380\ m$

$h = \frac{1}{2} g t^2$

$380 = \frac{1}{2} \times 9.81 t^2$

$\sqrt{\frac{760}{9.81}} = t = 8.80\ s$

$v^2 = u^2 + 2gh \quad u = 0$

$v^2 = 2gh = 2 \times 9.81 \times 380$

$v = \sqrt{2 \times 9.81 \times 380} = 86.35\ m/s$

11. $u = 18.0\ m/s \quad h = 11$

$v^2 = u^2 + 2gh = u^2 - 2gh$

$v^2 = 18^2 - 2 \times 9.81 \times 11 = 108.18$

$v = \sqrt{108.18} = 10.40\ m/s$

12. $h = 3200m - 350 = 2850\,m$

$V^2 = u^2 + 2gh \quad u = 0$

$V^2 = 2gh = 2 \times 9.81 \times 2850$

$V^2 = 55917.0$

$V = \sqrt{55917.} = 236.47\,m/s$

$h = \frac{1}{2}gt^2$

$2850 = \frac{1}{2} \times 9.81 \times t^2$

$\frac{2850 \times 2}{9.81} = t^2$

$t = \sqrt{\frac{2850 \times 2}{9.81}} = 581s$

Physics

Chapter 3 Math

Constant acceleration Test

1. $u = 0$

$v = 11.5 \text{ m/s}$

$s = 15 \text{ m}$

(a) From the formula $v^2 = u^2 + 2as$

$$a = \frac{v^2 - u^2}{2s}$$

$$a = \frac{11.5^2 - 0}{2 \times 15} = 4.408 \text{ m/s}^2$$

(b) $v = u + at$.

$$\therefore t = \frac{v - u}{a} = \frac{11.5 - 0}{4.408} = 2.61 s$$

3. $a = 277 \text{ m/s}^2$

$s = 3.5 \text{ m}$

$u = 0$

$v = ?$

We know that $v^2 = u^2 + 2as$

$v^2 = 0 + 2 \times 277 \times 3.5$

$v^2 = 1939$

$v = \sqrt{1939} = 44.034 \text{ m/s}$

acceleration test

3. $u = 110 \text{ km/h} = 110 \times 5/18 = 30.56 \text{ mtr}$
$v = 0$
$t = 6.80 \text{ s}$

a) $a = \frac{v-u}{t} = \frac{0-30.56}{6.8} = -4.494 \text{ m/s}^2$

b) $v^2 = u^2 + 2as$
$0 = 30.56^2 - 2(4.494)s$
$s = \frac{30.56^2}{2(4.494)} = 103.91 \text{ m}$

4. $u = 72.4 \text{ km/h} = 72.4 \times 5/18 = 20.11 \text{ m/s}$
$v = 0$
$a = -3.61 \text{ mtr}$
$t = 5.57 \text{ s}$

actual deceleration $a = \frac{v-u}{t} = \frac{0-20.11}{5.57} = -3.61 \text{ m/s}$

$v^2 = u^2 - 2as$
$\frac{v^2-u^2}{2a} = s \quad \frac{0-20.11^2}{2 \times -3.61} = s = 56.01 \text{ m}$

Physics

Chapter 3 Math

Conceptual free fall problems

1.

	How fast it is falling after	How far it has fallen
1s	10 m/s	5 m
2s	20 m/s	20 m
3s	30 m/s	45 m
4s	40 m/s	80 m
5s	50 m/s	125 m

How fast

$V = 10t$

for 1s $V = 10(1) = 10 m/s$

2s $V = 10(2) = 20 m/s$

3s $V = 10(3) = 30 m/s$

4s $V = 10(4) = 40 m/s$

5s $V = 10(5) = 50 m/s$

How far $y = 5t^2$

1s $y = 5(1^2)$

2s $y = 5(2^2)$

3s $y = 5(3^2)$

4s $y = 5(4^2)$

5s $y = 5(5^2)$

2.

	How fast it is falling after	How far it has fallen after
1s	30 m/s	5
2s	40 m/s	20
3s	50 m/s	45
4s	60 m/s	80
5s	70 m/s	125

$V = 10t$

1s $= 20 + 10(1)$

2s $= 20 + 10(2)$

3s $= 20 + 10(3)$

4s $= 20 + 10(4)$

5s $= 20 + 10(5)$

$y = 5t^2$

1s $y = 5(1^2) = 5$

2s $y = 5(2^2) = 20$

3s $y = 5(3^2) = 45$

4s $y = 5(4^2) = 80$

5s $y = 5(5^2) = 125$

3.

	How far is it travelling after:	How far above the ground:
3s	30 m/s	45
6s	0 m/s	180
7s	10m/s	175
9s	30 m/s	135
10s	40 m/s	100m

Initial speed = 60 m/s

$V = 10(t)$

1s $= 60 - 10(3) = 30$

6s $= 60 - 10(6) = 0$

7s $= 7 - 6 = 1s = 10(t) = 10(1)$

9s $= 9 - 6 = 3s = 10(3) = 30$

10s $= 10 - 6 = 4s = 10(4) = 40$

3s $y = 5(t^2)$

$= 5(3^2)$

6s $y = 5(6^2)$

1s $y = 5(1^2) = 180 - 5$

9s $t = 9 - 6 = 3s$ $y = 5(3^2) = 45$

10s $t = 4s$ $y = 5(4^2) = 80$ Height above the Ground $= 180 - y(t)$

4.

	How fast it is travelling	How far above / below the cliff
4s	0	80 above
8s	40 m/s	0 m above
10s	60 m/s	100m below
12s	80 m/s	320 m below
14s	100 m/s	580 m below

Initial speed = 40 m/s

after 4s $V = 10(t) = 40 - 40 = 0$

8s $V = 10(t) = 80$ m/s

10s $V = 10(10) = 100$ m/s

at $t = 12s$

$V = 10(8) = 80$

at $t = 14s$ $V = 10(10) = 100$ m/s

$y = 5t^2$

when $t = 4s$

$y = 5(4^2) = 80$ m

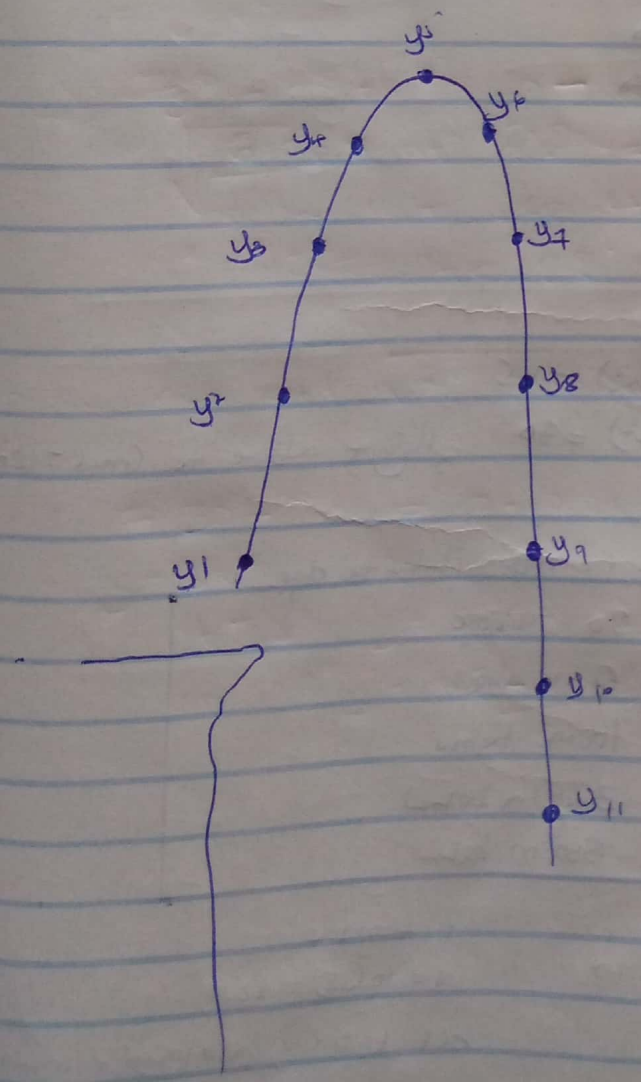
at 8s $y = 5(4^2) = 80$ m below the upper point reached. the ball is in level with the cliff

after 10s $y = 5(6^2) = 180$

12s $y = 5(8^2) = 320$

14s $y = 5(10^2) = 500$ m below

Conceptual free fall practice.



at y_1 $t=0$

$V_0 = 40$ $\quad V_0 - 4(10) = 0$ $\quad V_0 = 40$ m/s

$y_1 = 5(t^2) = 5(0^2) = 0$

at $t=1$

$y_2 = 5(t^2) = 5$ m

$V = 40 - 10(1) = 30$ m/s

at $t=2$ $\quad y_3 = 5(t^2) = 5(2^2) = 20$ m

$V = 40 - 10(2) = 20$ m/s

at $t=3$ $\quad y_4 = 5(t^2) = 5(3^2) = 45$ m

$V = 40 - 10(3) = 10$ m/s

at 4 m $\quad V = 40 - 10(4) = 0$ m/s

$y_5 = 5(t^2) = 5(4^2) = 80$

at $t=5$

$y_6 = 80 - 5(1^2) = 75$ m

$V = 10(t) = 10$ m/s

at $t=6$

$y_7 = 80 - 5(2^2) = 60$ m

$V = 10(t) = 10(2) = 20$ m/s

at $t=7$

$y_8 = 80 - 5(3^2) = 35$ m

$V = 10(3) = 30$ m/s

at $t=8$

$y_9 = 80 - 5(4^2) = 0$ m

$V = 10(8) = 40$ m/s

at $t=9$

$y_{10} = 80 - 5(5^2) = -45$ m below cliff

$V = 10(5) = 50$ m/s

at $t=10$

$y_{11} = 80 - 5(6^2) = -100$ m below cliff

$V = 10(6) = 60$ m/s

Speed at 4s when released at 30m/s

$V = 30 + 10(t) = 30 + 10(4) = 70 m/s$

$y = 5t^2 = 5(4^2) = 80m$

Position & speed of a ball released at 10m/s after 6s

$V = 10 + 10(t)$

$= 10 + 60(10) = 70 m/s$

$y = 5t^2 = 5(6^2) = 180m$

Position and speed of a ball thrown upwards at a speed of 50m/s after 8s

Velocity $= 10(t) = 50 + 10(t) = 50 + 10(8) = -30 m/s$

Speed at 8s = 30m/s but downward.

position after 5seconds $= y = 5t^2 = 5(5^2) = 125'$

position after 8s $= 125 - 5(3^2) = 80M$ above ground.

position and speed with initial speed of 30m/s at 8s

$V = 30 - 10(t) = 30 - 10(8) = -50 m/s = 50 m/s$ downward

$y = 5t^2$

at 3s $y = 5(3^2) = 45'$

at 8s $y = 45 - 5(3^2) = -80m = 80m$ below the ground