TOPIC 2: KINEMATICS QUIZ **Time: 30 minutes** **Score: / 22**

Name: ___________________________ **C.G.:** ______________

1. Define velocity.

....

.... [1]

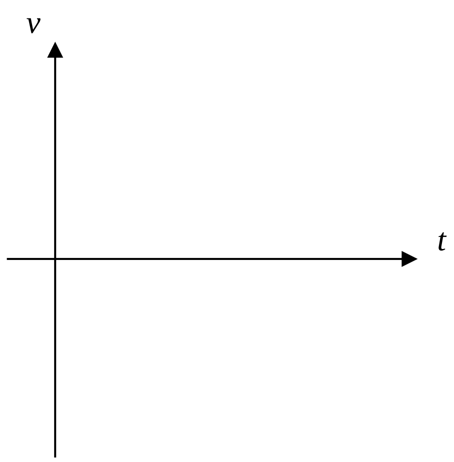
2. A ball is thrown vertically upwards with a velocity of 5 m s^{-1} and caught by the thrower on its return.

(a) Compute the maximum height and the time taken to reach this maximum height.

maximum height = ………….. m [2]

time taken = ………….. s [1]

(b) Sketch the velocity-time graph for the whole motion, and hence determine the maximum height from the graph.



Graph [1]

maximum height = ……..…….. m [1]

3. A hot air balloon ascends from rest with an acceleration of 2.50 m s^{-2}. When it reaches an altitude of 48.0 m above the initial ground level, a screw from its side came loose suddenly. Calculate the speed of the screw just before it reaches the ground?

speed = ……………… m s^{-1} [2]

4. A tennis player hits a lob shot from his baseline. He strikes the ball when it is 1.0 m off the ground, giving it a velocity of 15 m s^{-1} at an angle of 60° to the horizontal. Assuming there is no air resistance, calculate,

(i) the height above the ground at which the ball passes his opponents who is standing 15 m away.

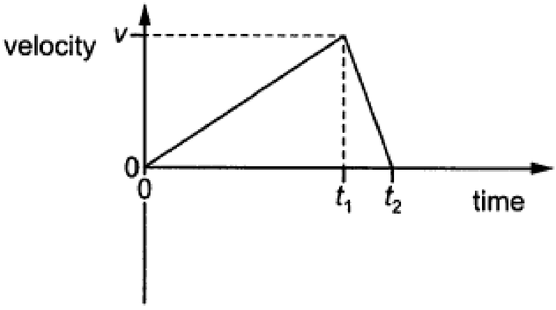
height = …………. m [2]

(ii) whether the ball will land 'in' or 'out' of the court, given that the tennis court is 25 m long.

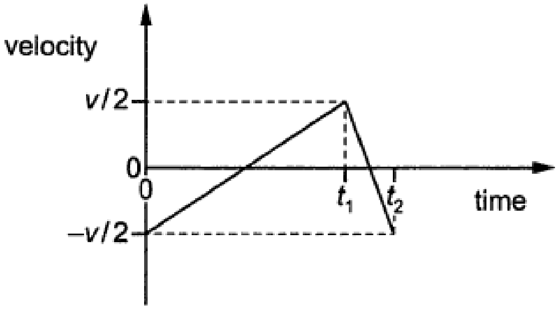
....[2]

5. [N18/P1/Q2 modified]
The motions of two objects P and Q along a straight line are shown in the following velocity-time graphs.

P



Q



Explain if the magnitudes of the displacement and total distance travelled are similar or different for the two objects.

Displacement: ……………………………………………………………………………………

....

.... [2]

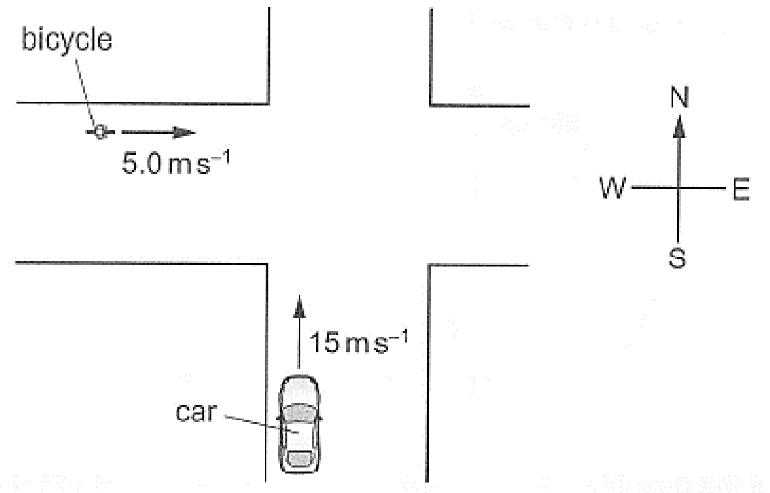
Total Distance: ....

....

.... [2]

6. [N19/P1/Q5 modified]

A car and a bicycle are equal distances from a crossroad. The car is travelling north with a speed of 15 m s^{-1}. The bicycle is travelling east with a speed of 5.0 m s^{-1}.



Determine the magnitude and direction of the velocity of the bicycle relative to the car.

magnitude = ……………………… m s^{-1} [2]

direction (you may calculate the angle and indicate it on a diagram)

……………………………………………………………………………………………………….[2]

7. Consider a body which is thrown vertically upwards with significant air resistance. Is the time of flight for the upward motion, t_u, less than or greater than the time of flight for the downward motion, t_d, to the same level? Explain.

....

....

....

.... [2]

Kinematics Quiz Solutions

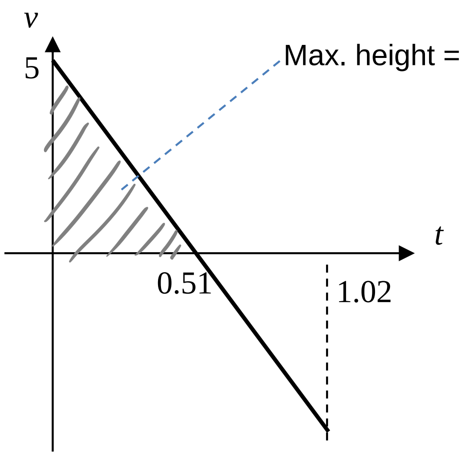
1. Velocity is defined as the displacement per unit time *OR* the rate of change of displacement (with respect to time). [1]

2(a) Let end point be at maximum height , $v_y = 0$, $u_y = 5$ m s^{-1}, $a_y = -9.81$ m s^{-2}

Using $v_y^2 = u_y^2 + 2as_y$ and taking upwards as positive,
$0 = 5^2 + 2(-9.81)\ s$ [1]
$\Rightarrow s =$ <u>1.3 m</u> [1]

Using $v_y = u_y + a_y t$ and taking upwards as positive,
$0 = 5 + (-9.81)t$
$\Rightarrow t =$ <u>0.51 s</u> [1]

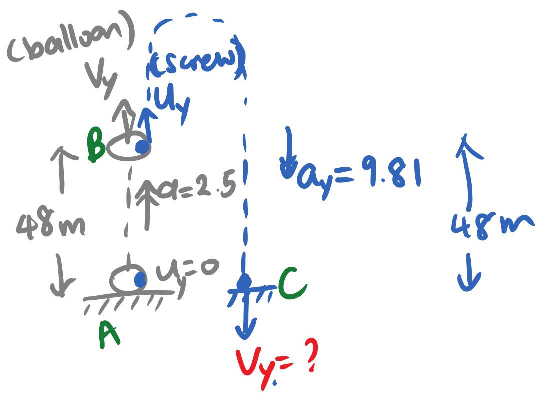
(b) Taking upwards as positive for the v-t graph:



Max. height = shaded area = $\frac{1}{2}(0.51)(5)$ = <u>1.3 m</u> [1]

Correct shape [1]

3.

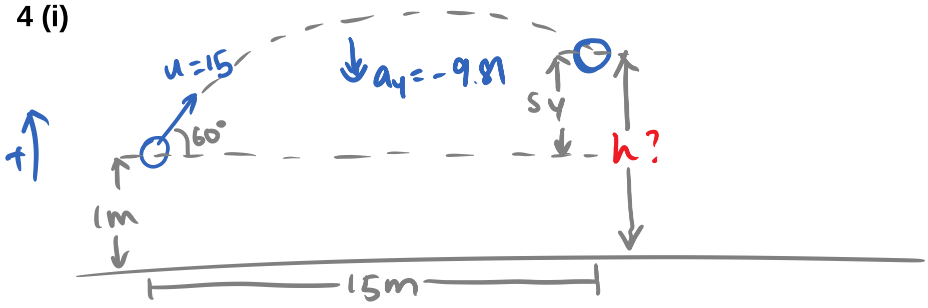


Since the hot air balloon ascends from rest, $u_y = 0$, $a_y = 2.50$ m s^{-2}, $s_y = 48.0$ m
For the balloon, taking upwards as positive,
and taking starting point at A, ending point at B,
$v_y^{\ 2} = u_y^{\ 2} + 2\ a_y\ s_y$
$= 0 + 2(2.50)(48.0)$ [1]
$u_y = 15.5$ m s^{-1}

This is the vertical speed of both the balloon and screw (at the moment it came loose).

For the screw, taking upwards as positive,
and taking starting point at B, ending point at C,
$v_y{}^2 = u_y{}^2 + 2\,a_y\,s_y$
$v_y{}^2 = 15.5^2 + 2\,(-9.81)(-48.0)$
$v_y\ = \underline{-\,34.4\ \text{m s}^{-1}}$ [1]

4 (i)

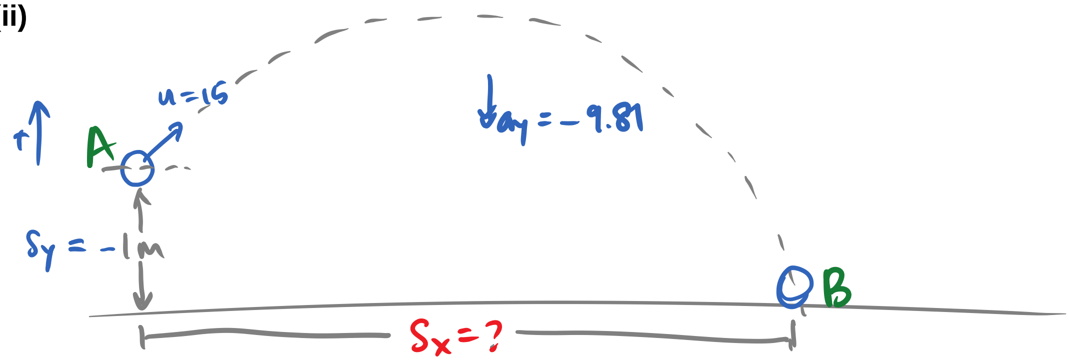


Using $s_x = u_x\,t$
$15 = (15 \cos 60^o)\,(t)$
$\Rightarrow\ t = 2.0$ s

Using $s_y = u_y\,t + ½\,a\,t^2$, taking upwards as positive,
$s_y = (15 \sin 60^o)(2.0) + ½\,(-\,9.81)(2.0)^2$
$= 6.36$ m [1]

Height, h, above ground = 1.00 + 6.36 = $\underline{7.36\ \text{m}}$ [1]

(ii)

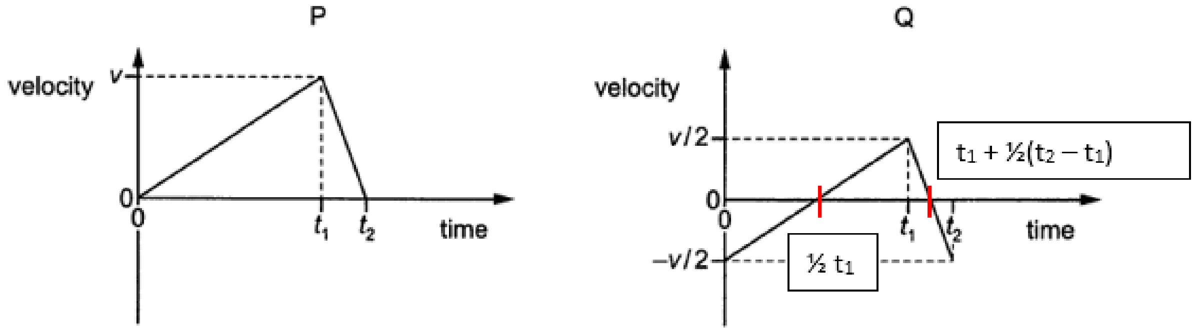


Using $s_y = u_y\,t + ½\,a\,t^2$, taking upwards as positive,
With starting point at A and ending point at B,
$-\,1 = (15 \sin 60^o)(\ t) + ½\,(-9.81)t^2$
$t = 2.72$ s [1]

Using $s_x = u_x\,t$
$= (15 \cos 60^o)(2.72)$
$=$ $\underline{20.4\ \text{m}}$, which is less than the court length of 25 m.

Hence the ball lands <u>within</u> the court. [1]

5.



Displacement is different [1]
because the net v-t graph area for P is positive but that for Q is zero. [1]
(For Q, the area under graph above and below the time axes are equal)

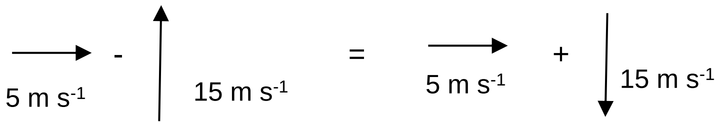
Total distance travelled is also different because [1]
the total area under v-t graph for P is larger than the total area for Q. [1]

{Proof below, not required for a qualitative question with answer lines}
Since the graph for P is shifted down by half (v become v/2 and 0 become -v/2), the position where the graph in Q cuts the x-axis is ½ t_1.

Area under graph for P = distance = displacement = ½ v t_1 + ½ v ($t_2 - t_1$)
Area under graph for Q (ignoring direction) = distance

$$= 2(\tfrac{1}{2})(v/2)(\tfrac{1}{2}t_1) + 2(\tfrac{1}{2})(v/2)\tfrac{1}{2}(t_2 - t_1)$$
$$= (v/2)(\tfrac{1}{2}t_1) + (\tfrac{1}{2})(v/2)(t_2 - t_1)$$

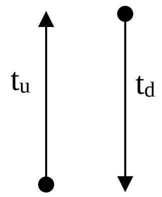
Area under graph for Q (including direction) = displacement = 0

6. $v_{bicycle} - v_{car}$ =  [1]

Magnitude = $\sqrt{5^2 + 15^2} = 15.8$ m s^{-1} [1]

Direction = $\tan^{-1}\left(\frac{15}{5}\right) = 71.6°$ [1]
South of the Eastern direction (you do not need to know this "naming" convention) [1]

7.



The net accelerating force, (W – air resistance) or acceleration when the body is moving *downwards* is always smaller than the retarding force, (W + air resistance) or deceleration when it is moving *upwards*. [1]

Since the <u>distance travelled</u> upwards is the same as the distance travelled downwards, Hence, $t_u < t_d$. [1]