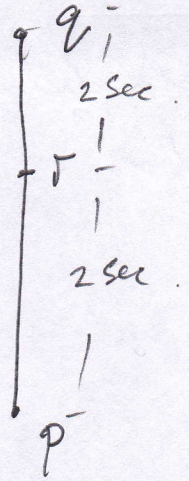
2009 Q1.

(a)



From $q \to r$:

$u = 0$
$v = v$
$t = 2$ sec.
$a = g$

$v = u + at$

$v = 0 + 2g$

$v = 2g$ eqn ①

From $p \to r$:

$u = u$
$v = v$
$t = 2$ sec.
$a = -g$

$v = u + at$

$v = u - 2g$ eqn ②

$v = 2g$ eqn ①

$v = u - 2g$ eqn ②

$\Rightarrow \boxed{2v = u \ *}$

From $q \to r$

$u = 0$
$v = v$
$a = g$
$s = |qr|$

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

$v^2 = 0^2 + 2g|qr|$

$v^2 = 2g|qr|$ eqn ③

From $p \to r$

$u = u$
$v = v$
$s = |pr|$
$a = -g$

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

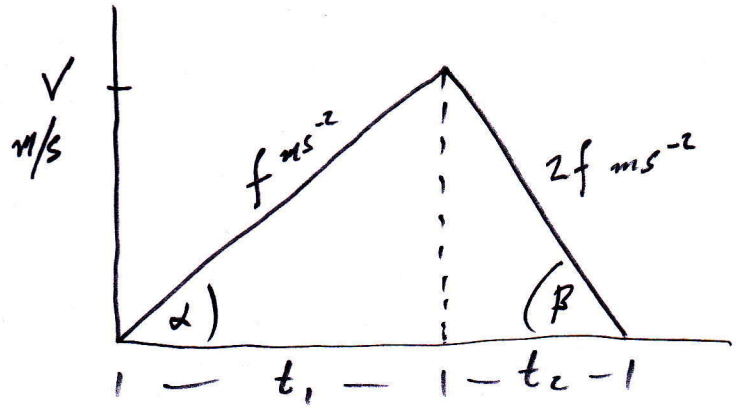
$\Rightarrow v^2 = u^2 - 2g|pr|$

$\Rightarrow v^2 = 4v^2 - 2g|pr|$ From * above

$\Rightarrow 3v^2 = 2g|pr|$ eqn ④

3. eqn ③ $\Rightarrow 6g|qr| = 2g|pr| \Rightarrow 3|qr| = |pr|$

(b) (i)



Total distance = d m

(ii)

The slope of each line = acceleration = Tan angles

$\Rightarrow$ Tan α = Slope = $f = \frac{V}{t_1} \Rightarrow t_1 = \frac{V}{f}$

Also Tan β = Slope = $2f = \frac{V}{t_2} \Rightarrow t_2 = \frac{V}{2f}$

$\Rightarrow t_1 + t_2 = \frac{V}{f} + \frac{V}{2f} = \frac{3V}{2f}$ * = Overall time

We now need overall distance:

$d = \frac{1}{2}t_1 V + \frac{1}{2}t_2 V = \frac{1}{2}(t_1 + t_2)V$

$\Rightarrow \frac{2d}{V} = t_1 + t_2$ *

$\Rightarrow \frac{3V}{2f} = \frac{2d}{V} \Rightarrow 3V^2 = 4fd$

Avg Speed = $\frac{\text{Total dist}}{\text{Total time}} \Rightarrow \sqrt{\frac{d}{3}} = \frac{d}{t_1 + t_2}$

$\Rightarrow \sqrt{\frac{d}{3}} = \frac{d}{\frac{3V}{2f}} \Rightarrow \sqrt{\frac{d}{3}} = \frac{2fd}{3V} \Rightarrow \frac{d}{3} = \frac{4f^2d^2}{9V^2}$

$\Rightarrow 12f^2d^2 = 9dV^2 \Rightarrow 4f^2d = 3V^2 \Rightarrow 4f^2d = 4fd$

$\Rightarrow f = 1\ ms^{-2}$