

Unit 1: Motion and It's Applications

Activity	Suggested Time Frame	Practise Questions	Discussion	Lab	Project	Quiz	Test
A1: Average Velocity	2	2013-02-13				2013-02-14	
A2: Average Acceleration	2	2013-02-15					
A3: Velocity and Acceleration Investigation	2		2013-02-20	2013-02-21			
A4: Forces and FBD	2	2013-02-22				2013-02-25	
A5: Force and Acceleration Investigation	2		2013-02-025	2013-02-026			
A6: Newton's Laws	2	2013-02-27					
A7: Gravity Project	2		2013-02-027	2013-02-028		2013-02-28	
A8: Motion Technology	Ongoing				2013-05-29		Monday
A9: Test	1						2013-03-04

Unit 2: Mechanical Systems

Activity	Suggested Time Frame	Practise Questions	Discussion	Lab	Project	Quiz	Test
A1: Problem Solving with Physics	2	2013-03-05					
A2: Friction Investigation	2		2013-03-06	2013-03-07			
A3: Work and Simple Machines	1 – 2	2013-03-08					
A4: Mechanical Advantage	2	2013-03-18					
A5: Levers Investigation	2		2013-03-20	03 / 21			
A6: Machines Design Project	2		03 / 22		2013-03-25	03 / 22	
A7: Mechanical Systems Technology	Ongoing				2013-05-30		Wednesday
A8: Test	1						03 / 27

Unit 3: Electricity and Magnetism							
Activity	Suggested Time Frame	Practise Questions	Discussion	Lab	Project	Quiz	Test
A1: Circuits, Ohm's Law and Equivalent Resistance	2	03 / 28				03 / 28	
A2: Circuit Investigation	3		04 / 02	2013-04-03			
A3: Electrical Safety Devices	1				2013-04-04		
A4: Magnetic Fields Investigation	2					2013-04-08	
A5: Oersted's Principle	2	04 / 10					
A6: Motor Principle	2	04 / 12					
A7: AC/DC Currents	1	2013-04-15					
A8: Electric Device Design Project	3		2013-05-26		2013-05-27	04 / 17	
A9: Electricity and Magnetism Technology	2				2013-05-28		Friday
A10: Test	1						2013-04-19

Unit 4: Energy Transformations							
Activity	Suggested Time Frame	Practise Questions	Discussion	Lab	Project	Quiz	Test
A1: Conservation of Energy	2	2013-04-22					
A2: Energy Transformation Investigation	2		2013-04-23	04 / 24			
A3: Efficiency Investigation	2		2013-04-28	2013-04-29			
A4: Energy Generation	2		04 / 30				
A5: Energy Transformation Design Project	3		05 / 03		2013-05-06	2013-05-06	
A6: Energy Transformation Technology	Ongoing				2013-05-31		Thursday
A7: Test	1						2013-05-09

Unit 5: Hydraulic and Pneumatic Systems							
Activity	Suggested Time Frame	Practise Questions	Discussion	Lab	Project	Quiz	Test
A1: Static Pressure Head	2	2013-05-13				2013-05-14	
A2: Pascal's Principle	2			2013-05-16			
A3: Components of Hydraulic and Pneumatic Systems	1	2013-05-20					
A4: Flow Rate Investigation	2		2013-05-20	2013-05-21			
A5: Hydraulic and Pneumatic Systems Design Project	3		2013-05-23		2013-05-24		
A6: Laminar Flow	2		2013-05-24		NONE		
A7: Bernoulli's Principle	1					2013-06-03	
A8: Hydraulic and Pneumatic Systems Technologies	ongoing				2013-06-06		Wednesday
A9: Test	1						2013-06-05

Unit 6: Final Assessment							
Activity	Suggested Time Frame	Practise Questions	Discussion	Lab	Project	Quiz	Test
A1: Exam Review	Ongoing				2013-06-10		
A2: Exam	1						06 / 18 ??

4C PHYSICS EQUATIONS

PREFIXES

$$\eta = \times 10^{-9} \quad \mu = \times 10^{-6} \quad m = \times 10^{-3} \quad k = \times 10^3 \quad M = \times 10^6 \quad G = \times 10^9$$

CONSTANTS

$$\begin{array}{llll} 1 \text{ year} = 3.16 \times 10^7 \text{ s} & 1 \text{ m/s} = 3.6 \text{ km/h} & c = 3.00 \times 10^8 \text{ m/s} & G = 6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2 \\ 1 \text{ kW}\cdot\text{h} = 3.6 \text{ MJ} & g = 9.8 \text{ m/s}^2 & e = 1.60 \times 10^{-19} \text{ C} & k = 9.00 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2 \end{array}$$

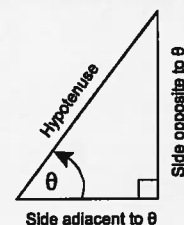
DERIVED UNITS

<i>Coulomb</i>	<i>Joule</i>	<i>Newton</i>	<i>Resistance</i>	<i>Volt</i>	<i>Watt</i>
$C = A\cdot s$	$J = \text{kg}\cdot\text{m}^2/\text{s}^2$	$N = \text{kg}\cdot\text{m}/\text{s}^2$	$\Omega = \text{kg}\cdot\text{m}^2/\text{A}^2\cdot\text{s}^3$	$V = \text{kg}\cdot\text{m}^2/\text{A}\cdot\text{s}^3$	$W = \text{kg}\cdot\text{m}^2/\text{s}^3$

TRIGONOMETRY

Right Triangle (SOHCAHTOA)

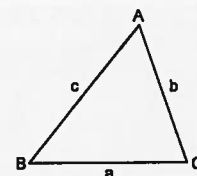
$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}} \quad \cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}} \quad \tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$



Non-Right Triangle
(Sine & Cosine Law)

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\begin{aligned} a^2 &= b^2 + c^2 - 2\cdot b\cdot c\cdot \cos A \\ b^2 &= a^2 + c^2 - 2\cdot a\cdot c\cdot \cos B \\ c^2 &= a^2 + b^2 - 2\cdot a\cdot b\cdot \cos C \end{aligned}$$



ERROR

$$\% \text{ Error} = \frac{|\text{accepted} - \text{measured}|}{\text{accepted}} \times 100\% \quad \% \text{ Difference} = \frac{|\text{value1} - \text{value2}|}{\left(\frac{\text{value1} + \text{value2}}{2}\right)} \times 100\%$$

KINEMATICS

$$\vec{v}_{avg} = \frac{\Delta \vec{d}}{\Delta t} = \frac{\vec{d}_2 - \vec{d}_1}{t_2 - t_1}$$

$$\vec{a}_{avg} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_2 - \vec{v}_1}{t_2 - t_1}$$

$$\Delta \vec{d} = \frac{(\vec{v}_1 + \vec{v}_2)}{2} \Delta t$$

$$\vec{v}_{avg} = \frac{\vec{v}_1 + \vec{v}_2}{2}$$

$$\vec{v}_2 = \vec{v}_1 + \vec{a} \Delta t$$

$$\Delta \vec{d} = \vec{v}_1 \Delta t + \frac{1}{2} \vec{a} (\Delta t)^2$$

$$\vec{v}_2^2 = \vec{v}_1^2 + 2 \vec{a} \Delta \vec{d}$$

$$\Delta \vec{d} = \vec{v}_2 \Delta t - \frac{1}{2} \vec{a} (\Delta t)^2$$

MECHANICAL SYSTEMS

$$T = Fd$$

$$F_E d_E = F_L d_L$$

$$\sum T = 0 \quad F_1 d_1 + F_2 d_2 + \dots = 0$$

$$AMA = \frac{F_L}{F_E}$$

$$IMA = \frac{d_E}{d_L}$$

$$eff = \frac{AMA}{IMA}$$

DYNAMICS & ENERGY

$$\vec{g} = \frac{\vec{F}_g}{m}$$

$$\vec{F}_f = \mu \vec{F}_N$$

$$\vec{F}_{net} = m\vec{a}$$

$$W = \Delta E = F\Delta d$$

$$\Delta E_G = mg\Delta h$$

$$\Delta E_K = \frac{1}{2}m\Delta v^2$$

$$E_T = E_G + E_K$$

$$P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t}$$

$$eff = \frac{E_{out}}{E_{in}}$$

$$eff_{overall} = (eff_1)(eff_2)(eff_3)\dots$$

HYDRAULICS & PNEUMATICS

$$D = \frac{m}{V}$$

$$p = \frac{F}{A}$$

$$p_{guage} = Dgh$$

$$p_{absolute} = p_{guage} + p_{atm}$$

$$\frac{F_S}{A_S} = \frac{F_L}{A_L}$$

$$q_V = Av$$

$$\Delta t = \frac{V}{q_V}$$

$$A_1 \cdot v_1 = A_2 \cdot v_2$$

ELECTRICITY & ELECTROMAGNETISM

$$V = IR$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$P_{loss} = I^2 R$$

$$cost = \Delta E \times rate$$

In series

$$V_{total} = V_1 + V_2 + \dots$$

$$I_{total} = I_1 = I_2 = \dots$$

$$R_{total} = R_1 + R_2 + \dots$$

$$P_{total} = P_1 + P_2 + \dots$$

In parallel

$$V_{total} = V_1 = V_2 = \dots$$

$$I_{total} = I_1 + I_2 + \dots$$

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$P_{total} = P_1 + P_2 + \dots$$

SPH4C: PHYSICS FORMULA SHEET

Prefixes

$$G = \times 10^9 \quad M = \times 10^6 \quad k = \times 10^3 \quad h = \times 10^2 \quad da = \times 10^1 \quad d = \times 10^{-1} \quad c = \times 10^{-2} \quad m = \times 10^{-3} \quad \mu = \times 10^{-6} \quad \eta = \times 10^{-9}$$

Conversions

$$1m^3 = 1000000cm^3 \quad 1m^2 = 10000cm^2 \quad 1cm^3 = 1mL \quad 1m^3 = 1L$$

Constants

$$\begin{aligned} 1year &= 3.16 \times 10^7 s & 1hr &= 3600s & c &= 3.00 \times 10^8 m/s & G &= 6.67 \times 10^{-11} N \cdot m^2 / kg^2 \\ 1kW \cdot h &= 3.6MJ & g &= 9.8m/s^2 & e &= 1.60 \times 10^{-19} C & k &= 9.00 \times 10^9 N \cdot m^2 / C^2 \\ 101.3kPa &= 760mmHg & p_s &= 101.3kPa \end{aligned}$$

Derived Units

$$\begin{aligned} \text{Coulomb} & \quad \text{Joule} & \quad \text{Newton} & \quad \text{Pascal} \\ C = A \cdot s & \quad J = kg \cdot m^2 / s^2 & \quad N = kg \cdot m / s^2 & \quad Pa = N / m^2 \end{aligned}$$

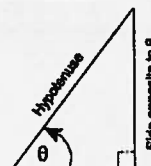
Area and Volumes

$$\begin{aligned} \text{Area of Rectangle} & \quad \text{Area of Circle} & \quad \text{Volume of Rectangle} & \quad \text{Volume of Sphere} & \quad \text{Volume of Cylinder} \\ A = lw & \quad A = \pi r^2 & \quad V = lwh & \quad V = \frac{4}{3} \pi r^3 & \quad V = Ah = \pi r^2 h \end{aligned}$$

Trigonometry

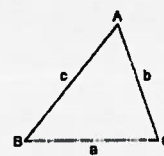
Right Triangle (SOHCAHTOA)

$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}} \quad \cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}} \quad \tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$



Non-Right Triangle

$$\begin{aligned} \frac{a}{\sin A} &= \frac{b}{\sin B} = \frac{c}{\sin C} & a^2 &= b^2 + c^2 - 2bc \cdot \cos A \\ b^2 &= a^2 + c^2 - 2ac \cdot \cos B & c^2 &= a^2 + b^2 - 2ab \cdot \cos C \end{aligned}$$



Motion and Its Applications

$$\begin{aligned} \vec{v} &= \frac{\vec{d}}{t} & \vec{a} &= \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_2 - \vec{v}_1}{t_2 - t_1} & \vec{d} &= \frac{\vec{v}_2 + \vec{v}_1}{2} \Delta t & \vec{F} &= \frac{Gm_1 m_2}{\vec{d}^2} \quad \mu = \frac{F_f}{F_N} \\ \vec{v} &= \frac{\vec{d}_2 - \vec{d}_1}{t_2 - t_1} & \vec{v}_2 &= \vec{v}_1 + \vec{a} \Delta t & \vec{d} &= \vec{v}_1 \Delta t + \frac{1}{2} \vec{a} \Delta t^2 & \vec{F}_{net} &= m \vec{a} \\ \vec{v}_2^2 &= \vec{v}_1^2 + 2 \vec{a} \vec{d} & \vec{d} &= \vec{v}_2 \Delta t - \frac{1}{2} \vec{a} \Delta t^2 & \vec{F} &= mg \end{aligned}$$

Mechanical Systems

$$\begin{aligned} T &= Fd & T_E &= T_L & AMA &= \frac{F_L}{F_E} \\ T_E &= F_E d_E & T_{CW} &= T_{CCW} & IMA &= \frac{d_E}{d_L} \\ T_L &= F_L d_L & F_E d_E &= F_L d_L & \%eff &= \frac{AMA}{IMA} \times 100 \end{aligned}$$

Machine	IMA
wheel and axle	the ratio of the radii, $\frac{r_E}{r_L}$
a set of gears	the ratio of the teeth count, $\frac{N_E}{N_L}$
a set of pulleys	the number of support strands
an inclined plane	the ratio $\frac{\text{length of inclined plane}}{\text{height}}$

Magnetism

$$\begin{aligned} \frac{V_S}{V_P} &= \frac{N_S}{N_P} & \frac{V_P}{V_S} &= \frac{I_S}{I_P} & P_S &= P_P & \mu &= \frac{\text{magnetic field in material}}{\text{magnetic field in vacuum}} \end{aligned}$$

Electricity

$$\begin{array}{llll}
 Q = It & P = VI & R = \frac{V}{I} & V_s = V_1 + V_2 + V_3 + \text{etc.} \\
 Q = Ne & P = I^2 R & E = P\Delta t & I_s = I_1 = I_2 = I_3 = \text{etc.} \\
 E = VQ & P = \frac{V^2}{R} & & V_p = V_1 = V_2 = V_3 = \text{etc.} \\
 \text{Cost} = \text{Rate} \times E & & I_p = I_1 + I_2 + I_3 + \text{etc.} &
 \end{array}$$

$$R_s = R_1 + R_2 + \dots + R_n$$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$$

Energy Transformations

$$\begin{array}{lll}
 W = F\Delta d & E_g = mg\Delta h & P = \frac{W}{\Delta t} \\
 W = -F_K \Delta d & E_K = \frac{mv^2}{2} & P = \frac{\Delta E}{\Delta t} \\
 \text{eff} = \frac{E_{\text{out}}}{E_{\text{in}}} & \text{eff} = \frac{P_{\text{out}}}{P_{\text{in}}} & \text{eff}_{\text{overall}} = (\text{eff}_1)(\text{eff}_2)(\text{eff}_3) \dots \\
 \text{eff} = \frac{E_{\text{out}}}{E_{\text{in}}} \times 100\% & \text{eff} = \frac{P_{\text{out}}}{P_{\text{in}}} \times 100\% &
 \end{array}$$

Hydraulic & Pneumatic Systems

$$\begin{array}{llll}
 p = \frac{F}{A} & p_s = p_L & q_v = \frac{V}{\Delta t} & p_g = p_{\text{abs}} - p_{\text{atm}} \\
 \frac{F_s}{A_s} = \frac{F_L}{A_L} & v = \frac{q_v}{A} & p_g = Dhg & D = \frac{m}{V}
 \end{array}$$

Table 3 Colour-Coded Resistors

Ring Colour	Digits (Rings 1 and 2)	Multiplier or Divider (Ring 3)	Tolerance (Ring 4)
black	0	10^0 or 1	—
brown	1	10^1 or 10^2	—
red	2	10^3 or 100	—
orange	3	10^4 or 1000 (1 k)	—
yellow	4	10^5 or 10 k	—
green	5	10^6 or 100 k	—
blue	6	10^7 or 1000 k (1 M)	—
violet	7	10^8 or 10^9 M	—
gray	8	10^9 or 100 M	—
white	9	10^{10} or 1000 M (1 G)	—
gold	—	10^{-1} or 1/10	$\pm 5\%$
silver	—	10^{-2} or 1/100	$\pm 10\%$
no colour	—	—	$\pm 20\%$

Table 1 Densities of Some Common Substances

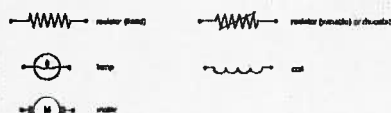
Substance	State	Density (kg/m ³ or g/L)	Density (g/cm ³ or g/mL)
hydrogen	gas (0 °C)	0.089	8.9×10^{-5}
helium	gas (0 °C)	0.178	1.78×10^{-4}
air	gas (0 °C)	1.29	1.29×10^{-3}
cork	solid	240 (varies)	0.24
ethyl alcohol	liquid	789	0.789
ice	solid (0 °C)	920	0.920
water	liquid (4 °C)	1000	1.00
seawater	liquid (0 °C)	1030 (varies)	1.03
glycerin	liquid	1260	1.26
aluminum	solid	2700	2.70
iron	solid	7860	7.86
brass	solid	8500	8.50
copper	solid	8960	8.96
mercury	liquid	13 600	13.6
gold	solid	19 300	19.3

Notes: Values listed are at 20 °C unless otherwise stated. Gases are at atmospheric pressure.

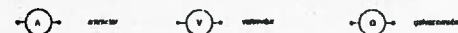
Sources of electric potential



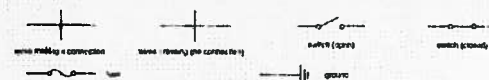
Electrical loads



Electrical meters



Wiring and connections



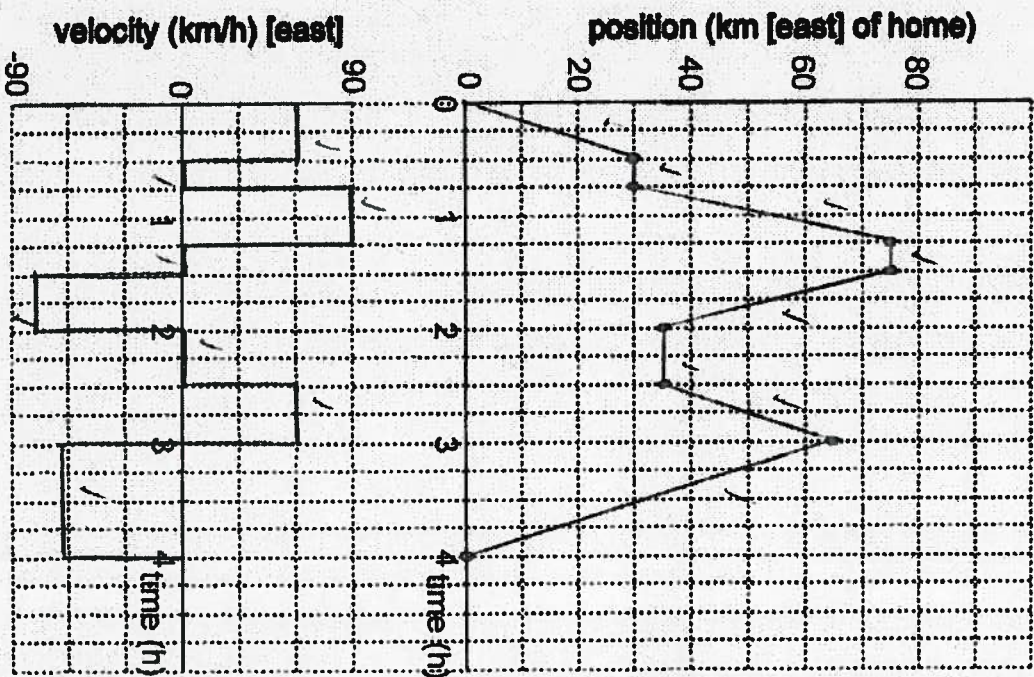
A delivery truck took the following route that has been divided into individual lettered segments A to H. Assume that each segment is covered at uniform velocity and that the road lies along a straight portion of an east-west highway.

- (A) East for 1/2 hour at 60 km/h. (E) West for 40 km at 80 km/h.
 (B) Stopped for 15 minutes making a delivery. (F) Stopped for a 1/2 hour coffee break.
 (C) East for another 30 minutes at 90 km/h. (G) East for 1/2 hour at 60 km/h.
 (D) Stopped for 15 minutes making a delivery. (H) Back directly home in one hour.

1. Use the data to complete the table below. Note: displacement is the change in position for each segment's while position is the delivery truck's position with respect to it's starting position (home).

	displacement (km [E])	velocity (km/h [E])	time (hours)	position (km [E] of home)
A	30	60	0.50	30
B	0	0	0.25	30
C	45	90	0.50	75
D	0	0	0.25	75
E	-40	-80	0.50	35
F	0	0	0.50	35
G	30	60	0.50	65
H	-65	-65	1.0	0

2. Plot a position-time graph for the entire journey on the d-t graph given.
 3. Plot a velocity-time graph for the entire trip on the v-t graph given.
 4. What is the (i) average speed (v_{avg}) and (ii) average velocity (\vec{v}_{avg}) for the entire trip?



$$1) \Delta d_T = 210 \text{ km}$$

$$\Delta t_T = 4 \text{ h}$$

$$v_{avg} = \frac{\Delta d_T}{\Delta t_T}$$

$$= \frac{210 \text{ km}}{4 \text{ h}}$$

$$v_{avg} = 52.5 \text{ km/h}$$

$$ii) \Delta \vec{d}_T = 0, v_{avg} = \frac{\Delta \vec{d}_T}{\Delta t_T}$$

$$\Delta t_T = 4 \text{ h}$$

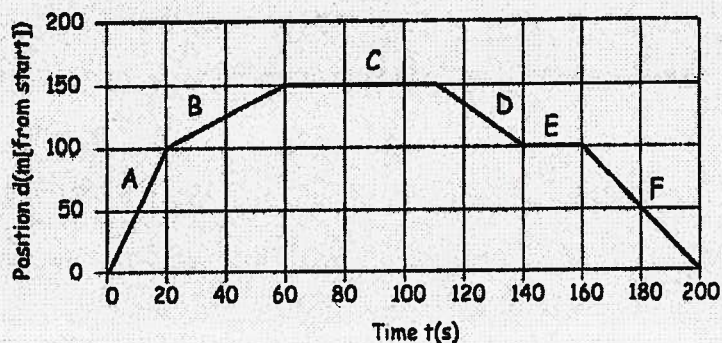
$$v_{avg} = 0$$

PART A: Complete the following statements using the following words: • constant • negative • slope (2)
• curve • positive • zero

- ① The position-time graph for an object with a constant velocity is a straight line with constant slope.
- ② The slope of the position-time graph for an object moving at a constant velocity gives the value of the constant velocity.
- ③ On a position-time graph
 - a positive slope represents a positive velocity,
 - a zero slope represents a zero velocity, and
 - a negative slope represents a negative velocity.
- ④ The position-time graph for an object that is changing velocity is a curve.
- ⑤ The average velocity between any two points on a position-time graph = the slope of the straight line joining the two points.

PART B: Answer questions 1 to 4 below in the space provided. If more room is needed use the back of this sheet or a separate sheet. Answer question 5 on the back of this sheet.

The following graph shows the motion of an inspector on a refrigerator assembly line. Position zero is the start of the assembly line. Use positive to represent directions away from, and negative to represent directions toward, the start.



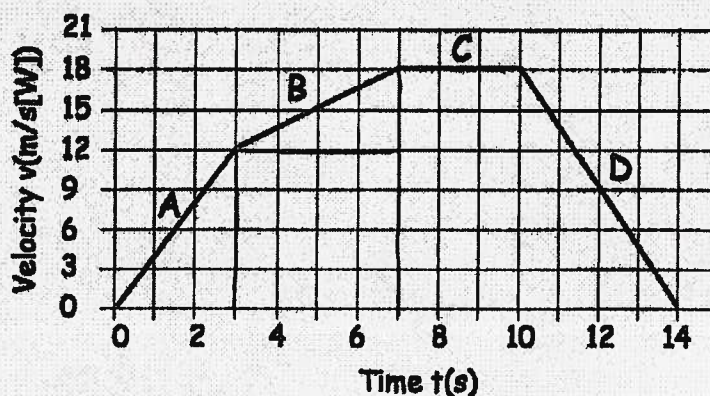
1. How far is the inspector from the starting point after: (d - i graph - read off graph)
 - (a) 20 s 100 m ✓
 - (b) 40 s 125 m ✓
 - (c) 80 s 150 m ✓
2. When is the inspector at the following positions: (read off graph)
 - (a) 50 m 10 s & 180 s
 - (b) 150 m 60 - 110 s
 - (c) 125 m 40 s & 125 s
3. What is the inspector's velocity during each of the lettered intervals? (d t - calculate slope)
 - A 100/20 5 m/s ✓
 - B 50/20 2.5 m/s ✓
 - C horizontal 0 ✓
 - D -50/30 -1.7 m/s ✓
 - E horizontal 0 ✓
 - F -100/40 -2.5 m/s ✓
4. For the entire trip what is the inspector's:
 - (i) displacement 0 ✓
 - (ii) distance 300 m ✓
 - (iii) average velocity 0 ✓
 - (iv) average speed 300/200 = 1.5 m/s ✓
5. On the back of this sheet describe the motion illustrated in the graph.

PART A: Complete the following statements using the following words: • constant • negative • slope (2)
• displacement • positive • zero

- ① The velocity-time graph for an object with a constant acceleration is a straight line with constant slope.
- ② The slope of the velocity-time graph for an object moving at a constant acceleration gives the value of the constant acceleration.
- ③ On a velocity-time graph
 - a positive slope represents a positive acceleration,
 - a zero slope represents a zero acceleration, and
 - a negative slope represents a negative acceleration.
- ④ The average acceleration between any two points on a velocity-time graph = the slope of the straight line joining the two points.
- ⑤ Displacement can be determined by calculating the area beneath a velocity-time graph.

PART B: Answer questions 1 & 2 below in the space provided. If more room is needed use the back of this sheet or a separate sheet. Answer question 3 on the back of this sheet.

The following shows the velocity-time graph for a dandelion seed blown by the wind. The seed's velocity changes during the four intervals A, B, C, and D.



1. Calculate:

(a) the acceleration during each interval. (slope)

$$A \frac{12}{3} = 4 \text{ m/s}^2$$

$$B \frac{6}{4} = 1.5 \text{ m/s}^2$$

$$C \text{ horizontal} = 0$$

$$D \frac{-18}{4} = -4.5 \text{ m/s}^2$$

(b) the displacement during each interval. (area)

$$A \frac{1}{2}(3)(12) = 18 \text{ m}$$

$$B \frac{1}{2}(4)(6) + (4)(12) = 60 \text{ m}$$

$$C (3)(18) = 54 \text{ m}$$

$$D \frac{1}{2}(4)(18) = 36 \text{ m}$$

(c) the final position of the dandelion seed.

$$\Delta \vec{r}_T = d_A + d_B + d_C + d_D$$

$$\Delta \vec{r}_T = 168 \text{ m [W]} \text{ of starting position!}$$

2. What is the seed's (i) speed and (ii) velocity at each of the following times: (read off graph)

(a) 2 s

$$\sim 8 \text{ m/s} \neq 8 \text{ m/s [W]}$$

(b) 8 s

$$18 \text{ m/s} \neq 18 \text{ m/s [W]}$$

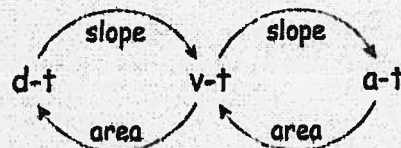
(c) 12 s

$$9 \text{ m/s} \neq 9 \text{ m/s [W]}$$

3. On the back of this sheet describe the motion illustrated in the graph.

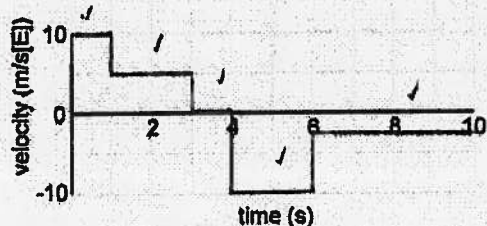
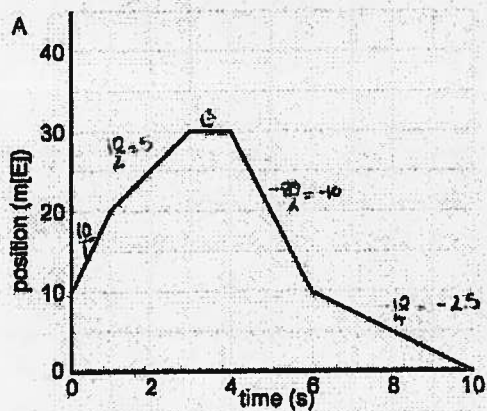
- The following graphs represent trips performed in several stages. Use the graph given to construct the graph required. You may find the diagram to the right useful for remembering what you need to do.

* don't forget slopes up to right \rightarrow +ve slope
 " down " \rightarrow -ve "
 area above t-line \rightarrow +ve area
 " below " \rightarrow -ve area

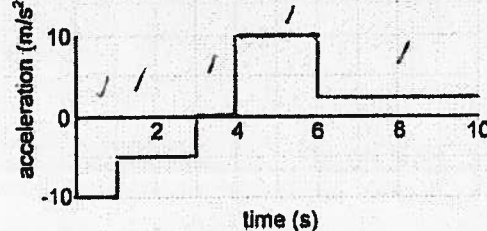
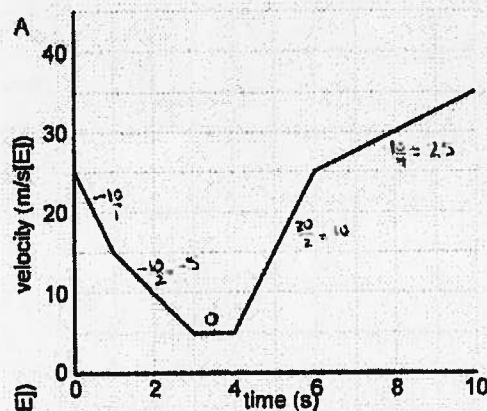


Remember that area is cumulative!

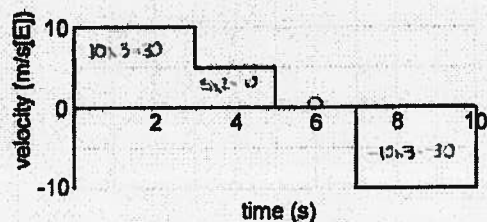
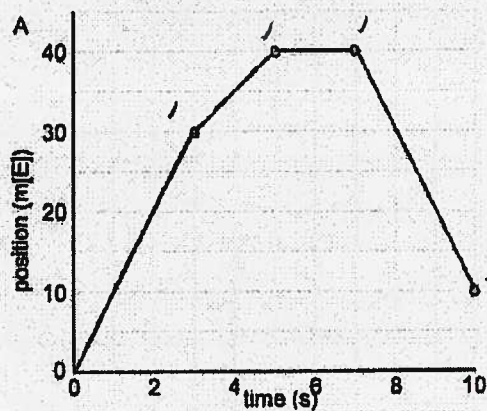
d-t \Rightarrow v-t



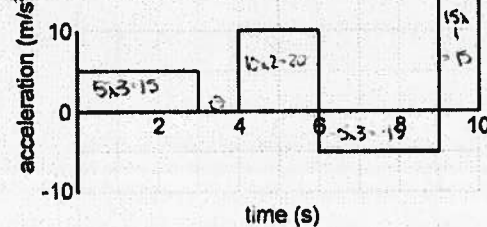
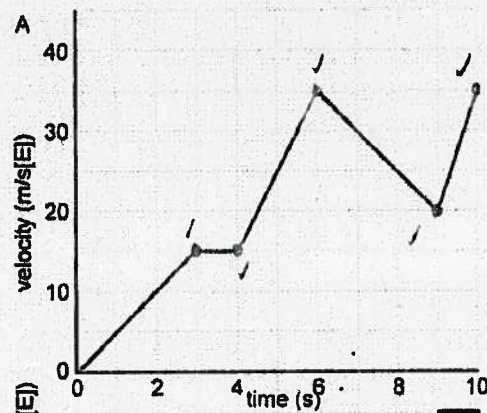
v-t \Rightarrow a-t



v-t \Rightarrow d-t



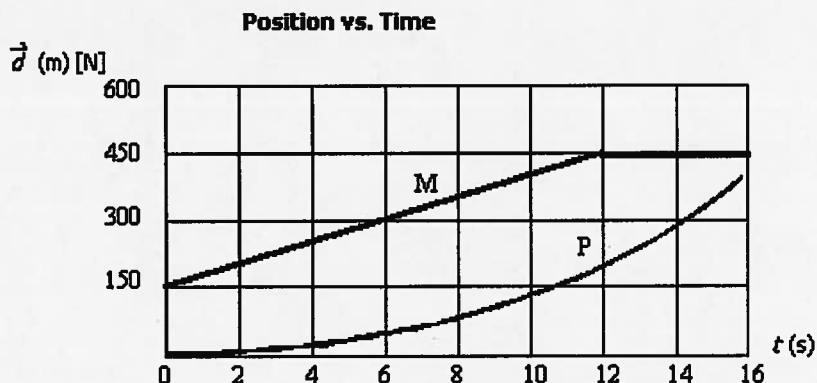
a-t \Rightarrow v-t



SPH4C Motion

Problem

1. An impatient motorist considers speeding as he travels between two cities. If the trip normally takes 2.8 h at an average speed of 100.0 km/h, how much time will be saved if he exceeds the speed limit by 10.0 km/h?
2. Two friends plan to meet at a cottage for a weekend retreat. One person must drive a distance of 1.5×10^2 km at an average speed of 85 km/h. The other person has only 90.0 km to travel and averages a speed of 1.0×10^2 km/h. If they both depart at the same time, how much earlier does the one friend arrive than the other. (Give your answer in minutes.)
3. A driver is travelling at 25 m/s when she spots a sign that reads "BRIDGE OUT AHEAD." It takes her 1.0 s to react and begin braking. The car slows down at a rate of 3.0 m/s^2 . Luckily, she stops 5.0 m short of the washed-out bridge.
 - (a) How much time was required to stop the car once the brakes were applied?
 - (b) How far was the driver from the bridge when she first noticed the sign?
4. A jogger runs 6.0 km [E], then 4.0 km [N], and finally 2.0 km [W]. The entire trip takes 2.0 h to complete. Calculate the jogger's
 - (a) average speed
 - (b) average velocity
5. A car leaves Toronto and drives west at 80.0 km/h for the next 1.5 h. The vehicle then proceeds north at 50.0 km/h for the next 2.0 h.
 - (a) What is the car's average speed for the entire trip?
 - (b) What is the car's average velocity for the entire trip?
6. The position-time graph below represents the motion of a police car, P, in pursuit of a motorcycle, M.



- (a) How far ahead of the police car was the motorcycle when the pursuit began?
 - (b) What was the motorcycle's velocity during most of the pursuit?
 - (c) How far did the motorcycle travel before stopping?
 - (d) What was the average velocity of the police car during the pursuit?
 - (e) What was the police car's velocity at $t = 8.0$ s?
 - (f) If the police car started from rest, what was its acceleration (assumed constant) during this pursuit?
7. A sprinter who is competing in a 100-m race accelerates from rest to a top speed of 10.0 m/s over a distance of 15 m. The remainder of the race is run at a constant speed.
 - (a) What length of time is required for the sprinter to reach top speed?
 - (b) What is the sprinter's acceleration?
 - (c) What is the sprinter's time for the entire race?

SPH4C Motion

Answer Section

PROBLEM

1. distance to travel

$$\begin{aligned}\Delta d &= v \Delta t \\ &= 100 \text{ km/h}(2.8\text{h}) \\ &= 280 \text{ km}\end{aligned}$$

time to travel if speeding ($v = 110 \text{ km/h}$)

$$\begin{aligned}\Delta t &= \frac{\Delta d}{v} \\ &= \frac{280 \text{ km}}{110 \text{ km/h}} \\ &= 2.55 \text{ h}\end{aligned}$$

$$\begin{aligned}\text{The time saved is } 2.8 \text{ h} - 2.55 &= 0.25\text{h} \\ &= 15 \text{ min}\end{aligned}$$

2. time to arrive for person A

$$\begin{aligned}\Delta t &= \frac{\Delta d}{v} \\ &= \frac{150 \text{ km}}{85 \text{ km/h}} \\ &= 1.76 \text{ h}\end{aligned}$$

time to arrive for person B

$$\begin{aligned}\Delta t &= \frac{\Delta d}{v} \\ &= \frac{90 \text{ km}}{100 \text{ km/h}} \\ &= 0.90 \text{ h}\end{aligned}$$

time difference

$$\begin{aligned}1.76 \text{ h} - 0.90 \text{ h} &= 0.86 \text{ h} \\ &= 52 \text{ min}\end{aligned}$$

Person B arrives 52 min earlier than person A.

3.

(a) time to stop

$$\begin{aligned}\Delta t &= \frac{v_f - v_i}{a} \\ &= \frac{0.0 \text{ m/s} - 25 \text{ m/s}}{-3.0 \text{ m/s}^2} \\ &= 8.3 \text{ s}\end{aligned}$$

The time required to stop is 8.3 s.

(b) distance travelled while reacting

$$\Delta d = v \Delta t$$

$$= 25 \text{ m/s}(1.0 \text{ s})$$

$$= 25 \text{ m}$$

distance travelled while braking

$$\begin{aligned}\Delta d &= \frac{(v_i + v_f)\Delta t}{2} \\ &= \frac{(25 \text{ m/s} + 0.0 \text{ m/s})8.33 \text{ s}}{2} \\ &= 104 \text{ m}\end{aligned}$$

distance to bridge when stopped: $\Delta d = 5.0 \text{ m}$ total distance: $25 \text{ m} + 104 \text{ m} + 5.0 \text{ m} = 1.3 \times 10^2 \text{ m}$ **The driver was $1.3 \times 10^2 \text{ m}$ from the bridge when she first noticed the sign.**

4.

(a) distance ran

$$\Delta d = 6.0 \text{ km} + 4.0 \text{ km} + 2.0 \text{ km}$$

$$= 12.0 \text{ km}$$

average speed

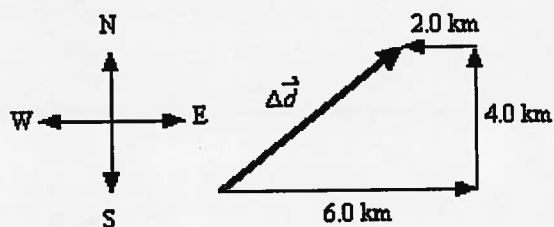
$$v = \frac{\Delta d}{\Delta t}$$

$$= \frac{12.0 \text{ km}}{2.0 \text{ h}}$$

$$= 6.0 \text{ km/h}$$

The jogger's average speed is 6.0 km/h.

(b) jogger's displacement



$$\Delta \vec{d} = 5.7 \text{ km [NE]} \text{ (Pythagoras)}$$

average velocity

$$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$$

$$= \frac{5.66 \text{ km [NE]}}{2.0 \text{ h}}$$

$$= 2.8 \text{ km/h [NE]}$$

The jogger's average velocity is 2.8 km/h [NE].

5.

(a) distance travelled

$$\Delta d = v \Delta t$$

$$= 80 \text{ km/h}(1.5 \text{ h})$$

$$= 120 \text{ km}$$

$$\Delta d = v \Delta t$$

$$= 50 \text{ km/h}(2.0 \text{ h})$$

$$= 100 \text{ km}$$

total distance travelled: $120 \text{ km} + 100 \text{ km} = 220 \text{ km}$

average speed

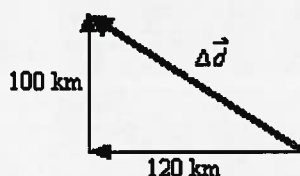
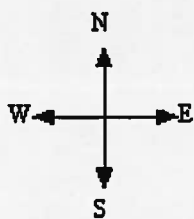
$$v = \frac{\Delta d}{\Delta t}$$

$$= \frac{220 \text{ km}}{3.5 \text{ h}}$$

$$= 63 \text{ km/h}$$

The car's average speed is 63 km/h.

(b) displacement



$$\Delta \vec{d} = 156 \text{ km } [50^\circ \text{ W of N}]$$

(Pythagoras)

average velocity

$$\vec{v} = \frac{\vec{\Delta d}}{\Delta t}$$

$$= \frac{156 \text{ km } [50^\circ \text{ W of N}]}{3.6 \text{ h}}$$

$$= 45 \text{ km/h } [50^\circ \text{ W of N}]$$

The car's average velocity is 45 km/h [50° W of N].

6.

(a) 150 m

(b) velocity = slope

$$= \frac{300 \text{ m [N]}}{12 \text{ s}}$$

$$= 25 \text{ m/s [N]}$$

(c) 300 m

(d) average velocity = $\frac{\text{displacement}}{\text{time}}$

$$= \frac{400 \text{ m [N]}}{16 \text{ s}}$$

$$= 25 \text{ m/s [N]}$$

(e) instantaneous velocity = slope of tangent to graph at $t = 8.0 \text{ s}$ (approximately 12 m/s [N])

(f) acceleration

$$\vec{a} = \frac{(\vec{V}_f - \vec{V}_i)}{\Delta t}$$

$$= \frac{12 \text{ m/s [N]} - 0.0 \text{ m/s}}{8.0 \text{ s}}$$

$$= 15 \text{ m/s}^2 \text{ [N]}$$

7.

$$\begin{aligned}
 \text{(a) } \Delta t &= \frac{2\Delta d}{v_i + v_f} \\
 &= \frac{2(15 \text{ m})}{0.0 \text{ m/s} + 10.0 \text{ m/s}} \\
 &= 3.0 \text{ s}
 \end{aligned}$$

The time required is 3.0 s.

$$\begin{aligned}
 \text{(b) } a &= \frac{v_f - v_i}{\Delta t} \\
 &= \frac{10.0 \text{ m/s} - 0.0 \text{ m/s}}{3.0 \text{ s}} \\
 &= 3.3 \text{ m/s}^2
 \end{aligned}$$

The acceleration is 3.3 m/s².

$$\begin{aligned}
 \text{(c) time to run 85 m: } \Delta t &= \frac{\Delta d}{v} \\
 &= \frac{85 \text{ m}}{10 \text{ m/s}} \\
 &= 8.5 \text{ s}
 \end{aligned}$$

total time: $\Delta t = 3.0 \text{ s} + 8.5 \text{ s} = 11.5 \text{ s}$

The sprinter's time for the race is 11.5 s.