p 40 21 – 32 all

(21) $u = 13\ ms^{-1}$
$v = 25\ ms^{-1}$
$t = 6.0\ s$

$v = u + at$

$a = \frac{v-u}{t} = \frac{25\ ms^{-1} - 13\ ms^{-1}}{6.0\ s} = \underline{2.0\ ms^{-2}}$

$s = \left(\frac{u+v}{2}\right)t = \left(\frac{13+25}{2}\right)6 = \underline{110\ m}$

(22) $u = 23\ ms^{-1}$
$v = 0$
$s = 85\ m$

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

$a = \frac{-u^2}{2s} = \frac{-(23\ ms^{-1})^2}{2(85\ m)} = \underline{-3.1\ ms^{-2}}$

(23) $u = 0$
$v = 33\ ms^{-1}$
$a = 3.0\ ms^{-2}$

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

$s = \frac{v^2 - u^2}{2a} = \frac{(33\ ms^{-1})^2}{2(3.0\ ms^{-2})} = \underline{180\ m}$

(24) $u = 0$
$v = 11.5\ ms^{-1}$
$s = 15.0\ m$
$a = ?$
$t = ?$

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

$a = \frac{v^2 - u^2}{2s} = \frac{(11.5\ ms^{-1})^2}{2(15.0\ m)} = \underline{4.41\ ms^{-2}}$

$v = u + at$

$t = \frac{v}{a} = \frac{11.5\ ms^{-1}}{4.41\ ms^{-2}} = \underline{2.61\ s}$

(25) $u = 21.0\ ms^{-1}$
$v = 0$
$t = 6.00\ s$
$s = ?$

$s = \left(\frac{u+v}{2}\right)t = \frac{(21.0\ ms^{-1})(6.00\ s)}{2} = \underline{63.0\ m}$

(26) $v = 0$
$s = 92\ m$
$a = -7.00\ ms^{-2}$
$u = ?$

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

$u = \sqrt{-2as} = \sqrt{-2(-7.00\ ms^{-2})(92\ m)} = \underline{36\ ms^{-1}}$

(27) $u = 85\ kmh^{-1} = 23.6\ ms^{-1}$
$v = 0$
$s = 0.80\ m$
$a = ?$

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

$a = \frac{-u^2}{2s} = \frac{-(23.6\ ms^{-1})^2}{2(0.80\ m)} = \underline{-350\ ms^{-2}}$

$\frac{350\ ms^{-2}}{9.80\ ms^{-2}} = \underline{-36\ g}$

(28) $u = 95\ km\,h^{-1} = 26.4\ m\,s^{-1}$

$v = 0$

During reaction time $\quad s = ut = (26.4\ m\,s^{-1})(1.0\ s) = 26.4\ m$

During stopping time

(a) $a = -4.0\ m\,s^{-2}$

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

$s = \dfrac{-u^2}{2a}$

$= \dfrac{-(26.4\ m\,s^{-1})^2}{2(-4.0\ m\,s^{-1})}$

$= 87.12\ m$

Total distance: $\underline{110\ m}$

(b) $a = -8.0\ m\,s^{-2}$

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

$s = \dfrac{-u^2}{2a}$

$= \dfrac{-(26.4\ m\,s^{-1})^2}{2(-8\ m\,s^{-2})}$

$= 43.56\ m$

Total distance: $\underline{70.\ m}$

(29) total stopping distance = distance travelled during reaction time + distance travelled while braking

during reaction time $\quad s = v_0 t_R$

during braking $\quad u = v_0$, $v = 0$, $a = a$

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

$s = \dfrac{-u^2}{2a} = \dfrac{-v_0^2}{2a}$

$d_s = v_0 t_R - \dfrac{v_0^2}{2a}$ $\quad$ QED

(30) $s = 10m + 20m + 10m + v_{truck}\, t_{pass} = 40m + 25 ms^{-1} t_p$

$u = 25\ ms^{-1}$
$a = 1.0\ ms^{-2}$

time required to pass truck, t_p

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

$$40 + 25t_p = 25t_p + \frac{1}{2}(1)t_p^2$$

$$t_p = 8.9s$$

distance passing
$s = 40 + 25t_p$
$= 40 + 25(8.9)$
$= 262.5m$

distance other car travels
$s = 25t_p$
$= 25(8.9)$
$= 222.5m$

but there is only 400m between them.

∴ The car should not pass

(31) $t = 3 \text{ min} = 180 \text{ s}$

$s = 1100 \text{ m}$

runner will start a velocity u accelerate for t_a to velocity v and then run at v for t_c seconds

initial velocity $u = \frac{s}{t} = \frac{10\,000 - 1100 \text{ m}}{(27.0 \text{ min})(60)} = 5.5 \text{ ms}^{-1}$

$t_c + t_a = 180 \text{ s} \qquad t_c = 180 - t_a$

$v = u + at_a$

distance accelerated: $s_a = ut_a + \frac{1}{2}at_a^2$

distance after acceleration: $s_c = vt_c = (u + at_a)t_c$

total distance $= ut_a + \frac{1}{2}at_a^2 + (u + at_a)t_c$

$= ut_a + \frac{1}{2}at_a^2 + (u + at_a)(180 - t_a)$

$= ut_a + \frac{1}{2}at_a^2 + 180u - ut_a + 180at_a - at_a^2$

$1100 = -\frac{1}{2}at_a^2 + 180u + 180at_a$

$1100 = -\frac{1}{2}(.2)t_a^2 + 180(5.5) + 180(.2)t_a$

$110 = -.1t_a^2 + 36t_a$

$.1t_a^2 - 36t_a + 110 = 0$

$t_a = \frac{36 \pm \sqrt{(36)^2 - 4(.1)(110)}}{2(.1)} = \frac{36 \pm 35.38}{.2}$

$t_a = \underline{3.1 \text{ s}}$

(32) Option 1 – Stopping

$v = 0$
$u = 45\ km\,h^{-1} = 12.5\ ms^{-1}$
$a = -5.8\ ms^{-2}$
$t = 2.0s$

$s = ut + \frac{1}{2}at^2 = (12.5\ ms^{-1})(2.0s) + \frac{1}{2}(-5.8\ ms^{-2})(2.0s)^2$
$= 13.4\ m$
$v^2 = u^2 + 2as \qquad s = \frac{v^2 - u^2}{2a} = \frac{-(12.5\ ms^{-1})^2}{2(-5.8\ ms^{-2})} = 13.5\ m$

Option 2 – Speed up

$v_1 = 45\ km\,h^{-1} = 12.5\ ms^{-1}$
$v_2 = 65\ km\,h^{-1} = 18.1\ ms^{-1}$
$t = 6.0s$
$a = \frac{18.1\ ms^{-1} - 12.5\ ms^{-1}}{6.0s} = 0.93\ ms^{-2}$

$u = 12.5\ ms^{-1}$
$a = 0.93\ ms^{-2}$
$t = 2.0s$
$s = ?$

$s = ut + \frac{1}{2}at^2 = (12.5\ ms^{-1})(2.0s) + \frac{1}{2}(0.93\ ms^{-2})(2.0s)^2$

$= \underline{26.86\ m}$

∴ driver should stop.