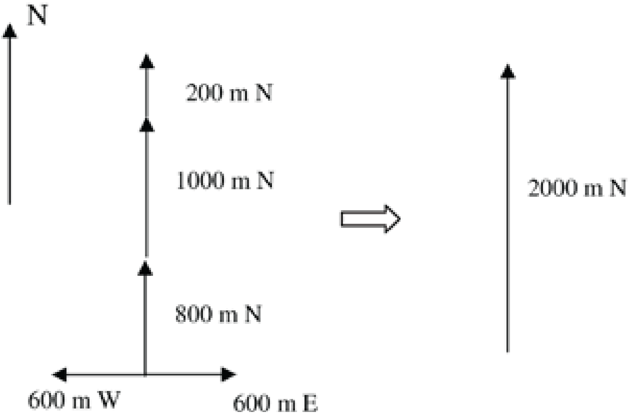
Motion & Forces

Set 1: Uniform Motion

1.1	(a)	$v_{av} = \frac{s}{t} = \frac{20.1\ m}{0.75\ s} = 26.8\ m\ s^{-1}$
	(b)	$\frac{26.8 \times 3600}{1000} = 96.5\ km\ h^{-1}$
1.2	(a)	$v_{av} = \frac{165\ km}{1.5\ h} = 110\ km\ h^{-1}$
	(b)	The **distance** between two points > **displacement** unless the path is absolutely straight.
1.3		$s = v_{av}t = 850\ km\ h^{-1} \times 3.5\ h = 3000\ km$
1.4	(a)	$s = x_f - x_i = 270\ km\ E - 255\ km\ E = 15\ km\ E$
	(b)	$v = \frac{s}{t} = \frac{15\ km\ E}{0.5\ h} = 30\ km\ h^{-1}\ E$
1.5		15 min = 0.25 h $v_{av} = \frac{s}{t} = \frac{1.0\ km\ W}{0.25\ h} = 4.0\ km\ h^{-1}\ W$ $s = v_{av}t = 4.0\ km\ h^{-1}\ W \times 1.25\ h = 5.0\ km\ W$
1.6		$3.84 \times 10^5\ km = (3.84 \times 10^5 \times 1000)\ m = 3.84 \times 10^8\ m$ $v_{av} = \frac{s}{t}$ $t = \frac{s}{v_{av}} = \frac{3.84 \times 10^8\ m}{6.40 \times 10^3\ m\ s^{-1}} = 6.00 \times 10^4\ s$
1.7		$280\ km = (280 \times 1000)\ m = 2.8 \times 10^5\ m$ $v_{av} = \frac{s}{t}$ $t = \frac{s}{v_{av}} = \frac{2.8 \times 10^5\ m\ SE}{8.2\ m\ s^{-1}\ SE} = 3.42 \times 10^4\ s$
1.8		Have timers standing at 10 m intervals who then record Rebecca's time as she passes them during one of her sprints. Time differences can then be calculated for each 10 m interval and hence her speed during each interval can be determined.
1.9		Have a passenger time how long it takes you to travel a known distance while your speedometer indicates a constant steady speed. Calculate your actual speed (distance ÷ time) and compare this to your speedometer reading.

1.10	(a)	Total distance = 800 m + 600 m + 1000 m + 600 m + 200 m = 3200 m
	(b)	$v_{av} = \frac{s}{t} = \frac{3200\ \text{m}}{(20 \times 60)\ \text{s}} = \frac{3200\ \text{m}}{1200\ \text{s}} = 2.67\ \text{m s}^{-1}$
	(c)	
	(d)	$v_{av} = \frac{s}{t} = \frac{2000\ \text{m N}}{(20)(60)\ \text{s}} = \frac{2000\ \text{m N}}{1200\ \text{s}} = 1.67\ \text{m s}^{-1}\ \text{N}$
1.11		Distance travelled = 26 708 km – 26 455 km = 253 km at 92 km h^{-1} travelling time must have been $t = \frac{s}{v_{av}} = \frac{253\ \text{km}}{92\ \text{km h}^{-1}} = 2.75\ \text{h}$ total time = 3 h $\therefore$ lunch time = $(3 - 2.75)\ \text{h} = 0.25\ \text{h}$ (or 15 mins)
1.12	(a)	$v_{av} = \frac{s}{t} = \frac{800\ \text{m}}{(20 \times 60)\text{s}} = \frac{800\ \text{m}}{1200\ \text{s}} = 0.67\ \text{m s}^{-1}$
	(b)	Stream speed must be $v_s = (4 - 0.67)\ \text{m s}^{-1} = 3.33\ \text{m s}^{-1}$
	(c)	$v_{av} = \frac{s}{t}$ $t = \frac{s}{v_{av}} = \frac{10\ 000\ \text{m}}{0.67\ \text{m s}^{-1}} = 15\ 000\ \text{s}$ or 4.17 h
	(d)	Speed downstream must be $v_s = (4 + 3.33)\ \text{m s}^{-1} = 7.33\ \text{m s}^{-1}$ $v_{av} = \frac{s}{t}$ $t = \frac{s}{v_{av}} = \frac{10000\ \text{m}}{7.33\ \text{m s}^{-1}} = 1364\ \text{s}$ or 0.38 h or 23 mins
1.13	(a)	Greatest speed is when the gradient is steepest, ie between D and E.
	(b)	Speed was zero when the gradient was zero ie between B and C.

	(c)	She turned back when the gradient became negative, ie at D.
	(d)	Total distance was 15 km out and 15 km back = 30 km.
	(e)	$v_{av} = \frac{s}{t} = \frac{30 \text{ km}}{0.8 \text{ h}} = 37.5 \text{ km h}^{-1}$
	(f)	The direction of travel.
1.14	(a)	$v_{av} = \frac{s}{t} = \frac{600 \text{ m upstream}}{1200 \text{ s}} = 0.50 \text{ m s}^{-1} \text{ upstream}$ Stream speed must be $v_s = (2.0 - 0.50) \text{ m s}^{-1} = 1.5 \text{ m s}^{-1}$
	(b)	Downstream speed must be $v_d = (2.0 + 0.50) \text{ m s}^{-1} \text{ downstream} = 2.5 \text{ m s}^{-1} \text{ downstream}$ $v_{av} = \frac{s}{t}$ $t = \frac{s}{v_{av}} = \frac{8400 \text{ m}}{2.50 \text{ m s}^{-1}} = 3360 \text{ s or } 0.93 \text{ h}$