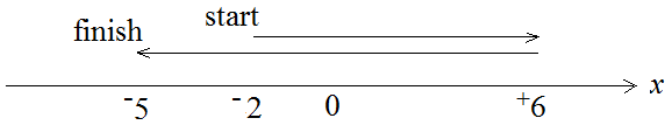
2018 Year 11 math topic test: Kinematics (linear motion)

Q1 The linear path of a particle is shown below.
The particle starts from rest at $x=^{-}2$ and stops at the finishing point $x=^{-}5$.
The time taken for the journey is 10 seconds. Position x is in metres. Take eastward direction as positive.



a. State the position of the particle at the moment it reverses its direction of motion. 1 mark

b. State the displacement of the particle for the journey. 1 mark

c. State the distance travelled by the particle for the journey. 1 mark

d. Calculate the average speed of the particle for the journey. 1 mark

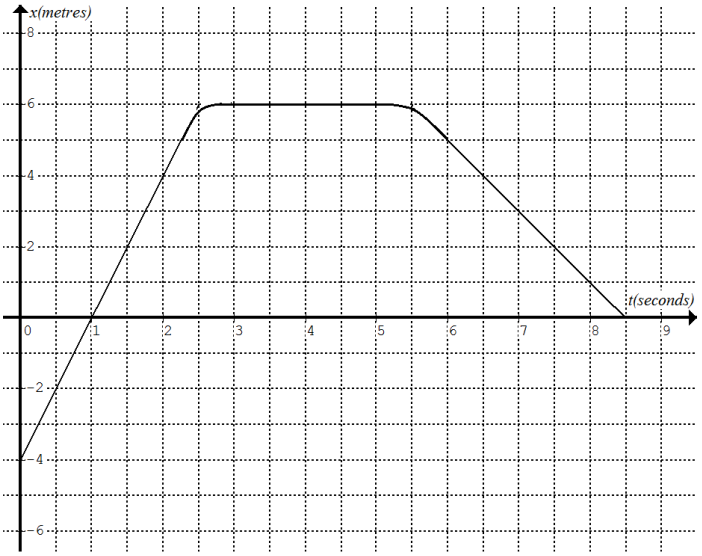
e. Calculate the average velocity of the particle for the journey. 1 mark

f. Determine the average acceleration of the particle for the journey. 1 mark

g. State the velocity of the particle at the moment it reverses its direction of motion. 1 mark

h. State the direction of the particle's acceleration at the moment it reverses its direction of motion.
1 mark

Q2 A particle travels in a straight line in the east-west direction.
Its position-time graph (x-t graph) is shown below. Take eastward direction as positive.
The particle is already moving at the start of the stopwatch, i.e. when $t = 0$. It is at $x = 0$ when $t = 8.5$.



a. Calculate the displacement of the particle in the first 8.5 seconds. 1 mark

b. Calculate the distance travelled by the particle in the first 8.5 seconds. 1 mark

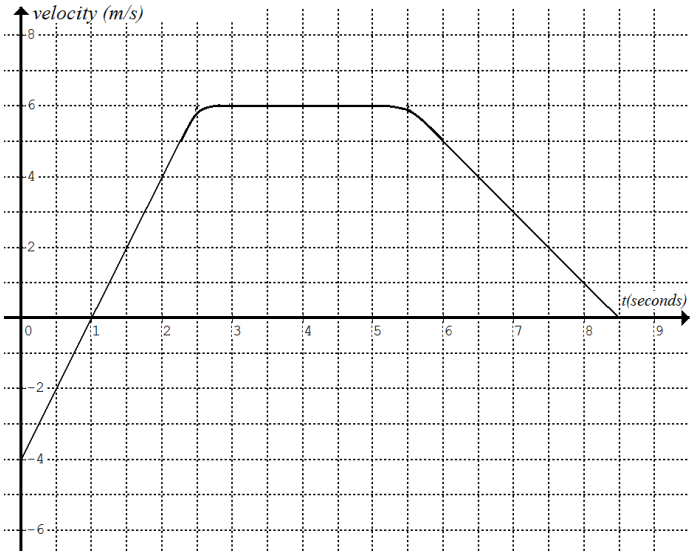
c. Calculate its velocity at the start of the stopwatch. 1 mark

d. Determine its acceleration when $t = 2$. 1 mark

e. Estimate the velocity of the particle when (i) $t = 2.5$ and (ii) $t = 5.5$. 3 marks

e. Estimate the average acceleration of the particle from $t = 5$ to $t = 6$. 3 marks

Q3 A particle travels in a straight line in the east-west direction. Take eastward direction as positive. Its velocity-time graph (v-t graph) is shown below. The particle is at position $x=^{-}2$ m when $t=2$.



a. Determine the maximum and minimum speed of the particle. 2 marks

b. Determine the positions of the particle when $t=0$ and $t=1$. 2 marks

c. Calculate the average acceleration of the particle in the first 8.5 seconds. 2 marks

d. Calculate the acceleration of the particle when $t=1$. 1 mark

e. Estimate the average velocity of the particle in the first 8.5 seconds. 3 marks

Q4 The position x (m) of a particle at time t (s) is given by the equation $x = \frac{1}{2}(t-2)(t-6)$ for $t \in [0, 10]$.

a. Determine the initial and final positions of the particle. 2 marks

b. Calculate the initial and final velocities of the particle. 3 marks

c. Calculate the average velocity of the particle in the time interval $[0, 10]$. 1 mark

d. Calculate the average speed of the particle in the time interval $[0, 10]$. 3 marks

e. Show that the acceleration of the particle is constant. 1 mark

f. Show that $v^2 = 4 + 2x$ where v (m s^{-1}) is the speed of the particle at position x. 2 marks

Q5 The acceleration a (m s^{-2}) of a particle varies with time t (s) according to $a = {}^{-}(0.1t + 1)$ for $t \in [0, 10]$. The velocity v of the particle is $^{+}2$ m s^{-1} when $t = 0$.

a. Describe the motion of the particle in terms of its speed and direction of motion in the time interval $[0, 10]$. 3 marks

b. Calculate the change in velocity and the final velocity in the time interval $[0, 10]$. 3 mark

Q6 A particle is projected vertically upwards and moves under the force of gravity only. The velocity of the particle is $^{+}20$ m s^{-1} when it is 2.0 metres above the ground. Take upward direction as positive. Assume the magnitude of the acceleration due to the force of gravity is 9.8 m s^{-2}.

a. Calculate the maximum height above the ground reached by the particle. 2 marks

b. Calculate the maximum speed of the particle. 2 marks

