

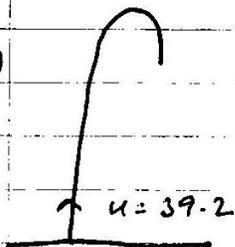
2008 Linear Motion Question

1. (a) A ball is thrown vertically upwards with an initial velocity of 39.2 m/s.
- Find (i) the time taken to reach the maximum height
- (ii) the distance travelled in 5 seconds.
- (b) Two particles P and Q, each having constant acceleration, are moving in the same direction along parallel lines. When P passes Q the speeds are 23 m/s and 5.5 m/s, respectively. Two minutes later Q passes P, and Q is then moving at 65.5 m/s.
- Find (i) the acceleration of P and the acceleration of Q
- (ii) the speed of P when Q overtakes it
- (iii) the distance P is ahead of Q when they are moving with equal speeds.

2008

Q.1
(a)

(i)

At max height, $V = 0$

$$\begin{aligned}
 u &= 39.2 & V &= u + at \\
 V &= 0 & 0 &= 39.2 + (-9.8)(T) \\
 a &= -9.8 & 0 &= 39.2 - 9.8T \\
 S &= - & 9.8(T) &= 39.2 \\
 T &= ? & T &= \frac{39.2}{9.8} \\
 & & T &= 4 \text{ sec}
 \end{aligned}$$

(5)

(ii) In 5 sec. the ball has travelled to max. height and fallen down for 1 sec.

To max height:

$$\begin{aligned}
 u &= 39.2 & S &= uT + \frac{1}{2} aT^2 \\
 V &= 0 & S &= (39.2)(4) + \frac{1}{2} (-9.8)(4)^2 \\
 a &= -9.8 & S &= 156.8 - 78.4 \\
 S &= ? & S &= 78.4 \text{ m} \\
 T &= 4
 \end{aligned}$$

(5)

From max height down for 1 sec:

$$\begin{aligned}
 u &= 0 & S &= uT + \frac{1}{2} aT^2 \\
 V &= - & S &= 0(1) + \frac{1}{2} (9.8)(1)^2 \\
 a &= +9.8 & S &= 0 + 4.9 \\
 S &= ? & S &= 4.9 \text{ m} \\
 T &= 1
 \end{aligned}$$

(5)

$$\begin{aligned}
 \therefore \text{Total distance} &= 78.4 + 4.9 \\
 &= \underline{\underline{83.3 \text{ m}}}
 \end{aligned}$$

(5)

(b)

$$u_p = 23$$

P

P

P

Q

Q

Q

$$u_q = 5.5$$

→

→

$$65.5$$

2 minutes

(i)

Q

$$u = 5.5$$

$$v = u + at$$

$$v = 65.5$$

$$65.5 = 5.5 + a(120)$$

$$a = ?$$

$$65.5 - 5.5 = 120a$$

$$s = -$$

$$60 = 120a$$

$$T = 120$$

$$\underline{\underline{0.5 \text{ ms}^{-2} = a_q}}$$

(5)

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

$$(65.5)^2 = (5.5)^2 + 2(0.5)(s)$$

$$4290.25 = 30.25 + s$$

$$4260 = s \quad ; \quad \text{Dist. WHEN OVERTAKING OCCURS}$$

(5)

P

$$u = 23$$

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

$$v = -$$

$$4260 = 23(120) + \frac{1}{2}(a)(120)^2$$

$$a = ?$$

$$4260 = 2760 + 7200a$$

$$s = 4260$$

$$1500 = 7200a$$

$$T = 120$$

$$\underline{\underline{\frac{5}{24} \text{ ms}^{-2} = a_p}}$$

(5)

(ii) SPEED OF P:

$$v = u + at$$

$$v = 23 + \frac{5}{24}(120)$$

$$v = 23 + 5(5)$$

$$\underline{\underline{v = 48 \text{ m/s}}}$$

(5)

(ii) Find time when speeds are equal:

$$\text{Q} \quad V = u + at$$

$$V = 5.5 + (0.5)(T)$$

$$\text{P} \quad V = u + at$$

$$V = 23 + \frac{5}{24}(T)$$

$$V = V$$

$$5.5 + 0.5T = 23 + \frac{5}{24}(T) \quad (\times 24)$$

$$132 + 12T = 552 + 5T$$

$$12T - 5T = 552 - 132$$

$$7T = 420$$

$$T = 60 \text{ sec.}$$

(5)

Now find distance each has travelled in this time:

Q

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

$$S = 5.5(60) + \frac{1}{2}(0.5)(60)^2$$

$$S = 330 + 900$$

$$S_Q = 1230 \text{ m}$$

P

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

$$S = 23(60) + \frac{1}{2}\left(\frac{5}{24}\right)(60)^2$$

$$S = 1380 + \frac{5}{48}(3600)$$

$$S_P = 1755 \text{ m}$$

$$\text{Dist. between: } 1755 - 1230 = \underline{\underline{525 \text{ m}}}$$

(5)