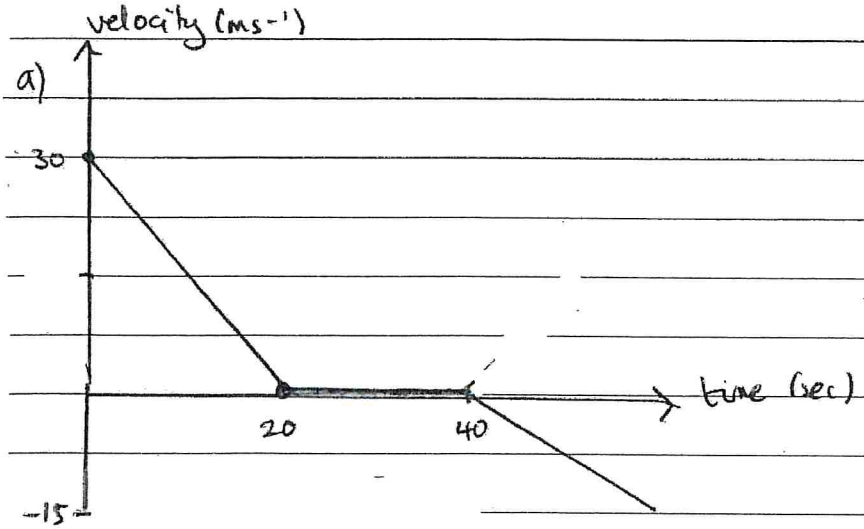
Mechanics 3 "suvat" Equations solutions

Section 1

a)



b) $30/20 = 1.5\,ms^{-2}$

c) $\frac{1}{2} \times 20 \times 30 = 300\,m$

d) $0.375 = \frac{15}{t} \Rightarrow t = \frac{15}{0.375} = 40\,sec.$

Section 2

1.) Time t - it is the only variable that does not have a direction. (2)

2) a.) $s = ut + \frac{1}{2}at^2 = 70 \times 10 + \frac{1}{2} \times -3 \times 10^2 = 550m$

b) $s = \frac{1}{2}(u+v)t = \frac{1}{2}(15+29) \times 9 = 198m$

c) $v = u + at$: $38 = 3 + 7a \Rightarrow 7a = 35 \Rightarrow a = 5ms^{-2}$

d) $v^2 = u^2 + 2as$: $28^2 = 22^2 + 2 \times 6 \times s \Rightarrow 784 = 484 + 12s$

$12s = 300 \Rightarrow s = 25m$

e) $s = vt - \frac{1}{2}at^2$: $0 = -28t - \frac{1}{2}(-7)t^2$

$0 = -28t + 3.5t^2$

$0 = t(-28 + 3.5t)$

$t = 0$ or $3.5t - 28 = 0 \Rightarrow t = 8$ sec (10)

3) $u = 24ms^{-1}$ $a = 5ms^{-2}$

a.) $v^2 = u^2 + 2as$: $v^2 = 24^2 + 2 \times 5 \times 10 = 676$

$v = 26ms^{-1}$

b) $v = u + at$: $26 = 24 + 5t \Rightarrow t = 0.4$ sec (4)

4) $u = 60ms^{-1}$, $a = -8ms^{-2}$ $t = 10$ sec.

a) $v = u + at = 60 - 8 \times 10 = -20ms^{-1}$

b) $v = 0$ $t = ?$

$v = u + at$ $0 = 60 - 8t \Rightarrow t = 7.5$ sec (4)

5.) $t = 40$ sec $\quad a = 0.5\,ms^{-2} \quad u = 0$

a) $v = u + at = 0 + 0.5 \times 40 = 20\,ms^{-1}$ ✓ ✓

b) $s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 0.5 \times 40^2 = 400\,m$ ✓ ✓ (4)

6) $u = 5\,ms^{-1} \quad a = 3\,ms^{-2} \quad s = 84\,m \quad t = T$

$s = ut + \frac{1}{2}at^2$: $\quad 84 = 5T + \frac{1}{2} \times 3 \times T^2$ ✓

$\times 2$: $\quad 168 = 10T + 3T^2$

$\Rightarrow 3T^2 + 10T - 168 = 0$ as required. ✓

Solving quadratic equation : $T = 6$ or $(-28/3)$ ✓ (3)

7.) $60\,kmh^{-1} = \frac{60 \times 1000}{3600} = \frac{50}{3}\,ms^{-1}$ ✓

$u = 0 \quad v = 50/3\,ms^{-1} \quad t = 8\,sec \quad s = ?$

$s = \frac{1}{2}(u+v)t = \frac{1}{2}\left(0 + \frac{50}{3}\right) \times 8 = \frac{200}{3}\,m$ ✓

a) Distance remaining for 200m $= 200 - \frac{200}{3} = \frac{400}{3}\,m$

Time at steady speed $= \frac{400}{3} / \frac{50}{3} = 8$ sec.

Total time $= 8 + 8 = 16$ sec. ✓

b) Distance remaining for 1km $= 1000 - \frac{200}{3} = \frac{2800}{3}\,m$

Time at steady speed $= \frac{2800}{3} / \frac{50}{3} = 56$ sec.

Total time $= 8 + 56 = 64$ sec ✓ (4)

8) A : $u=0$ $a=6ms^{-2}$ $s=x$

B : $u=0$ $a=2ms^{-2}$ $s=100-x$

$s=ut+\frac{1}{2}at^2$: $x=3t^2$ ✓

$100-x=t^2$ ✓

① + ② $100=4t^2 \Rightarrow t^2=25 \Rightarrow t=5sec$

$\Rightarrow x=3\times5^2=75m$

a) 75m ✓

b) 5 sec ✓

c) A : $v=u+at = 0+5\times6 = 30ms^{-1}$ ✓ } taking direction of A

B : $v=u+at = 0-2\times5 = -10ms^{-1}$ ✓ } as positive.

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9) $u=13ms^{-2}$ $a=-2ms^{-2}$ $s=\pm30m$ ✓

$s=ut+\frac{1}{2}at^2$: $30=13t-t^2 \Rightarrow t^2-13t+30=0$

$t=3sec$ or $10sec$ ✓ ✓

$-30=13t-t^2 \Rightarrow t^2-13t-30=0 \Rightarrow t=15sec$ (or -2) ✓

$t=3, 10$ or 15

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Extension Question

RL : $a=0.15ms^{-2}$ $v=9ms^{-1}$ $s=240m$ $u=?$

$v^2=u^2+2as$: $9^2=u^2+2\times0.15\times240$

$\Rightarrow u^2=9 \Rightarrow u=3ms^{-1}$

(velocity at restaurant)

$v=u+at$: $9=3+0.15t \Rightarrow t=40sec$

$\Rightarrow$ Time for garage $\rightarrow$ restaurant $= 20sec$.

GR : $a=0.15ms^{-2}$ $t=20sec$ $v=3ms^{-1}$ $s=?$

$s=vt-\frac{1}{2}at^2$

$=3\times20-\frac{1}{2}\times0.15\times20^2 = 30m$

Total distance garage $\rightarrow$ library $= 30+240 = 270m$