HCL 1992 1(a)

let: desp

$\uparrow u$ — constant speed of balloon ascent

$\downarrow g$

height $= u(7.2)$

Key where to choose origin

$\ominus\downarrow \quad \oplus\uparrow$

origin — $\uparrow u$

depth $-7.2u$

s = distance above / below origin

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

$s_{\text{hits ground}} = u(9) - \frac{1}{2}(9.8)9^2$

$s_{\text{hits ground}} = 9u - 396.9$

~~when hitting ground~~ hits ground

$7.2u$ below origin $\Rightarrow$

$-7.2u = 9u - 396.9$

$-16.2u = -369.9$

$\Rightarrow u = 24.5$ m/s

$\therefore |\text{height}| = 7.2(24.5) = 176.4$m

(25)

R: $9 = 2t_1 + t_2$ (1)

find t_1: s_1: dist from release to rest.

$(s_1 = ut_1 - 4.9t_1^2)$

at $v = 0 \Rightarrow 0 = u - 9.8t_1 \Rightarrow t_1 = \frac{u}{9.8}$ (2)

t_1, t_1, t_2, $7.2u$

find t_2: $9.8\downarrow \ \downarrow u$ $\quad \oplus\downarrow$

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

$7.2u = ut_2 + \frac{1}{2}(9.8)t_2^2$

$7.2u = ut_2 + 4.9t_2^2$ (3)

(1),(2) $\Rightarrow t_2 = 9 - 2\left(\frac{u}{9.8}\right) = 9 - \frac{u}{4.9}$

$\therefore 7.2u = u\left(9 - \frac{u}{4.9}\right) + 4.9\left(9 - \frac{u}{4.9}\right)^2$

$7.2u = 9u - \frac{u^2}{4.9} + 4.9\left(81 - \frac{18u}{4.9} + \frac{u^2}{(4.9)^2}\right)$

$7.2u = 9u - \frac{u^2}{4.9} + 4.9(81) - 18u + \frac{u^2}{4.9}$

$\Rightarrow 7.2u = -9u + 396.9$

$\Rightarrow 16.2u = 396.9$

$\Rightarrow u = \frac{396.9}{16.2} = 24.5$

$\therefore$ height $= 7.2(24.5) = 176.4$m

(25)

1992 (b)

(i) $S_p = 1(t) + 0.5(5)t^2$

$S_q = 11(t) + 0.5(4)t^2$

$S_p + 25.5 = S_q$

$t^2 - 20t + 51 = 0$

$(t - 3)(t - 17) = 0$

$t = 3$ or $t = 17$

(ii) distance $= S_q - S_p - 25.5$

$= 10t - 0.5t^2 - 25.5$

$\frac{d(\text{distance})}{dt} = 10 - t$

$= 0$ when $t = 10$

Maximum distance $= 10(10) - 0.5(100) - 25.5 = 24.5$ m.