2010 – Linear Motion Question

1. **(a)** A car is travelling at a uniform speed of 14 ms^{-1} when the driver notices a traffic light turning red 98 m ahead.

Find the minimum constant deceleration required to stop the car at the traffic light,

(i) if the driver immediately applies the brake

(ii) if the driver hesitates for 1 second before applying the brake.

(b) A particle passes P with speed 20 ms^{-1} and moves in a straight line to Q with uniform acceleration.

In the first second of its motion after passing P it travels 25 m.

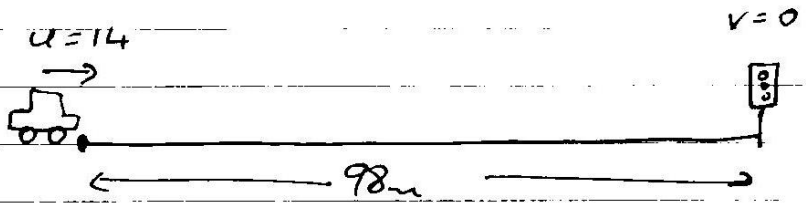
In the last 3 seconds of its motion before reaching Q it travels $\frac{13}{20}$ of $|PQ|$.

Find the distance from P to Q.

2010

Q.1

(a)



(i) $u = 14$, $v = 0$, $a = ?$, $s = 98$, $T = -$

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

$(0)^2 = (14)^2 + 2(a)(98)$

$0 = 196 + 19\ a$

$-196 = 196a$

$-1\ ms^{-2} = a$ 5

(ii) AFTER 1 SEC AT 14 m/s THE CAR IS CLOSER TO THE LIGHTS BY 14m. SO THE DIST. IS 84m 5

$u = 14$, $v = 0$, $a = ?$, $s = 84$, $T = -$

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

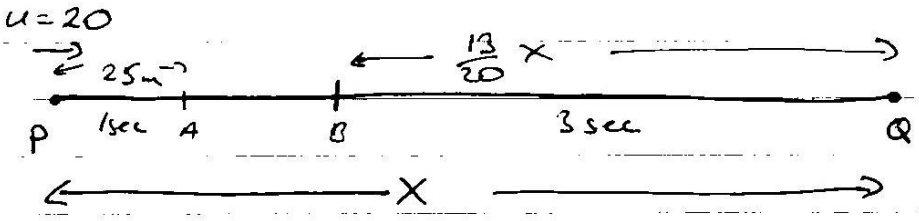
$(0)^2 = (14)^2 + 2(a)(84)$ 5

$0 = 196 + 168(a)$

$-196 = 168(a)$

$-1.167\ ms^{-2} = a$ 5

(b)



P → A

$u = 20$	$S = uT + \frac{1}{2}aT^2$
$v = -$	$25 = 20(1) + \frac{1}{2}(a)(1)^2$
$a = a$	$25 = 20 + \frac{1}{2}(a)$
$S = 25$	$5 = \frac{1}{2}a$
$T = 1$	$10\,ms^{-2} = a$

5

TOTAL DISTANCE $|PQ| = X$

TOTAL TIME $= T$

$u = 20$	$S = uT + \frac{1}{2}aT^2$
$v = -$	$X = 20T + \frac{1}{2}(10)(T)^2$
$a = 10$	$\boxed{X = 20T + 5T^2}$
$S = X$	
$T = T$	

5

Last 3 sec. from rest:

$u = 20$
$v = ?$
$a = 10$
$S = \frac{7}{20}x$
$T = T - 3$

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

$\frac{7}{20}x = 20(T-3) + \frac{1}{2}(10)(T-3)^2$

$\frac{7}{20}x = 20T - 60 + 5(T^2 - 6T + 9)$

$\frac{7}{20}x = 20T - 60 + 5T^2 - 30T + 45$

$$\boxed{\frac{7}{20}x = 5T^2 - 10T - 15}$$ 5

So $\frac{7}{20}(20T + 5T^2) = 5T^2 - 10T - 15$ $(\times 20)$

$7(20T + 5T^2) = 100T^2 - 200T - 300$ 5

$140T + 35T^2 = 100T^2 - 200T - 300$

$0 = 65T^2 - 340T - 300$ $(\div 5)$

$0 = 13T^2 - 68T - 60$

$0 = (13T + 10)(T - 6)$

$T = -\frac{10}{13}$ $\boxed{T = 6}$ 5

So, $x = 20(6) + 5(6)^2$

$x = 120 + 5(36) = \underline{\underline{300\text{m}}}$ 5