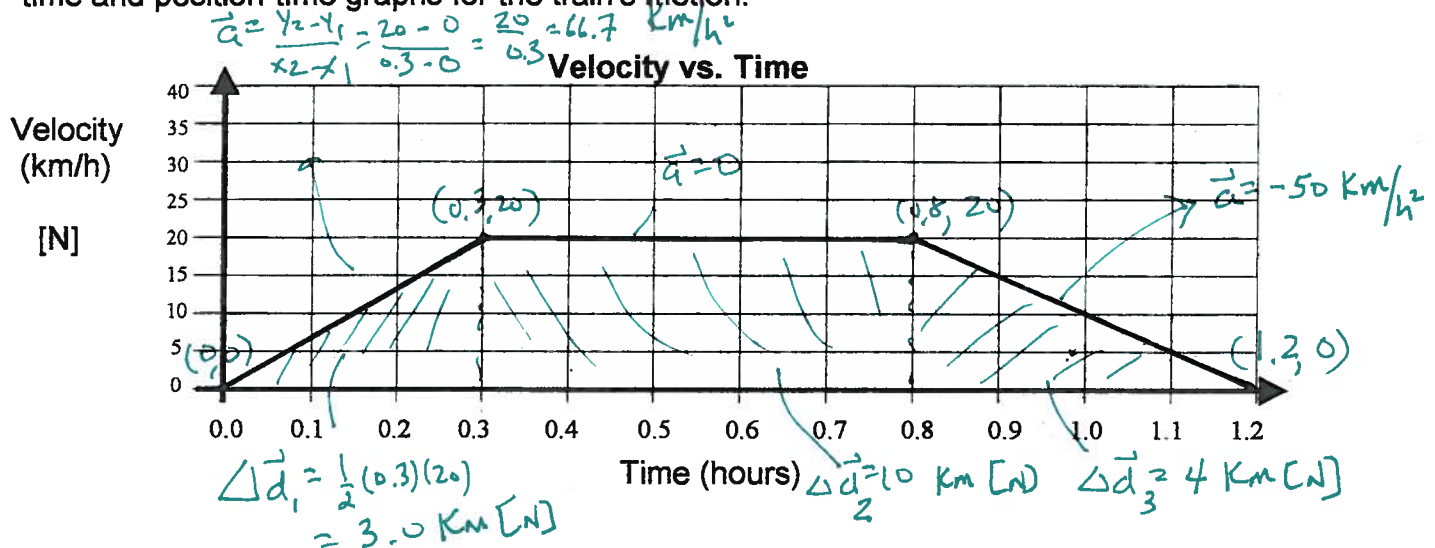**_Motion-Graph Analysis_: Generating Position-Time and Acceleration-Time Graphs from a Velocity-Time Graph**
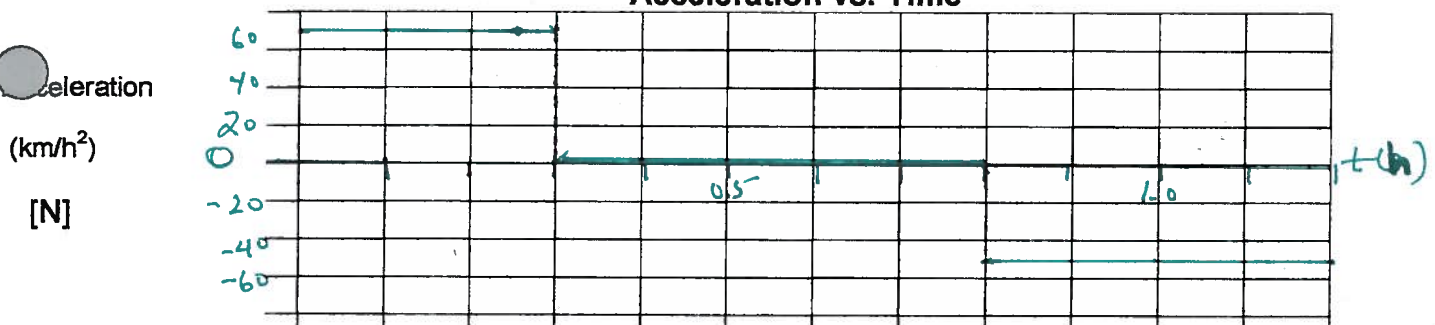
The graph below shows the velocity-time graph for a train travelling on a straight track. The train starts at rest at the station or the origin. Draw the corresponding acceleration-time and position-time graphs for the train's motion.

$$\vec{a} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{20 - 0}{0.3 - 0} = \frac{20}{0.3} = 66.7 \text{ km/h}^2$$

Velocity vs. Time

$(0.3, 20)$ $\vec{a} = 0$ $(0.8, 20)$ $\vec{a} = -50 \text{ km/h}^2$ $(1.2, 0)$

$$\Delta \vec{d}_1 = \frac{1}{2}(0.3)(20) = 3.0 \text{ km [N]}$$

Time (hours) $\Delta \vec{d}_2 = 10 \text{ km [N]}$ $\Delta \vec{d}_3 = 4 \text{ km [N]}$

>>Required Analysis: | Slope of v-t graph

Acceleration vs. Time

>>Required Analysis: | Area under the curve

I. chart:

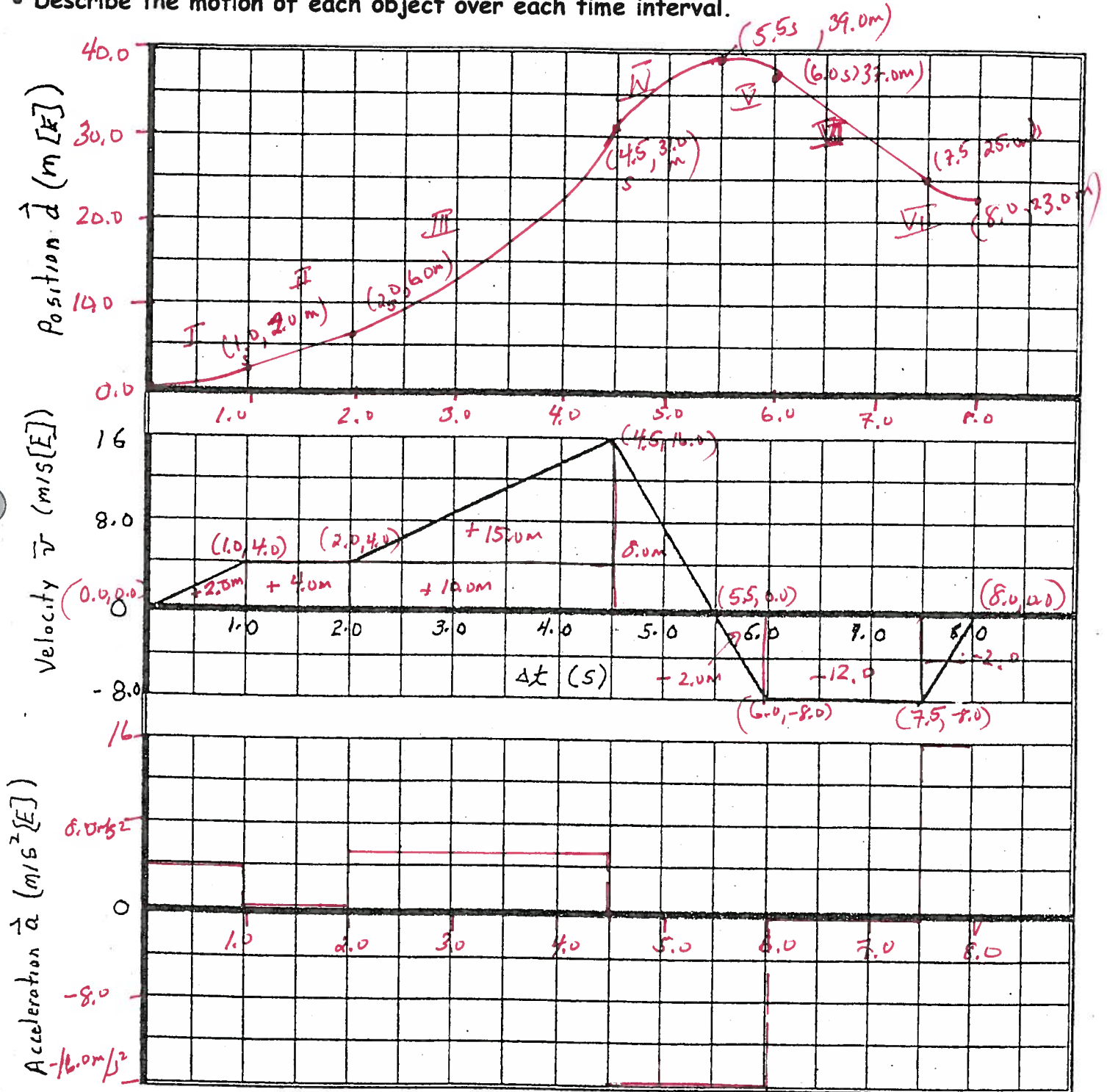| t	$\vec{d}$ (km)
0	0
0.3	3.0
0.8	13.0
1.2	17.0

Position vs. Time

- Apply the rules for interpreting and plotting graphs to draw the position-time and acceleration-time graphs for each of the velocity-time graphs given. Assume that each object starts at the origin (position 0.0 m) at time 0.0.

- Describe the motion of each object over each time interval.

Position-time graph (Position $\vec{d}$ (m [E])), axis values 40.0, 30.0, 20.0, 14.0, 0.0; time axis 1.0–8.0:
- (5.5s, 39.0m)
- (6.0s) 37.0m)
- (4.5, 30.0 m) IV
- V
- VII
- (7.5, 25.0 m)
- (8.0, 23.0 m) VI
- III
- (2.0, 6.0 m)
- II
- I (1.0, 2.0 m)

Velocity-time graph (Velocity $\vec{v}$ (m/s [E])), axis values 16, 8.0, -8.0, 16; time axis 1.0–8.0, Δt (s):
- (0.0, 0.0)
- (1.0, 4.0)
- (2.0, 4.0)
- +2.0m, +4.0m, +10.0m, +15.0m
- (4.5, 16.0)
- 8.0m
- (5.5, 0.0)
- (8.0, 4.0)
- -2.0m
- -12.0
- (6.0, -8.0)
- (7.5, -4.0)

Acceleration-time graph (Acceleration $\vec{a}$ (m/s^2 [E])), axis values 8.0 m/s^2, 0, -8.0, -16.0 m/s^2; time axis 1.0–8.0

Motion description: Slopes $a_1 = 4.0$ m/s^2, b) 4.8 m/s^2, -11.0 m/s^2, 0.0 m/s^2, +16.0 m/s^2

I – moving E speeding up uniformly

II – moving E constant velocity

III – moving E speeding up uniformly

IV – moving E slowing down uniformly to

V – moving W speeding up uniformly

VI – moving W constant velocity

VII – moving W slowing down
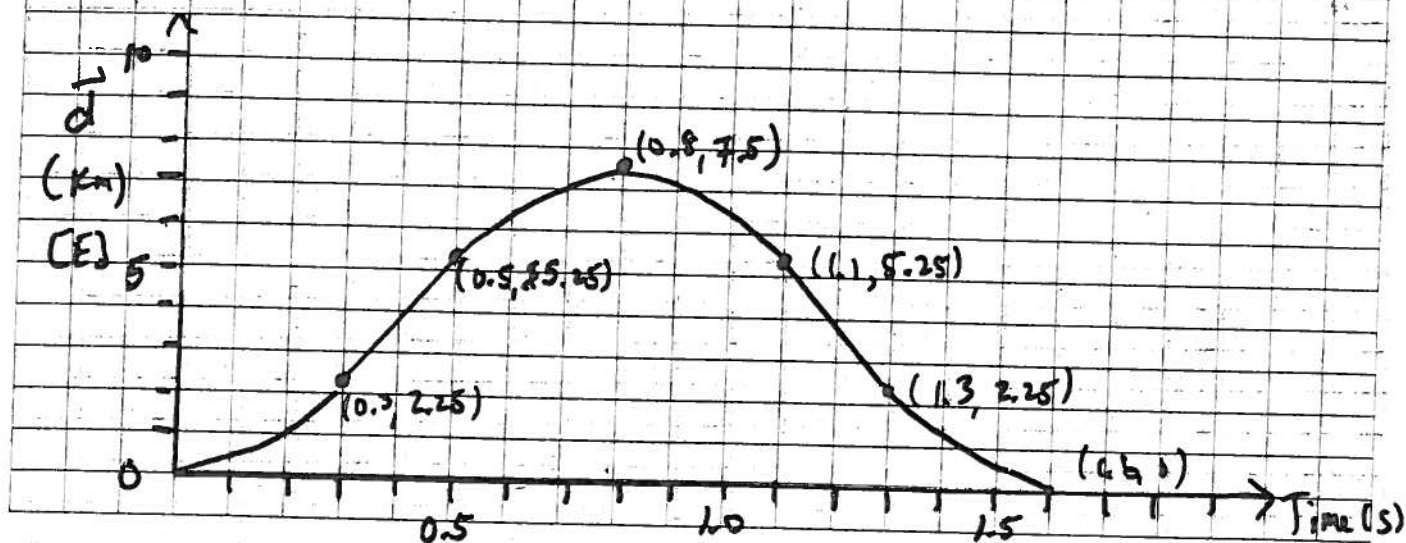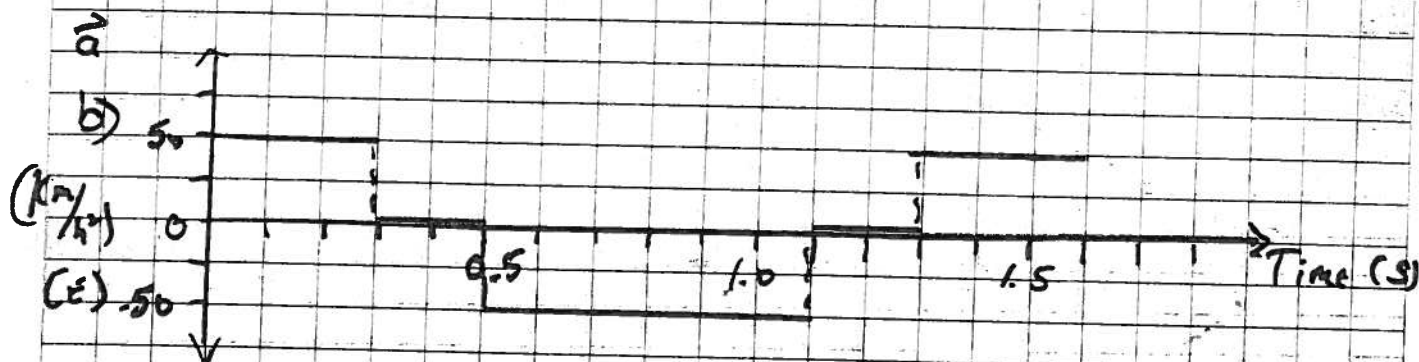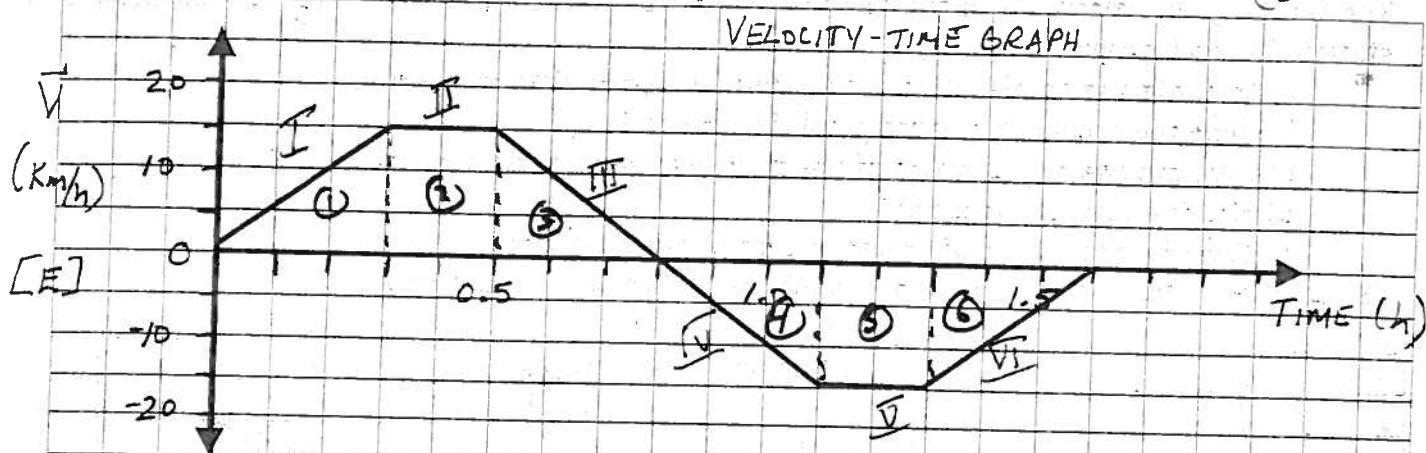
I moving E speeding up uniformly (const. accel E) 2.

II constant Velocity E

III moving E slowing down to rest uniformly

IV moving W speeding up uniformly (constant acc W)

V constant velocity W

VI moving W slowing down uniformly (const. acc. E)

VELOCITY - TIME GRAPH

$\vec{v}$ (Km/h) [E]

20, 10, 0, -10, -20

I, II, III, ①, ②, ③, ④, ⑤, ⑥, V, VI

0.5, 1.0, 1.5, TIME (h)

$\vec{a}$

b) (Km/h²) [E]

50, 0, -50

0.5, 1.0, 1.5, Time (S)

$\vec{d}$ (Km) [E]

10, 5, 0

(0.8, 7.5)

(0.5, 5.25)

(1.1, 5.25)

(0.3, 2.25)

(1.3, 2.25)

(1.5, 0)

0.5, 1.0, 1.5, Time (S)

c) $\Delta \vec{d}_1 = 2.25 \, Km \, [E]$ $\Delta \vec{d}_4 = -2.25 \, Km \, [E] = 2.25 \, Km \, [W]$

$\Delta \vec{d}_2 = 3.0 \, Km \, [E]$ $\Delta \vec{d}_5 = -3.0 \, Km \, [E]$

$\Delta \vec{d}_3 = 2.25 \, Km \, [E]$ $\Delta \vec{d}_6 = -2.25 \, Km \, [E]$

d) $\Delta \vec{d}_t = 0 \, Km$