UNIFORMLY ACCELERATED MOTION - SOLUTIONS

1. GIVEN:

$v_i = 120 \frac{m}{s}$

$v_f = 160 \frac{m}{s}$

$a = 8.0 \frac{m}{s^2}$

$t = ?$

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a}$$

$$= \frac{160 - 120}{8.0}$$

$$= \boxed{5\ s}$$

2. GIVEN:

$v_i = 60.0 \frac{km}{h} \xrightarrow{\div 3.6} = 16.\overline{66} \frac{m}{s}$

$a = 2.0 \frac{m}{s^2}$

$v_f = 90.0 \frac{km}{h} \xrightarrow{\div 3.6} = 25.0 \frac{m}{s}$

$t = ?$

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a}$$

$$= \frac{25.0 - 16.\overline{66}}{2.0}$$

$$= \boxed{4.2\ s}$$

3. GIVEN:

$v_i = +20.0 \frac{m}{s}$

$t = 3.0\ s$

$a = -9.8 \frac{m}{s^2}$

$v_f = ?$

$$v_f = v_i + at$$

$$= +20.0 + (-9.8)(3.0)$$

$$= -9.4 \frac{m}{s}$$

$$\longrightarrow \boxed{9.4 \frac{m}{s}\ \text{DOWN}}$$

4. a) GIVEN:

$d = +36.0\text{ m}$

$V_i = 0$

$a = +9.8\ \frac{m}{s^2}$

$V_f = ?$

$\downarrow$
$+$

$$V_f^2 = \cancelto{V_i=0}{V_i^2} + 2ad$$

$$V_f^2 = 2ad$$

$$V_f = \sqrt{2ad}$$

$$= \sqrt{2(9.8)(36.0)}$$

$$= 27\ \frac{m}{s}$$

b) GIVEN:

$d = +36.0\text{ m}$

$V_i = 0$

$a = +9.8\ \frac{m}{s^2}$

$t = ?$

$\downarrow$
$+$

$$d = \cancelto{V_i=0}{v_i t} + \frac{1}{2}at^2$$

$$d = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2d}{a}}$$

$$= \sqrt{\frac{2(36.0)}{9.8}}$$

$$= 2.7\text{ s}$$

5. GIVEN:

$t = 2.1\text{s}$

$V_i = 0$

$a = +9.8\ \frac{m}{s}$

$d = ?$

$\downarrow$
$+$

$$d = \cancelto{V_i=0}{v_i t} + \frac{1}{2}at^2$$

$$= \frac{1}{2}at^2$$

$$= \frac{1}{2}(+9.8)(2.1)^2$$

$$= 22\text{ m}$$

6. GIVEN:

$v_i = 40.\ \frac{m}{s}$

$v_f = 80.\ \frac{m}{s}$

$d = 200.\ m$

$a = ?$

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

$$a = \frac{v_f^2 - v_i^2}{2d}$$

$$= \frac{(80.)^2 - (40.)^2}{2(200.)}$$

$$= 12\ \frac{m}{s^2}$$

7. GIVEN:

$d = +99.0\ m$

$a = -9.8\ \frac{m}{s}$

$v_f = 0$

$v_i = ?$

$v_f = 0$

$$\cancel{v_f}^2 = v_i^2 + 2ad$$

$$0 = v_i^2 + 2ad$$

$$v_i = \sqrt{-2ad}$$

$$= \sqrt{-2(-9.8)(+99.0)}$$

$$= \enclose{circle}{\pm} 44\ \frac{m}{s}$$

WE REJECT THE NEGATIVE VALUE. WE ARE TOLD THE BALL IS THROWN UPWARDS (+).

$\longrightarrow$ $44\ \frac{m}{s}$ UP

8. GIVEN:

$v_i = +14.0\ \frac{m}{s}$

$v_f = +4.0\ \frac{m}{s}$

$t = 10.0\ s$

$a = ?$

$\longrightarrow +$

$$v_f = v_i + at$$

$$a = \frac{v_f - v_i}{t}$$

$$= \frac{4.0 - 14.0}{10.0}$$

$$= -1.0\ \frac{m}{s^2}$$

$\longrightarrow$ $1.0\ \frac{m}{s^2}$ WEST

9. GIVEN:

$t = 2.0 s$

$V_i = 0$

$V_f = 42 \frac{m}{s}$

$d = ?$

$$d = \left(\frac{\cancelto{0}{V_i} + V_f}{2}\right) t$$

$$= \frac{V_f}{2} t$$

$$= \frac{42}{2}(2.0)$$

$$= 42 d$$

10. a) GIVEN:

$a = -5.0 \frac{m}{s^2}$

$V_i = +89.5 \frac{km}{h} = +24.86\overline{11} \frac{m}{s}$

$V_f = 0$

$t = ?$

$$\cancelto{0}{V_f} = V_i + at$$

$$0 = V_i + at$$

$$t = -\frac{V_i}{a}$$

$$= -\frac{(+24.86\overline{11})}{(-5.0)}$$

$$= 5.0 s$$

b) GIVEN:

$a = -5.0 \frac{m}{s^2}$

$V_i = +89.5 \frac{km}{h} = +24.86\overline{11} \frac{m}{s}$

$V_f = 0$

$d = ?$

$$\cancelto{0}{V_f^2} = V_i^2 + 2ad$$

$$0 = V_i^2 + 2ad$$

$$d = -\frac{V_i^2}{2a}$$

$$= -\frac{(+24.86\overline{11})^2}{2(-5.0)}$$

$$= 62 m$$

11. GIVEN:

$t = 10.0\,s$

$a = -9.8\,\frac{m}{s^2}$

$V_i = -V_f = ?$

$\uparrow^{+}$

$$V_f = V_i + at$$
$$-V_i = V_i + at$$
$$-2v_i = at$$
$$V_i = -\frac{at}{2}$$
$$= -\frac{(-9.8)(10.0)}{2}$$
$$= 49\,\frac{m}{s}$$

12. GIVEN:

$V_i = +36\,\frac{m}{s}$

$d = 0$

$a = -9.8\,\frac{m}{s^2}$

$t = ?$

$\uparrow^{+}$

$$\cancelto{0}{d} = v_i t + \tfrac{1}{2}at^2$$
$$0 = v_i t + \tfrac{1}{2}at^2$$
$$0 = t\left(v_i + \tfrac{1}{2}at\right)$$
$$\swarrow \qquad\qquad \searrow$$

$t = 0$

$$V_i + \tfrac{1}{2}at = 0$$
$$t = -\frac{2v_i}{a}$$
$$= -\frac{2(+36)}{(-9.8)}$$
$$= 7.3\,s$$

13. GIVEN:

$v_i = +25\ \frac{m}{s}$

$t = 2.0\ s$

$a = +9.8\ \frac{m}{s^2}$

$d = ?$

$\downarrow +$

$$d = v_i t + \frac{1}{2} a t^2$$
$$= (+25)(2.0) + \frac{1}{2}(+9.8)(2.0)^2$$
$$= 70.\ m$$

14. a) GIVEN:

$v_i = 5.00 \times 10^2\ \frac{m}{s}$

$d = 10.0\ cm = 0.100\ m$

$v_f = 0$

$a = ?$

$$\cancelto{0}{v_f^2} = v_i^2 + 2ad$$
$$0 = v_i^2 + 2ad$$
$$a = -\frac{v_i^2}{2d}$$
$$= -\frac{(5.00 \times 10^2)^2}{2(0.100)}$$
$$= -1.25 \times 10^6\ \frac{m}{s^2}$$

→ $1.25 \times 10^6\ \frac{m}{s^2}$ IN THE DIRECTION OPPOSITE OF MOTION

b) GIVEN:

$v_i = 5.00 \times 10^2\ \frac{m}{s}$

$d = 10.0\ cm = 0.100\ m$

$v_f = 0$

$t = ?$

$$d = \left(\frac{v_i + \cancelto{0}{v_f}}{2}\right) t$$
$$d = \frac{v_i}{2} t$$
$$t = \frac{2d}{v_i}$$
$$= \frac{2(0.100)}{5.00 \times 10^2}$$
$$= 4.00 \times 10^{-4}\ s$$

15. GIVEN:

$t=10.0\text{ s}$

$\bar{v}=15\frac{m}{s}$

$v_f=0$

$a=?$

$$\bar{v}=\frac{v_i+\cancelto{0}{v_f}}{2}$$

$$\bar{v}=\frac{v_i}{2}$$

$$v_i=2\bar{v}$$

$$\cancelto{0}{v_f}=v_i+at$$

$$0=v_i+at$$

$$0=2\bar{v}+at$$

$$a=-\frac{2\bar{v}}{t}$$

$$=-\frac{2(15)}{10.0}$$

$$=-3.0\frac{m}{s^2}$$

→ $3.0\frac{m}{s^2}$ IN THE DIRECTION OPPOSITE OF MOTION

16. PART 1 $\left(a=+10.0\frac{m}{s^2}\right)$

GIVEN:

$a=+10.0\frac{m}{s^2}$

$t=3.0\text{ s}$

$v_i=0$

$v_f=?$

$d=?$

$+\uparrow$

$$v_f=\cancelto{0}{v_i}+at$$

$$=at$$

$$=(+10.0)(3.0)$$

$$=+30.\ \frac{m}{s}$$

$$d = \overset{v_i=0}{\cancel{v_i}}t + \tfrac{1}{2}at^2$$

$$= \tfrac{1}{2}at^2$$

$$= \tfrac{1}{2}(+10.0)(3.0)^2$$

$$= +45 \text{ m}$$

PART 2 $(a=-10.0\,\frac{m}{s^2})$

GIVEN:

$a=-10.0\,\frac{m}{s}$

$v_i = +30\,\frac{m}{s}$

$V_f = 0$

$d = ?$

$+\uparrow$

THE INITIAL VELOCITY FOR THIS PART IS EQUAL TO THE FINAL VELOCITY FROM THE PREVIOUS PART.

$$\overset{0}{\cancel{v_f}}{}^2 = v_i^2 + 2ad$$

$$0 = v_i^2 + 2ad$$

$$d = -\frac{v_i^2}{2a}$$

$$= -\frac{(+30)^2}{2(-10.0)}$$

$$= +45 \text{ m}$$

$$\text{TOTAL DISPACEMENT} = \overset{\text{PART 1}}{+45} + \overset{\text{PART 2}}{45}$$

$$= +90 \text{ m}$$

17. PART 1 ($a = +2.0 \frac{m}{s^2}$)

GIVEN:

$v_i = 0$

$a = +2.0 \frac{m}{s^2}$

$t = 10.0 s$

$v_f = ?$

$d = ?$

$$v_f = \cancelto{0}{v_i} + at$$

$$= at$$

$$= (+2.0)(10.0)$$

$$= +20. \frac{m}{s}$$

$$d = \cancelto{v_i = 0}{v_i} t + \frac{1}{2}at^2$$

$$= \frac{1}{2}at^2$$

$$= \frac{1}{2}(+2.0)(10.0)^2$$

$$= 1.0 \times 10^2 \text{ m}$$

PART 2 (CONSTANT VELOCITY)

GIVEN:

$v_i = +20. \frac{m}{s}$

$t = 10.0 s$

$d = ?$

THE INITIAL VELOCITY FOR THIS PART IS EQUAL TO THE FINAL VELOCITY FROM THE PREVIOUS PART.

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

$$d = vt$$

$$= (+20.)(10.0)$$

$$= 2.0 \times 10^2 \text{ m}$$

PART 3 $(a = -2.0\,\frac{m}{s^2})$

GIVEN:

$v_i = +20.\,\frac{m}{s}$

$v_f = 0$

$a = -2.0\,\frac{m}{s^2}$

$d = ?$

THE INITIAL VELOCITY FOR THIS PART IS EQUAL TO THE FINAL VELOCITY FROM PART 1. (THE CAR'S SPEED DID NOT CHANGE DURING PART 2.

$$\overset{0}{\cancel{v_f}^2} = v_i^2 + 2ad$$

$$0 = v_i^2 + 2ad$$

$$d = -\frac{v_i^2}{2a}$$

$$= -\frac{(+20.)^2}{2(-2.0)}$$

$$= +1.0\times10^2\ m$$

TOTAL DISPLACEMENT

$= 1.0\times10^2 + 2.0\times10^2 + 1.0\times10^2$

$= 4.0\times10^2\ m$

18. GIVEN

$v_i = +30.0\,\frac{m}{s}$

$v_f = 0$

$d = d$

$a = ?$

$$\overset{0}{\cancel{v_f}^2} = v_i^2 + 2ad$$

$$0 = v_i^2 + 2ad$$

$$a = -\frac{v_i^2}{2d}$$

$$= -\frac{(+30.0)^2}{2d}$$

$$= -\frac{450}{d}\ \frac{m^2}{s^2}$$

GIVEN:

$v_i = +60.0 \frac{m}{s}$

$v_f = 0$

$a = -\frac{450}{d} \frac{m^2}{s^2}$

$d' = ?$

TO SHOW THAT THIS "d" IS DIFFERENT THAN THE "d" USED PREVIOUSLY.

$$\cancelto{0}{v_f}^2 = v_i^2 + 2ad'$$

$$0 = v_i^2 + 2ad$$

$$d' = -\frac{v_i^2}{2a}$$

$$= -\frac{(60.0)^2}{2\left(\frac{450}{d}\right)}$$

$$= 4d$$

19. GIVEN:

$v_1 = 4.0 \frac{m}{s}$

$t_1 = 25 s$

$d_1 = ?$

$$v_1 = \frac{d_1}{t_1}$$

$$d_1 = v_1 t_1$$

$$= (4.0)(25)$$

$$= 1.0 \times 10^2 m$$

GIVEN:

$v_2 = 20.0 \frac{m}{s}$

$t_2 = 15 s$

$d_2 = ?$

$$v_2 = \frac{d_2}{t_2}$$

$$d_2 = v_2 t_2$$

$$= (20.0)(15)$$

$$= 3.0 \times 10^2 m$$

GIVEN:

$d_T = 1.0 \times 10^2 + 3.0 \times 10^2 = 4.0 \times 10^2 m$

$t_T = 25 + 15 = 40. s$

$v_T = ?$

$$v_T = \frac{d_T}{t_T}$$

$$= \frac{4.0 \times 10^2}{40.}$$

$$= 10. \frac{m}{s}$$

20. CAR 1

GIVEN:

$v_{i_1}=0$

$a_1=3.0\frac{m}{s}$

$t_1=t_1$

$d_1=?$

$$d_1=\overset{v_i=0}{\cancel{v_{i_1}t_1}}+\frac{1}{2}at_1^2$$

$$d_1=\frac{1}{2}a_1t_1^2$$

$$=\frac{1}{2}(3.0)t_1^2$$

CAR 2

GIVEN:

$v_{i_2}=0$

$a_2=5.0\frac{m}{s^2}$

$t_2=t_1-6.0$

$d_2=?$

CAR 2 STARTS 6.0s AFTER CAR 1.

$$d_2=\overset{v_{i_2}=0}{\cancel{v_{i_2}t_2}}+\frac{1}{2}a_2t_2^2$$

$$d_2=\frac{1}{2}a_2t_2^2$$

$$=\frac{1}{2}(5.0)(t_1-6.0)^2$$

CAR 2 OVERTAKES CAR 1 WHEN IT REACHES THE SAME POSITION

$$d_1=d_2$$

$$\frac{1}{2}(3.0)t_1^2=\frac{1}{2}(5.0)(t_1-6.0)^2$$

$$\frac{1}{2}(3.0)t_1^2=\frac{1}{2}(5.0)(t_1^2-12.0t+36)$$

$$1.5t_1^2=2.5t_1^2-30.t_1+90.$$

$$0=1.0t_1^2-30t+90.$$

$$t_1=\frac{+30.\pm\sqrt{(-30.)^2-4(1.0)(90.)}}{2(1.0)}$$

$$=3.38\,s \text{ or } \underline{\underline{26.62}}\ s$$

REJECT AS CAR 2 HASN'T EVEN STARTED.

$$t_2 = t_1 - 6.0$$

$$= 26.62 - 6.0$$

$$= 20.62 \text{ s}$$

$$\longrightarrow 21 \text{ s}$$