1. (a) $s = ut + \frac{1}{2}at^2$

$= 0 \times 3 + \frac{1}{2} \times 9.8 \times 9$

$s = 44.1\,m$

(b) $v = u + at$

$= 0 + 9.8 \times 3$

$v = 29.4\,ms^{-1}$

2. $s = ut + \frac{1}{2}at^2$

$= 15 \times 2.5 + \frac{1}{2} \times 9.8 \times 2.5^2$

$= 37.5 + 30.625$

$s = 68.1\,m$

3. $v^2 = u^2 + 2as$

$25^2 = 0^2 + 2 \times 9.8s$

$625 = 19.6s$

$s = 31.89\,m$

4. (a) $v^2 = u^2 + 2as$
$35^2 = 5^2 + 2 \times 9.8s$
$1225 = 25 + 19.6s$
$1200 = 19.6s$
$s = 61.2m$

(b) $v = u + at$
$35 = 5 + 9.8t$
$30 = 9.8t$
$t = 3.06s$

5. (a) $v^2 = u^2 + 2as$
$v^2 = 25 + 2 \times 9.8 \times 60$
$= 25 + 1176$
$v^2 = 1201$
$v = 34.7 ms^{-1}$

(b) $v = u + at$
$34.7 = 5 + 9.8t$
$29.7 = 9.8t$
$t = 3.03s$

6. (a) $v = u + at$
$0 = 40 - 9.8t$
$9.8t = 40$
$t = 4.08s$

(b) $v^2 = u^2 + 2as$
$0 = 1600 + 2 \times -9.8s$
$0 = 1600 - 19.6s$
$19.6s = 1600$
$s = 81.6m$

7. $v^2 = u^2 + 2as$
$0 = u^2 + 2 \times -9.8 \times 180$
$0 = u^2 - 3528$
$u^2 = 3528$
$u = 59.4 ms^{-1}$

8. $s = ut + \frac{1}{2}at^2$
$0.4 = 0 \times 0.29 + \frac{1}{2} \times a \times (0.29)^2$
$0.4 = 0 + 0.04205a$
$a = 9.5 ms^{-2}$

9.(a) ↑ +ve

$u = 20ms^{-1}$

$a = -9.8ms^{-2}$

$s = -105m$

$v^2 = u^2 + 2as$

$= 400 + 2 \times -9.8 \times -105$

$= 400 + 2058$

$v^2 = 2458$

$v = -49.6ms^{-1}$

(b) ↑ +ve

$u = 20ms^{-1}$

$v = -49.6ms^{-1}$

$a = -9.8ms^{-2}$

$t = ?$

$v = u + at$

$-49.6 = 20 - 9.8t$

$-49.6 - 20 = -9.8t$

$9.8t = -69.6$

$t = 7.1s$

(c) $v = 0ms^{-1}$

$u = 20ms^{-1}$

$a = -9.8ms^{-2}$

$s = ?$

$v^2 = u^2 + 2as$

$0 = 400 + 2 \times -9.8s$

$0 = 400 + (-19.6s)$

$19.6s = 400$

$s = 20.4m$

Max. Height $= 105 + 20.4$

$= 125.4m$

10.a)(i) ↑ +ve

$u = 4ms^{-1}$

$a = -9.8ms^{-2}$

$t = 2s$

$s = ut + \frac{1}{2}at^2$

$= 4 \times 2 + \frac{1}{2} \times -9.8 \times 4$

$= 8 - 19.6$

$= -11.6m$

Height above sea level $= 33 - 11.6$

$= 21.4m$

(ii) $v = u + at$

$= 4 - 9.8 \times 2$

$= -15.6ms^{-1}$

10.b) ↑ +ve

$u = 4ms^{-1}$
$a = -9.8ms^{-2}$
$v = 0ms^{-1}$
$s = ?$

$v^2 = u^2 + 2as$
$0 = 16 + 2 \times -9.8 \times s$
$0 = 16 - 19.6s$
$19.6s = 16$
$s = 0.82m$

Total distance $= (2 \times 0.82) + 33$
$= \underline{34.64m}$

11.a) ↑ +ve

$u = 5ms^{-1}$
$t = 2s$
$a = -9.8ms^{-2}$
$v = ?$

$v = u + at$
$= 5 + -9.8 \times 2$
$= 5 - 19.6$
$= \underline{-14.6ms^{-1}}$

b)

$s = ut + \frac{1}{2}at^2$
$= 5 \times 2 + \frac{1}{2} \times -9.8 \times 4$
$= 10 - 19.6$
$= \underline{-9.6m}$

c) ↑ +ve

$u = 5ms^{-1}$
$v = 0ms^{-1}$
$a = -9.8ms^{-2}$
$s = ?$

$v^2 = u^2 + 2as$
$0 = 25 + 2 \times -9.8s$
$0 = 25 - 19.6s$
$19.6s = 25$
$s = 1.28m$

Max. Height $= 9.6 + 1.28$
$= \underline{10.88m}$

12. ↑ +ve

$u = ?$
$a = -9.8 ms^{-2}$
$s = -80m$
$t = 5s$

$s = ut + \frac{1}{2}at^2$
$-80 = u \times 5 + \frac{1}{2} \times -9.8 \times 25$
$-80 = 5u + (-122.5)$
$42.5 = 5u$
$u = 8.5 ms^{-1}$

13. (a) $s = \bar{v}t$
$= 40 \times 3$
$= 120m$

(b) $s = ut + \frac{1}{2}at^2$
$= 0 \times 3 + \frac{1}{2} \times 9.8 \times 9$
$= 0 + 44.1$
$= 44.1m$

14. (a) $t = \frac{s}{\bar{v}}$
$= \frac{60}{12}$
$= 5s$

(b) $s = ut + \frac{1}{2}at^2$
$= 0 \times 5 + \frac{1}{2} \times 9.8 \times 25$
$= 0 + 122.5$
$= 122.5m$

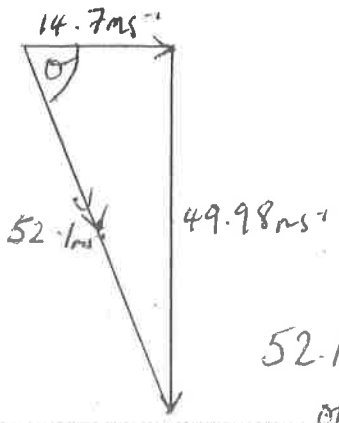
15. (a) $s = ut + \frac{1}{2}at^2$
$125 = 0 + \frac{1}{2} \times 9.8 \times t^2$
$125 = 4.9t^2$
$t^2 = 25.5$
$t = 5.1s$

(b) $\bar{v} = \frac{s}{t}$
$= \frac{75}{5.1}$
$= 14.7 ms^{-1}$

16. (a) $14.7 ms^{-1}$

(b) $v = u + at$
$= 0 + 9.8 \times 5.1$
$= 49.98 ms^{-1}$

(c)



$\tan\theta = \frac{49.98}{14.7}$

$\theta = 73.6°$

52.1ms⁻¹ at an angle of 73.6°

17. (a) $s = ut + \frac{1}{2}at^2$

$300 = 0 + \frac{1}{2} \times 9.8 \times t^2$

$t^2 = 61.2$

$t = 7.8s$

(b) $s = \bar{v}t$

$= 300 \times 7.8$

$= 2340m$

(c) The plane is directly above the box assuming it does not change course.

18. (a) The bullet follows a curved, projectile path (which causes it to miss the target) due to the acceleration due to gravity.

(b) $t = \frac{s}{\bar{v}}$

$= \frac{120}{240}$

$= 0.5s$

$s = ut + \frac{1}{2}at^2$

$= 0 \times 0.5 + \frac{1}{2} \times 9.8 \times (0.5)^2$

$= 0 + 1.225$

$= 1.2m$

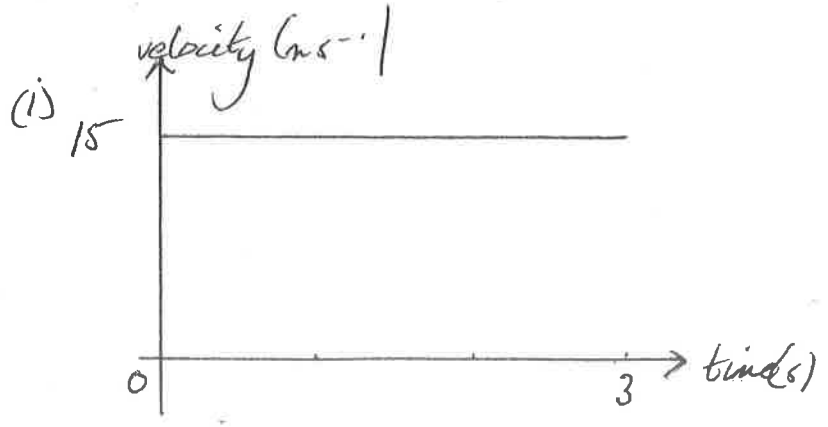
19. (a) $t = \frac{s}{\bar{v}} = \frac{45}{15} = 3s$

$v = u + at$

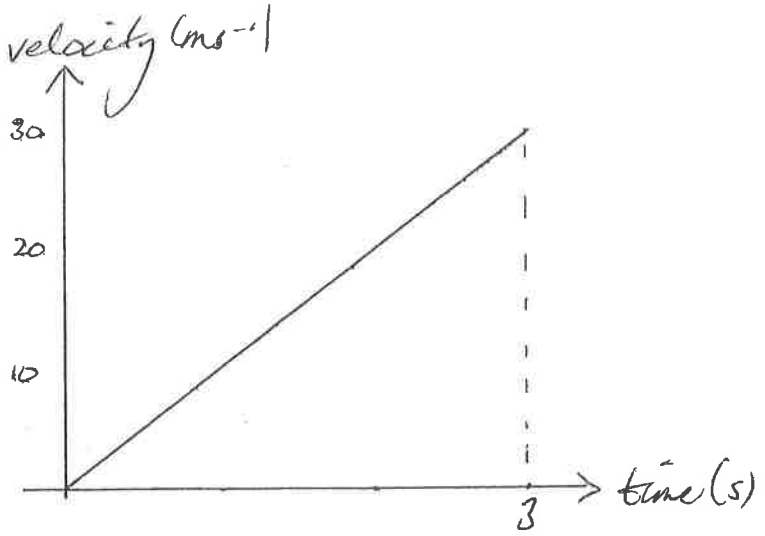
$= 0 + 9.8 \times 3$

$= 29.4ms^{-1}$

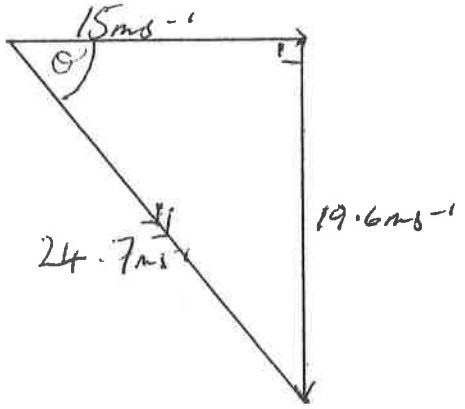
(i)



19.(a) (ii)



(b)



$v = u + at$

$= 0 + 9.8 \times 2$

$= 19.6 ms^{-1}$

$\tan\theta = \frac{19.6}{15}$

$\theta = 52.6°$

$24.7 ms^{-1}$ at an angle of $52.6°$

20.(a) $s = ut + \frac{1}{2}at^2$

$2 = 0 \times t + \frac{1}{2} \times 9.8 \times t^2$

$2 = 0 + 4.9t^2$

$t^2 = 0.41$

$t = 0.645$

$\bar{v} = \frac{s}{t}$

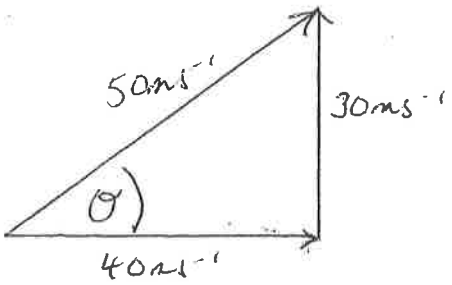
$= \frac{10}{0.64}$

$= 15.6 ms^{-1}$

(b) Assumed the horizontal velocity remains constant, unaffected by air resistance, and that the unbalanced force acting upon the truck is unaffected by air resistance

21. (a) i) Constant velocity ii) Constant deceleration (acceleration)

(b)



$\tan\theta = \frac{30}{40}$

$\theta = 36.9°$

50ms⁻¹ at an angle of 36.9° to the horizontal.

(c) 40ms⁻¹ travelling horizontally
Vertical velocity is 0 ms⁻¹ as some of the projectiles kinetic energy has changed to potential energy at the maximum height

(d) d = area under vertical velocity - time graph
$= \frac{1}{2} \times 3 \times 30$
$= 45m$

(e) d = area under horizontal velocity - time graph
$= 40 \times 6$
$= 240m$

22. (a) $t = \frac{s}{\bar{v}}$

$= \frac{7200}{120}$

$= 60s$

(b) $t = 30s$
$v = 0ms^{-1}$
$a = -9.8ms^{-2}$
$u = ?$

$v = u + at$
$0 = u - 9.8 \times 30$
$u = 294ms^{-1}$

23. (a) $u = 80ms^{-1}$
$v = 0ms^{-1}$
$a = -9.8ms^{-2}$
$t = ?$

$v = u + at$
$0 = 80 - 9.8t$
$9.8t = 80$
$t = 8.16s$

Time of flight $= 2 \times 8.16 = \underline{16.32s}$

(b) $s = \bar{v}\, t$
$= 60 \times 16.32$
$= \underline{979.2m}$

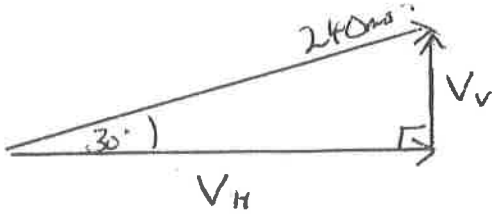
(c) $s = ut + \frac{1}{2}at^2$
$= 80 \times 8.16 + \frac{1}{2} \times -9.8 \times 66$
$= 652.8 - 326.3$
$= \underline{326.5m}$

24. $t = \frac{s}{v}$
$= \frac{600}{100}$
$= 6s$

$s = ut + \frac{1}{2}at^2$
$= 40 \times 6 + \frac{1}{2} \times -9.8 \times 36$
$= 240 - 176.4$
$= 63.6m$

Shell misses building by $63.6 - 55$
$= \underline{8.6m}$

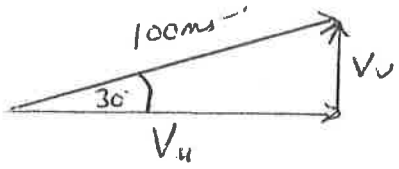
25.



$\cos 30 = \frac{V_H}{240}$
$V_H = 240 \cos 30$
$= \underline{207.8ms^{-1}}$

$\sin 30 = \frac{V_V}{240}$
$V_V = 240 \sin 30$
$= \underline{120ms^{-1}}$

26. (a)



$V_V = 100 \sin 30$ $\quad V_H = 100 \cos 30$

$V_V = 50 ms^{-1}$ $\quad V_H = 86.6 ms^{-1}$

(b) $u = 50 ms^{-1}$ $\quad v = u + at$

$v = 0 ms^{-1}$ $\quad 0 = 50 - 9.8t$

$a = -9.8 ms^{-2}$ $\quad 9.8t = 50$

$t = ?$ $\quad t = 5.1s$

time of flight = 10.2s

(c) $s = \bar{v} t$

$= 86.6 \times 10.2$

$= 883.3m$

27. (a) $V_H = 40 \cos 30$ $\quad V_V = 40 \sin 30$

$= 34.6 ms^{-1}$ $\quad = 20 ms^{-1}$

(b) $u = 20 ms^{-1}$ $\quad v^2 = u^2 + 2as$

$v = 0 ms^{-1}$ $\quad 0 = 400 + 2s \times -9.8 \times s$

$a = -9.8 ms^{-2}$ $\quad 19.6s = 400$

$s = ?$ $\quad s = 20.4m$

(c) $v = u + at$

$0 = 20 - 9.8t$

$9.8t = 20$

$t = 2.0s$

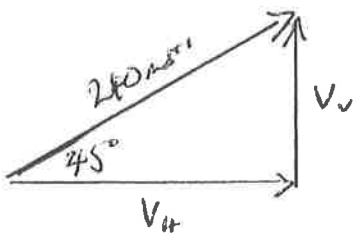
time of flight = 4.0s

(d) $s = \bar{v} t$

$= 34.6 \times 4$

$= 138.4m$

28.(i)



$V_v = 240 \sin 45$ $\quad V_H = 240 \sin 45$

$= 169.7 ms^{-1}$ $\quad = 169.7 ms^{-1}$

$v = u + at$

$0 = 169.7 - 9.8t$

$9.8t = 169.7$

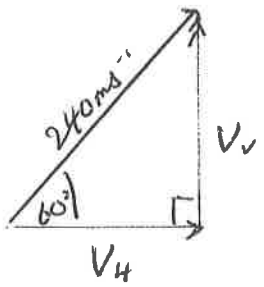
$t = 17.3s$ time of flight $= 34.6s$

$s = \bar{v} t$

$= 169.7 \times 34.6$

$= \underline{\underline{5871.6m}}$

(ii)



$V_v = 240 \sin 60$ $\quad V_H = 240 \cos 60$

$= 207.8 ms^{-1}$ $\quad = 120 ms^{-1}$

$v = u + at$

$0 = 207.8 - 9.8t$

$9.8t = 207.8$

$t = 21.2s$ time of flight $= 42.4s$

$s = \bar{v} t$

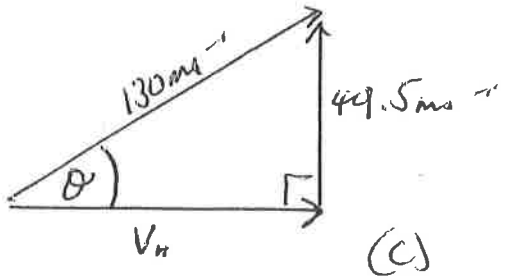
$= 120 \times 42.4$

$= \underline{\underline{5088m}}$

(a) $u = ?$
$v = 0 ms^{-1}$
$a = -9.8 ms^{-2}$
$s = 125m$

$v^2 = u^2 + 2as$
$0 = u^2 + 2 \times -9.8 \times 125$
$0 = u^2 - 2450$
$u^2 = 2450$
$u = 49.5 ms^{-1}$

(b)



$130^2 = 49.5^2 + V_H^2$
$V_H = 120.2 ms^{-1}$

(c) $\sin\theta = \frac{49.5}{130}$
$\theta = 22.4°$

(d) $v = u + at$
$0 = 49.5 - 9.8t$
$9.8t = 49.5$
$t = 5.05s$

time of flight $= 10.1s$

$s = \bar{v}t$
$= 120.2 \times 10.1$
$= 1214m$

30. (a) $V_H = 100\cos 60$
$= 50 ms^{-1}$

$V_V = 100\sin 60$
$= 86.6 ms^{-1}$

$t = \frac{s}{v}$
$= \frac{400}{50}$
$= 8s$

(b) $u = 86.6 ms^{-1}$
$t = 8s$
$a = -9.8 ms^{-2}$
$s = ?$

$s = ut + \frac{1}{2}at^2$
$= 86.6 \times 8 + \frac{1}{2} \times -9.8 \times 64$
$= 692.8 - 313.6$
$= 379.2m$

(31) Although a satellite travels at a constant speed it is continually changing direction. Therefore the velocity, which is a vector quantity, is changing which means the satellite is accelerating.

(32) $F = \frac{G m_1 m_2}{r^2}$ $\quad G = 6.67 \times 10^{-11} m^3 kg^{-1} s^{-2}$

(33) $F = \frac{6.67 \times 10^{-11} \times (5 \times 10^7)^2}{20^2}$

$= \underline{\underline{417\ N}}$

(34) $F = \frac{G m_1 m_2}{r^2}$

$= \frac{6.67 \times 10^{-11} \times (1000)^2}{0.5^2}$

$= \underline{\underline{2.67 \times 10^{-4} N}}$

(35) $F = \frac{G m_1 m_2}{r^2}$

$= \frac{6.67 \times 10^{-11} \times 1.67 \times 10^{-27} \times 9.11 \times 10^{-31}}{(6.3 \times 10^{-11})^2}$

$= \underline{\underline{3.61 \times 10^{-47} N}}$

(36) $$F = \frac{G m_1 m_2}{r^2}$$

$$= \frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24} \times 1.99 \times 10^{30}}{(1.5 \times 10^{11})^2}$$

$$= \underline{\underline{3.53 \times 10^{22} N}}$$

(37) $$F = \frac{G m_1 m_2}{r^2}$$

$$1.16 \times 10^{-35} = \frac{6.67 \times 10^{-11} \times (1.67 \times 10^{-27})^2}{r^2}$$

$$1.16 \times 10^{-35} = \frac{1.86 \times 10^{-64}}{r^2}$$

$$r^2 = 1.6 \times 10^{-29}$$

$$r = \underline{\underline{4 \times 10^{-15} m}}$$