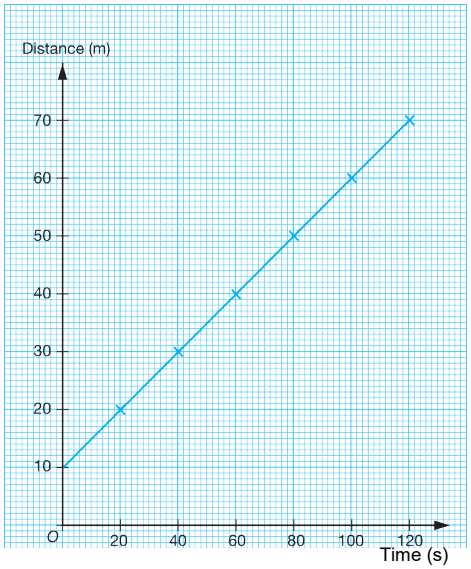
Form 4 Chapter 7
Graphs of Motion
Fully-Worked Solutions

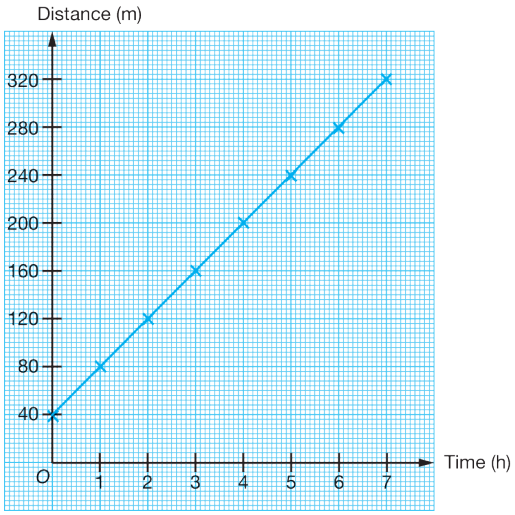
UPSKILL 7.1

1



2

s (m)	0	80	120	160	200	240	280	320
t (km)	0	1	2	3	4	5	6	7



3

Graph	*Gradient of graph*	*Interpretation of graph*
AB	$\frac{10\text{ m}}{5\text{ s}} = 2\text{ m s}^{-1}$	Uniform speed of 2 m s^{-1} from *H* to *K*
BC	0 m s^{-1}	Stationary at *K* for 7 seconds 10 m from *H*
CD	$-\frac{10\text{ m}}{4\text{ s}} = -2.5\text{ m s}^{-1}$	Return from *K* to *H* with a uniform velocity of 2.5 m s^{-1}

$$\frac{140-40}{1} = 100 \text{ km h}^{-1}$$

(b) Speed = 0 km h^{-1}

(c) Gradient = $= \frac{140}{2} = -70$

Hence, speed = 70 km h^{-1}

5 (a) Average speed of the truck

$$= \frac{300}{16} = 18.75 \text{ m s}^{-1}$$

(b) Gradient $-\frac{300}{10} = -30$

Hence, the speed of the taxi = 30 m s^{-1}

(c) Distance from Q = 300 – 60 = 240 m

6 (a) Difference of distance = 24 – 12 = 12 m

(b) The speed of the bicycle

$$= \frac{16-4}{8-0} = \frac{16-4}{8} = 1.5 \text{ m s}^{-1}$$

(c) The time taken to meet = $2\frac{2}{3}$ s

7 (a) The time when both vehicles meet = 0840

(b) Speed of bus = $\frac{60}{\frac{50}{60}} = 72$ km h^{-1}

(c) Gradient = $-\frac{120}{\frac{60}{60}} = -120$

Hence, speed of taxi = 120 km h^{-1}

8 (a) Speed = $\frac{15}{6} = 2\frac{1}{2}$ m s^{-1}

(b) The period of time at rest = 14 – 6 = 8 s

(c) $\frac{x}{24} = \frac{5}{4}$

$x = 30$

9 (a) Gradient $= -\dfrac{100}{10} = -10$

Speed $= 10$ m s^{-1}

(b) The period of time at rest is 10 s

(c) Average of speed $= \dfrac{200}{T} = \dfrac{20}{3}$

$T = \dfrac{3}{20} \times 200$

$T = 30$

10 (a) Gradient $= -\dfrac{180}{6} = -30$

Speed of car $= 30$ m s^{-1}

(b) Speed of van $= \dfrac{80}{3} = 26\dfrac{2}{3}$ m s^{-1}

(c) Distance travelled by the car

$= 180 - 80$

$= 100$ m

11 (a) Distance travelled

$= 80 - 30$

$= 50$ m

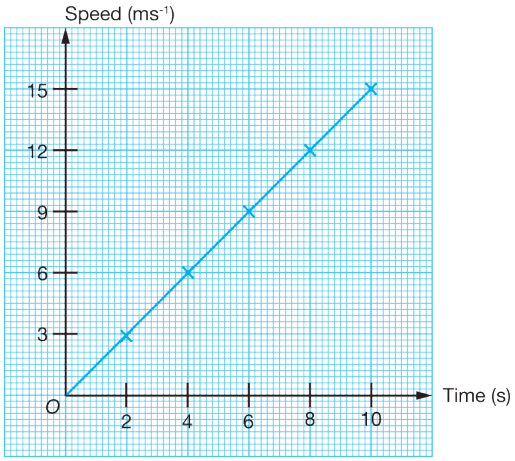
(b) Speed $= \dfrac{30}{2} = 15$ m s^{-1}

(c) Average speed $= \dfrac{100}{t} = \dfrac{25}{3}$

$t = 12$

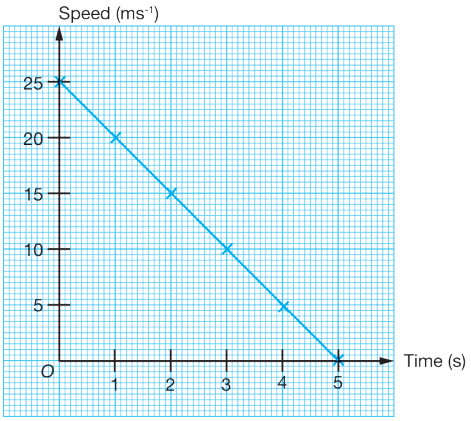
UPSKILL 7.2

1



2

v (m)	25	20	15	10	5	0
t (m s^{-1})	0	1	2	3	4	5



3 (a) Distance $= 110 \times 2 = 220$ km

(b) Distance $= \dfrac{1}{2} \times 6 \times 20 = 60$ m

(c) Distance $= \dfrac{1}{2} \times (6 + 16)(8) = 88$ m

4 (a) Total distance

$= 6 \times 10 + \dfrac{1}{2}(10 + 24)(5) + \dfrac{1}{2}(7)(24)$

$= 229$ m

(b) Total distance

$= \dfrac{1}{2}(10 + 30)(5) + \dfrac{1}{2}(30 + 18)(2) + 3(18)$

$= 100 + 48 + 54$

$= 202$ m

5 (a)

Graf	*Area under a graph*	*Interpretation of graph*
HK	90 km	Total distance travelled is 90 km.
KL	30 km	Total distance travelled is 30 km.
LM	97.5 km	Total distance travelled is 97.5 km.

(b)

Graf	*Gradient of graph*	*Interpretation of graph*
HK	-15 km h^{-2}	The deceleration is 15 km h^{-2}
KL	0 km h^{-2}	The acceleration is 0 km h^{-2} / The uniform speed is 30 km h^{-1}.
LM	$46\frac{2}{3}$ km h^{-2}	The acceleration is $46\frac{2}{3}$ km h^{-2}.

(c) The van decelerates uniformly from a speed of 60 km h^{-1} with a deceleration of 15 km h^{-2} until the speed is 30 km h^{-1} in 2 hours. The distance travelled during the deceleration id 90 km. Then, the van travels with a uniform speed of 30 km h^{-1} for 30 km in 1 hour. Then, the van accelerates uniformly with an acceleration of $46\frac{2}{3}$ km h^{-2} for 97.5 km until it reaches a speed of 100 km h^{-1} in 1.5 hours.

6 (a) Distance = 265

$$\frac{1}{2}(10+40)(7)+\frac{1}{2}(40+u)(3)=265$$

$$175+\frac{3(40+u)}{2}=265$$

$$\frac{3(40+u)}{2}=90$$

$$40+u=\frac{180}{3}$$

$$40+u=\frac{180}{3}$$

$$u=20$$

(b) Average speed = $\frac{175}{7}$ = 25 m s^{-1}

(c) Rate of change of speed

$$=-\frac{40-20}{3}$$

$$=-6\frac{2}{3}\text{ m s}^{-2}$$

7 (a) The time travelling at uniform speed = 12

$$t-4=12$$

$$t=16$$

(b) Total distance = 330 m

$$\frac{1}{2}(v+15)(8)+4(15)+\frac{1}{2}(4)(15)=330$$

$$4v+60+60+30=330$$

$$4v=180$$

$$v=45$$

(c) Rate of change of speed

$$=\frac{30}{14}$$

$$=7.5\text{ m s}^{-2}$$

8 (a) Uniform speed = 10 m s^{-1}

(b) (i) Rate of change of speed = $\frac{5}{7}$

$$\frac{10}{t}=\frac{5}{7}$$

$$5t=70$$

$$t=14$$

(ii) Total distance

$$=\frac{1}{2}(14)(10)+10(2)+\frac{1}{2}(10+16)(8)$$

$$=194\text{ m}$$

Average speed = $\frac{194}{24}=8\frac{1}{12}$ m s^{-1}

9 (a) Distance travelled at a uniform speed = 144 m

$$18(12-t)=144$$

$$12-t=8$$

$$t=4$$

(b) Rate of change of speed

$$=-\frac{18}{3}$$

$$=-6\text{ m s}^{-2}$$

(c) Total distance

$$=\frac{1}{2}\times(30+18)\times4+144+\frac{1}{2}(3)(18)$$

$$=267\text{ m}$$

Average speed = $\frac{267}{15}=17\frac{4}{5}$ m s^{-1}

10 (a) Distance travelled at a uniform speed

$$10\times8=80\text{ m}$$

(b) Rate of change of speed

$$=\frac{8}{4}=2\text{ m s}^{-2}$$

(c) Total distance = 156

$$\frac{1}{2}(v+8)(8)+10(8)=156$$
$$4(v+8)+80=156$$
$$4v+32+80=156$$
$$4v=44$$
$$v=11$$

11 (a) Speed = 20 m s^{-1}

(b) Rate of change of speed

$$=\frac{20}{6}=3\frac{1}{3}\text{ m s}^{-2}$$

(c) Total distance travelled by motorcycle P

$$=\frac{1}{2}\times T\times 20$$
$$=10T$$

Total distance travelled by motorcycle Q

$$=\frac{1}{2}(6)(20)+20(T-6)$$
$$=60+20T-120$$
$$=20T-60$$
$$20T-60-10T=30$$
$$10T=90$$
$$T=9$$

12 (a) Uniform speed = 25 m s^{-1}

(b) Rate of change of speed = $\frac{25-10}{5}=3$ m s^{-2}

(c) Total distance = 212.5 m

$$\frac{1}{2}(10+25)(5)+25(t-5)=212.5$$
$$\frac{175}{2}+25t-125=212.5$$
$$175+50t-250=425$$
$$50t=500$$
$$t=10$$

13 (a) Distance travelled at a uniform speed

$$=2\times 12=24\text{ m}$$

(b) Rate of change of speed

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

(c) Distance travelled in the first 4 seconds

$$=\frac{1}{2}(4)(12)=24\text{ m}$$

Distance travelled from the 6th second to the t^{th} second $=\frac{1}{2}(12+20)(t-6)$

$$=16(t-6)$$
$$=16t-96$$

Hence, $24=\frac{1}{3}(16t-96)$

$$72=16t-96$$
$$16t=168$$
$$t=10.5$$

14 (a) Distance travelled by the car

$$=\frac{1}{2}(6)(30)+\frac{1}{2}(30+10)(4)=170\text{ m}$$

Distance travelled by the motorcycle

$$=\frac{1}{2}(10)(10)=50\text{ m}$$

Difference of distance

= 170 – 50 = 120 m

(b) Rate of change of speed

$$=\frac{30}{6}=5\text{ m s}^{-2}$$

(c) Gradient along the straight-line OP

$$\frac{v}{12}=\frac{10}{10}$$
$$v=12$$

Summative Practice 7

Multiple Choice Questions

1 Speed $= \frac{120-70}{0.5} = 100 \text{ h}^{-1}$

Answer: D

2 Average speed $= \frac{60+120}{30} = 6 \text{ m s}^{-1}$

Answer: C

3 Distance = 260 m

$$\frac{1}{2}(9+16)(t)+(18-t)(16)=260$$

$$\frac{25}{2}t+288-16t=260$$

$$25t+576-32t=520$$

$$-7t=-56$$

$$t=8$$

Answer: C

4 Total distance

$$=\frac{1}{2}(6)(8)+\frac{1}{2}(8+24)(4)+5(24)$$

$$=208 \text{ m}$$

Answer: C

5 Rate of change of speed

$$=-\frac{11-3}{5}=-\frac{8}{5} \text{ m s}^{-2}$$

Answer: C

Structured Questions

1 (a) (i) Distance between Abidin's house and the cake shop = 5 km

(ii) Distance between the cake shop and the public library

= 12 – 5 = 7 km

(b) (i) Speed $= \frac{5}{\frac{15}{60}} = 20 \text{ km h}^{-1}$

(ii) Speed $= \frac{12-5}{\frac{45-15}{60}} = 14 \text{ km h}^{-1}$

(c) Average speed $= \frac{12}{\frac{45}{60}} = 16 \text{ km h}^{-1}$

2 (a) Speed $= \frac{25}{5} = 5 \text{ m s}^{-1}$

(b) Gradient $= -\frac{25}{13-5} = -3\frac{1}{8}$

Speed $= 3\frac{1}{8} \text{ m s}^{-1}$

(c) Distance = 25 m

(d) Average speed $= \frac{50}{13} = 3\frac{11}{13} \text{ m s}^{-1}$

3 (a) $h = 3 - 1.75 = 1.25$ jam = 75 minutes

(b) $k = 5.5 - 4 = 1.5$ jam = 90 minutes

(c) Distance $= 90 - 50 = 40$ km

(d) (i) Speed $= \frac{50}{1.75} = 28\frac{4}{7} \text{ km h}^{1}$

(ii) Speed $= \frac{90-50}{1} = 40 \text{ km h}^{-1}$

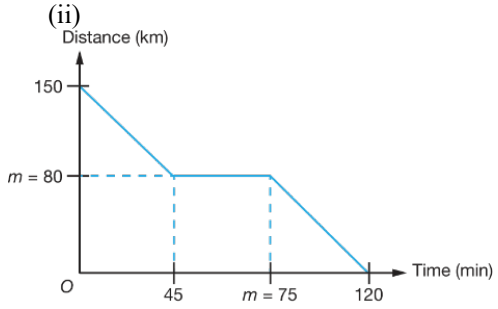
(iii) Gradient $= -\frac{90}{2} = -45$

Speed = 45 km h^{-1}

(e) Average speed $= \frac{180}{7.5} = 24 \text{ km h}^{-1}$

4 (a) (i) $m = 80$, $n = 75$

(ii)



(b) Average speed $= \frac{150}{\frac{120}{60}} = 75 \text{ km h}^{-1}$

5 (a) Selva won the race

(b) 36 – 18 = 18 seconds

(c) 200 – 140 = 60 m

(d) Aishah's average speed

$$= \frac{200}{40} = 5 \text{ m s}^{-1}$$

6 (a) Rate of change of speed = 60 km h^{-1}

$$\frac{110-u}{0.5}=60$$

$$110-u=30$$

$$u=80$$

(b) Distance travelled at uniform speed = 66 km

$$110(k-0.5)=66$$

$$110k-55=66$$

$$k=1.1$$

(c) Total distance

$$=\frac{1}{2}(80+110)(0.5)+66+\frac{1}{2}(0.4)(110)$$

$$=47.5+66+22$$

$$=135.5 \text{ km}$$

Average speed $= \frac{135.5}{1.5} = 90\frac{1}{3} \text{ km h}^{-1}$

7 (a) Rate of change of speed = 1.5 m s^{-2}

$$\frac{v-6}{4}=1.5$$
$$v-6=6$$
$$v=12$$

(b) Total distance = 122 m

$$\frac{1}{2}(6+v)(4)+8v=122$$
$$12+2v+8v=122$$
$$10v=110$$
$$v=11$$

8 (a) Rate of change of speed = 1.2 m s^{-2}

$$\frac{v-8}{10}=1.2$$
$$v-8=12$$
$$v=20$$

(b) Total distance = 184

$$\frac{1}{2}(8+v)(10)+\frac{1}{2}(6)(v)=184$$
$$40+5v+3v=184$$
$$8v=144$$
$$v=18$$

9 (a) Distance = 120 m

$$\frac{1}{2}(25+15)(x)=120$$
$$20x=120$$
$$x=6$$

(b) Rate of change of speed = 3 m s^{-1}

$$\frac{v-15}{10-x}=3$$
$$\frac{v-15}{10-6}=3$$
$$v-15=12$$
$$v=27$$

10 (a) $\frac{1}{2}(8+v)(4)=\frac{1}{5}\times 14v$

$$5(8+v)(4)=2(14v)$$
$$160+20v=28v$$
$$8v=160$$
$$v=20$$

(b) Total distance

$$=\frac{1}{2}(8+20)(4)+14(20)$$
$$=56+280$$
$$=336 \text{ m}$$

Average speed $=\frac{336}{18}=18\frac{2}{3}$ m s^{-1}

11 (a) Rate of change of speed = -3 m s^{-2}

$$-\frac{30-u}{4}=-3$$
$$30-u=12$$
$$u=18$$

(b) Distance travelled at uniform speed

$$= 18(2)$$
$$= 36 \text{ m}$$

(c) Total distance

$$=\frac{1}{2}(30+18)(4)+36+\frac{1}{2}(18)(6)$$
$$=186 \text{ m}$$

Average speed = $\frac{186}{12}$ = 15.5 m s^{-1}