# Review

T1 Wk 3

# Q1

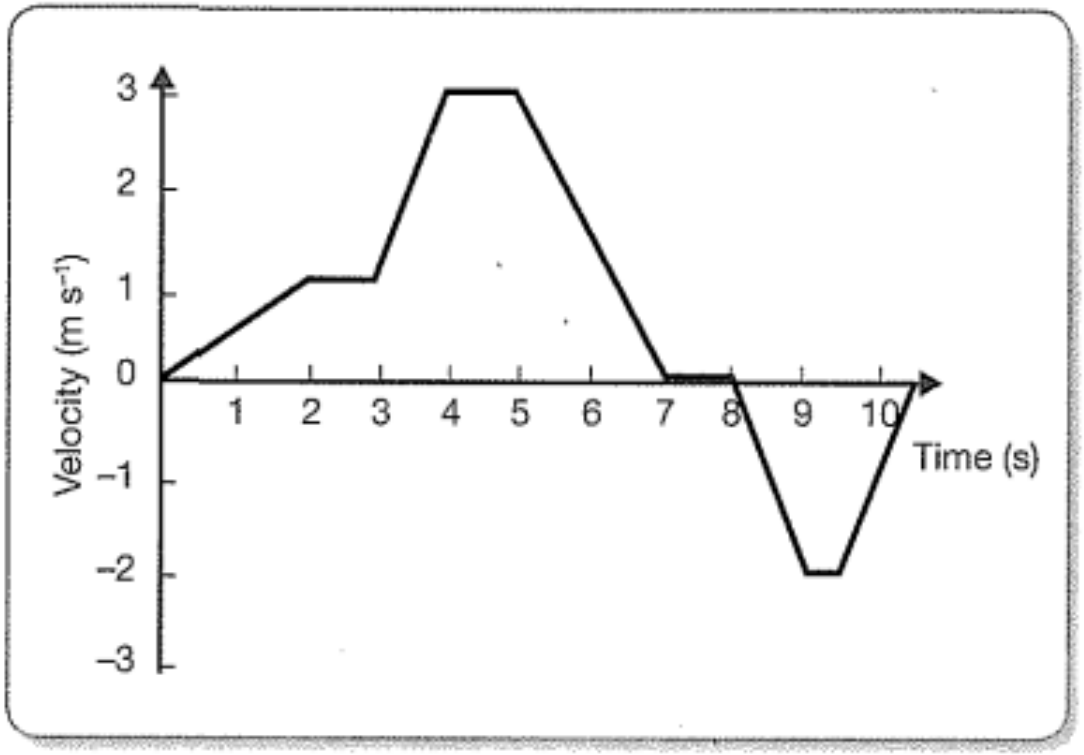
This velocity-time graph refers to the questions below.

(a) Deduce the velocity at 4 s.

(b) During which periods was the object stationary?

(c) Deduce its acceleration during the period 3 s to 4 s.

(d) During which period of time was the velocity negative?




(a) $3\ \text{m s}^{-1}$

(b) 7 to 8 s

(c) $a = \frac{v-u}{t} = \frac{3-1}{4-3} = 2\ \text{m s}^{-2}$

(d) 8 to 10 s

# Q2

Study the following velocity-time graph.

Identify the displacement from:

(a) 0 s to 2 s

(b) 2 s to 3 s

(c) 3 s to 4 s

(d) 4 s to 5 s

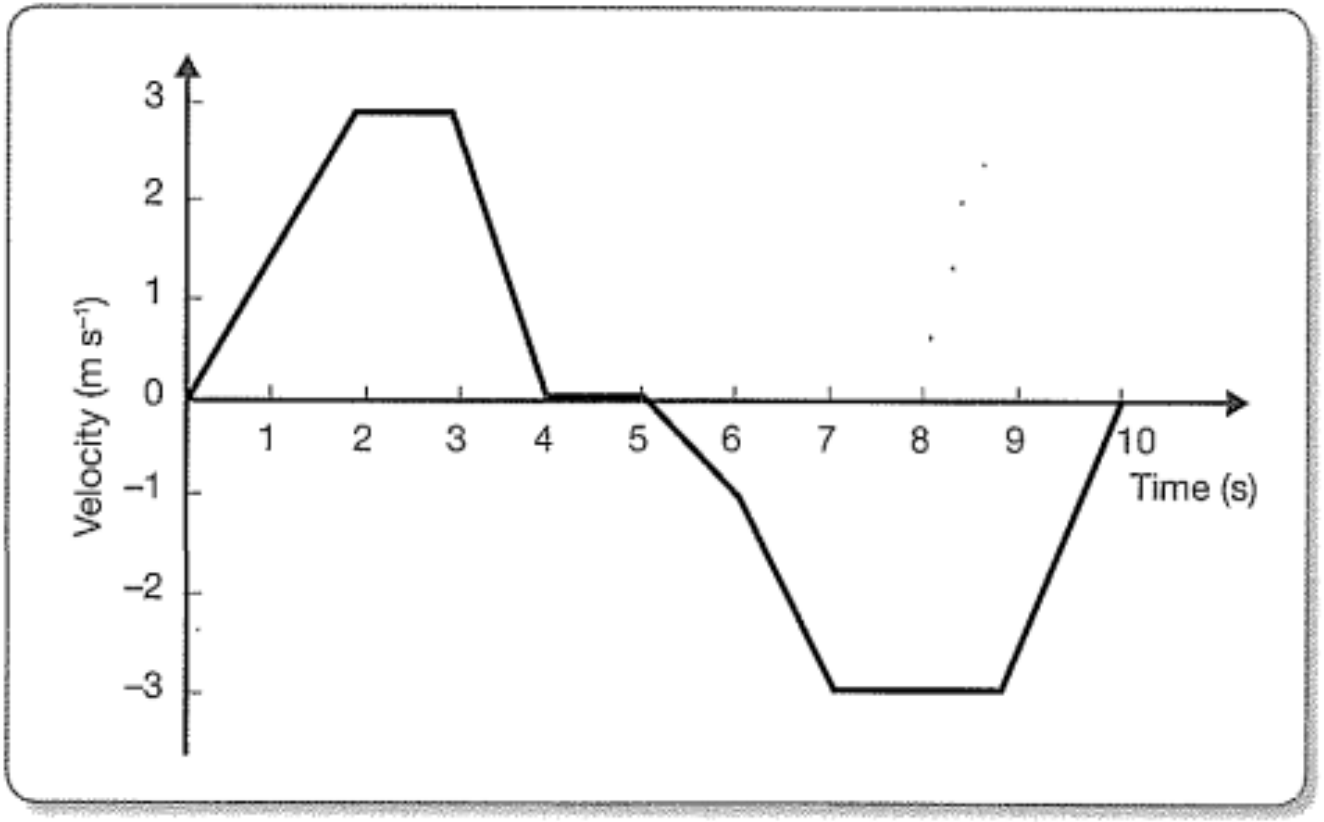
(e) 5 s to 6 s

(f) 6 s to 7 s

(g) 7 s to 9 s

(h) 9 s to 10 s

(i) 0 s to 10 s




(a) Displacement from 0 to 2 s = area of triangle

$s = \frac{1}{2} \times \text{base} \times \text{height} = 0.5 \times 2 \times 3 = 3.0$ m

(b) Displacement from 2 to 3 s = area of triangle

$s = \text{base} \times \text{height} = 1 \times 3 = 3.0$ m

(c) Displacement from 3 to 4 s = area of triangle

$s = \frac{1}{2} \times \text{base} \times \text{height} = 0.5 \times 1 \times 3 = 1.5$ m

(d) Displacement from 4 to 5 s = 0 m

(e) Displacement from 5 to 6 s = area of triangle

$s = \frac{1}{2} \times \text{base} \times \text{height} = 0.5 \times 1 \times 1 = 0.5$ m

(f) Displacement from 6 to 7 s = area of trapezium

$s = 1 \times \frac{1}{2} \times (1+3) = 2$ m

(g) Displacement from 7 to 9 s = area of triangle

$s = 2 \times 3 = 6$ m

(h) Displacement from 9 to 10 s = area of triangle

$s = \frac{1}{2} \times 1 \times 3 = 1.5$ m

(i) Total displacement from 0 to 10 s

$= 3 + 3 + 1.5 + 0 - 0.5 - 2 - 6 - 1.5 = -2.5$ m

# Q3

A certain car has a maximum acceleration of 3.0 m $s^{-2}$. At this maximum acceleration, calculate the time it would take for the car to accelerate from 15.0 m $s^{-1}$ to 31.5 m $s^{-1}$.

$$v = u + at$$

$$t = \frac{v - u}{a}$$

$$= \frac{31.5 - 15.0}{3.0}$$

$$= 5.5 \text{ s}$$

# Q4

- The same car from Q3 took 1.5 s to slow down from 31,5m s to stop. Calculate its acceleration during its slow down.

$$v = u + at$$

$$a = \frac{v - u}{t}$$

$$= \frac{0 - 31.5}{1.5}$$

$$= -21.0 \text{ m s}^{-2}$$

# Q5

At an acceleration of 3.0 m $s^{-2}$ calculate how far the car would travel if it began from a standing start and reached a velocity of 28.0 m $s^{-1}$.

$$v^2 = u^2 + 2as$$

$$s = \frac{v^2 - u^2}{2a}$$

$$= \frac{28.0^2 - 0}{2 \times 3.0}$$

$$= 130.7 \text{ m}$$

# Q6

A rocket travelling at 42.6 m $s^{-1}$ accelerated at 15.2 m $s^{-2}$ for a distance of 1800 m. Calculate its velocity then.

$$
\begin{aligned}
v^2 &= u^2 + 2as \\
&= (42.6)^2 + 2 \times 15.2 \times 1800 \\
&= 56534.76 \\
v &= \sqrt{56534.76} \\
&= 237.8 \text{ m s}^{-1}
\end{aligned}
$$

# Q7

A boat, initially travelling at 21.4 m $s^{-1}$ accelerated at 1.6 m $s^{-2}$ for 6.5 s. Calculate how far it travelled in this time.

$$s = ut + \frac{1}{2}at^2$$

$$= 21.4 \times 6.5 + \frac{1}{2} \times 1.6 \times 6.5^2$$

$$= 173 \text{ m}$$

# Q8

An aeroplane flying at 200.0 m $s^{-1}$ accelerated for 6.2 s during which time it travelled 2000.0 m. Calculate its acceleration.

$$s = ut + \frac{1}{2}at^2$$

$$a = \frac{2(s-ut)}{t^2}$$

$$= \frac{2(2000 - 200.0 \times 6.2)}{6.2^2}$$

$$= 39.5 \text{ m s}^{-2}$$

# Q9

At an acceleration of 12.0 m $s^{-2}$ calculate the time it would take for an object to travel 180.0 m if its velocity was originally 6.0 m $s^{-1}$ .

$$s = ut + \frac{1}{2}at^2$$

$$at^2 + 2ut - 2s = 0$$

$$12t^2 + 2 \times 6 \times t - 2 \times 180 = 0$$

$$t^2 + t - 30 = 0$$

$$(t+6)(t-5) = 0$$

$$t = -6 \text{ or } 5$$

Since time cannot be negative,

time is 5 s.

# Q10

A cyclist whose initial velocity was 5.0 m $s^{-1}$ accelerated at 0.8 m $s^{-2}$ for 4.3 s. Calculate the distance travelled by the cyclist during this time.

$$s = ut + \frac{1}{2}at^2$$

$$= 5.0 \times 4.3 + 0.5 \times 0.8 \times 4.3^2$$

$$= 28.9 \text{ m}$$

# Q11

An object originally moving at 15.0 m $s^{-1}$ accelerated to 105 m $s^{-1}$ in 8.0 s. Calculate the distance it travelled during this time.

$$a = \frac{v - u}{t}$$

$$= \frac{105.0 - 15.0}{8.0}$$

$$= 11.25$$

$$s = \frac{v^2 - u^2}{2a}$$

$$= \frac{105.0^2 - 15.0^2}{2 \times 11.25}$$

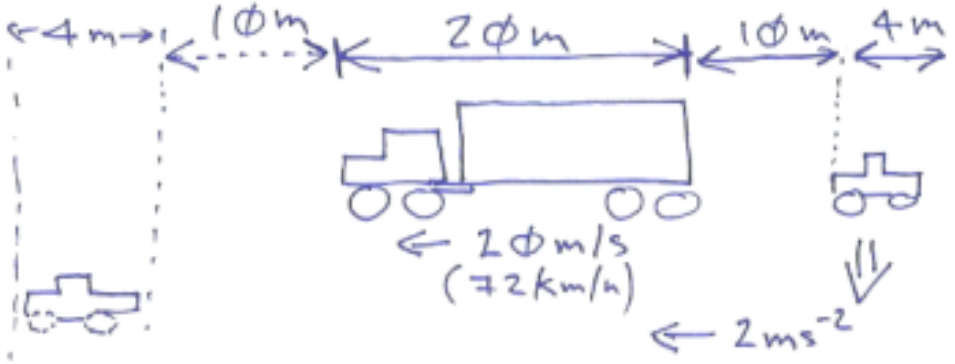
$$= 480 \text{ m}$$

# Q12

A car 4.0 m long caught up with a semitrailer truck 20.0 m long, travelling at a steady 72 km $h^{-1}$. The front of the car was kept at 10.0 m behind the truck. The driver of the car decided to overtake the truck. If the car pulled out from its front being 10.0 m behind the truck accelerating at 2.0 m $s^{-2}$ until the back of the car was 10.0 m in front of the truck, calculate how far the car would travel and what time it would take.

First calculate the time taken to overtake the truck from a standing start:

# Q12 continued




$4m + 10m + 20m + 10m = 44m$

Find t

$s = ut + \frac{1}{2}at^2$

$s - ut = \frac{1}{2}at^2$

$2s - 2ut = at^2$

$2(44) - 2(0)(t) = 2t^2$

$88 = 2t^2$

$44 = t^2$

$\sqrt{44} = t$

$t = \underline{6.63s}$

s

$s = 20 \times 6.63 + \frac{1}{2} 6.63^2 \times 2$

$s = 132.6 + 43.95$

$= 176.56m$

# 13

A bus accelerates uniformly from the bus stop for 12 s. It then moves with constant speed for another 25 s over a distance of 200 m. As it approaches the next bus stop it brakes and stops 5 s later.

(a) What is the magnitude of its constant speed?

(b) What is the rate of its acceleration?

(c) What is the rate of its deceleration?

(d) How far is it between the two bus stops?

# 13 continued

$u = 0$; $a = 0.6\dot{7}$ m s$^{-2}$; $t = 1\dot{2}$ s; $v = ?$; $t = 25$ s; $s = 200$ m; $t = 5$ s

(a) $v = s/t = 200/25 = 8$ m s$^{-1}$

(b) $a = (v - u)/t = (8 - 0)/12 = 0.67$ m s$^{-2}$

(c) $a = (0 - 8)/5 = -1.6$ or $1.6$ m s$^{-2}$ against motion

(d) $s1 = 0 + \frac{1}{2} \times 0.67 \times 12^2 = 48.24$ m

$s2 = 200$ m

$s3 = 8 \times 5 + \frac{1}{2} \times (-1.6) \times 5^2 = 40 - 20 = 20$ m

Total $s = 48.24 + 200 + 20 = 268$ m

# Q14

A cyclist accelerates from rest to 3.0 m $s^{-1}$ in 6 s.

(a) What is his acceleration?

(b) How far does he travel while accelerating?

$u = 0$; $v = 3.0$ m $s^{-1}$; $t = 6$ s; $a = ?$; $s = ?$

(a) $a = (3 - 0)/6 = 0.5$ m $s^{-2}$

(b) $s = 0 + \frac{1}{2} \times 0.5 \times 6^2 = 9$ m

# Q15

(a) Find how long it takes a rocket to accelerate from rest to 1000 m $s^{-1}$ if the acceleration is 40 m $s^{-2}$.

(b) How far would it travel in this time?

$u = 0$; $v = 1000$ m $s^{-1}$; $a = 40$ m $s^{-2}$; $t = ?$; $s = ?$;

(a) $t = (1000 - 0)/40 = 25$ s

(b) $s = 0 + \frac{1}{2} \times 40 \times 25^2 = 12\,500$ m

# Q16

A car, moving at 30 m $s^{-1}$ in a 80 km $h^{-1}$ zone passes an unmarked, stationary police car. The driver of the car brakes urgently to try to hide the fact that he was speeding. He stops in 15 s.

(a) By how much is the car breaking the speed limit?

(b) What is the magnitude of the deceleration of the car?

(c) How far does the car travel in this time?

# Q16 continued

$u = 30$ m s$^{-1}$; $v = 0$; $t = 15$ s

(a) Speed limit $= (80 \times 1000)/3600 = 22.22$ m s$^{-1}$

Above speed limit by $30 - 22.22 = 7.78$ m s$^{-1}$ or 28 km h$^{-1}$

(b) $a = (0 - 30)/15 = -2.0$ m s$^{-2}$

(c) $s = 0 + \frac{1}{2} \times -2 \times 15^2 = 225$ m

# Q17

A car travelling at 15 m $s^{-1}$ loses the trailer it is towing. The trailer coasts to a stop over a distance of 150 m while the car continues to travel forwards at the same speed.

(a) What is its acceleration?

(b) How long does it take the trailer to stop?

(c) How far in front of the trailer will the car be when the trailer stops?

# Q17 continued

$u = 15$ m s$^{-1}$; $s = 150$ m; $v = 0$; $a = ?$; $t = ?$

(a) $a = (v^2 - u^2)/2\ s = (0 - 15^2)/2 \times 150 = -0.75$ m s$^{-2}$ or $0.75$ m s$^{-2}$ against the motion

(b) $t = (v - u)/a = (0 - 15)/-0.75 = 20$ s

(c) $s$ car $= vt = 15 \times 20 = 300$ m

$s$ trailer $= 150$ m

$s = 300 - 150 = 150$ m

# Q18

A car accelerates uniformly from rest, reaching a speed of 24 m $s^{-1}$ in 2 minutes. Some time later, it brakes suddenly and stops in 20 s.

(a) Calculate the magnitude of its acceleration.

(b) How far does it travel while it is accelerating?

(c) What is its acceleration when braking?

(d) How far does it travel while braking?

(e) If the speed limit in the area is 80 km $h^{-1}$, by how much is the car under or breaking the speed limit when it is at maximum speed?

# Q18 continued

$u = 0$; $v = 24$ m s$^{-1}$; $t = 120$ s; $t = 20$ s

(a) $a = (24 - 0)/120 = 0.2$ m s$^{-2}$

(b) $s = 0 + \frac{1}{2} \times 0.2 \times 120^2 = 1440$ m

(c) $a = (0 - 24)/20 = -1.2$ m s$^{-2}$ or $1.2$ m s$^{-2}$ against the motion

(d) $s = 24 \times 20 + \frac{1}{2} \times -1.2 \times 20^2 = 480 - 240 = 240$ m

(e) Speed limit $= 24 \times 3600/10000 = 86.4$ km h$^{-1}$

Car is over the limit by $86.4 - 80 = 6.4$ km h$^{-1}$

# Q19

A car travelling at 6 m $s^{-1}$ E accelerates at 2.5 m $s^{-2}$ E for 4 s, then accelerates at 2.0 m $s^{-2}$ E for a further 8 s.

(a) Calculate the final velocity of the car.

(b) Determine how far it travels in the 12 s.

(c) At what constant acceleration would it need to travel to reach the same speed in the same time?

# Q19 continued

$u = 6\ \text{m s}^{-1}$; $a1 = 2.5\ \text{m s}^{-2}$; $t1 = 4\ \text{s}$; $a2 = 2\ \text{m s}^{-2}$; $t2 = 8\ \text{s}$

(a) $v1 = 6 + 2.5 \times 4 = 16\ \text{m s}^{-1}\ \text{E}$

$v2 = 16 + 2 \times 8 = 32\ \text{m s}^{-1}\ \text{E}$

(b) $s1 = 6 \times 4 + \frac{1}{2} \times 2.5 \times 4^2 = 44\ \text{m}$

$s2 = 16 \times 8 + \frac{1}{2} \times 2 \times 8^2 = 192\ \text{m}$

$s1 + s2 = 44 + 192 = 236\ \text{m E}$

(c) $a = (32 - 6)/12 = 2.17\ \text{m s}^{-2}\ \text{E}$

# Q20

A sports car travelling at 30 m $s^{-1}$ passes a police car which is cruising at 15 m $s^{-1}$. The police car accelerate at 1.5 m $s^{-2}$ and gives chase.

(a) How long does it take the police to catch up to the sports car?

(b) Find the distance the police car travels before it catches up to the sports car.

# Q20 continued

(a) Distance travelled by car – distance travelled by police

Therefore $30 \times t = 15t + \frac{1}{2} \times 1.5t^2$

$30t = 15t + 0.75t^2$

Therefore $t = 20$ s

(b) Distance travelled by car $= 30 \times 20 = 600$ m

# Q22

A bike rider starts from rest and accelerates at $1.25\ m\ s^{-2}$ for 8.0 s and then continues with uniform speed. He stops with a uniform deceleration over a time period of 12 s. He travels a total distance of 450 m.

(a) What is his maximum speed during the journey?

(b) What is the magnitude of his deceleration?

(c) How far does he travel at constant speed?

# Q22 continued

(a) From $v = u + at = 0 + 1.25 \times 8 = 10$ m s$^{-1}$ = maximum speed

(b) From $v = u + at$

$0 = 10 + 12a$

Therefore $a = -0.833$ m s$^{-2}$, i.e. 0.833 m s$^{-2}$ opposite the direction of motion.

(c) Average speed while accelerating = 5 m s$^{-1}$ for 8 s = 40 m

Average speed while decelerating = 5 m s$^{-1}$ for 12 s = 60 m

Therefore distance travelled at constant speed = 450 – 100 = 350 m

# Q23

A hot air balloon is stationary, 50 m above the ground when an object is dropped vertically from it. How long does it take for the object to fall and what will be its speed just before it hits the ground?

$u = 0$; $s = 50$ m; $g = 9.8$ m s$^{-2}$; $t = ?$; $v = ?$

(a) $s = ut + \frac{1}{2}gt^2$; $50 = 0 + \frac{1}{2} \times 9.8 \times t^2$; $t^2 = 2 \times 50/9.8$; $t = 3.2$ s

(b) $v^2 = u^2 + 2as = 0 + 2 \times 9.8 \times 50$; $v = 31.3$ m s$^{-1}$

# Q24

A ball is thrown vertically upwards at 58.8 m $s^{-1}$.

(a) How long will it take to reach its maximum height?

(b) What will be its speed at its maximum height?

(c) What will be its maximum height?

(d) How long will it take to fall from the maximum height back to the ground?

# Q24 continued

$u = +58.8$ m s$^{-1}$; $g = -9.8$ m s$^{-2}$; $v$ at maximum height = 0

(a) $v = u + at$; $0 = 58.8 + (-9.8)t$; $t = 58.8/9.8 = 6$ s

(b) $v$ at maximum height = 0

(c) $v^2 = u^2 + 2as$; $0 = 58.8^2 + 2 \times (-9.8)s$; $s = 58.8^2/2 \times 9.8 = 176.4$ m

(d) Same time as it took to reach maximum height, i.e. 6 s.

# Q25

An object is thrown vertically up at 40 m $s^{-1}$.

(a) How long will it be before it returns to its launch position?

(b) How high will it rise?

(c) What will be its height above the launch position at time 3 s?

(d) When will it be 50 m above the launch point?

# Q25 continued

$u = +40$ m s$^{-1}$; $g = -9.8$ m s$^{-2}$; $v$ at maximum height = 0; $v$ back at ground level = $-40$ m s$^{-1}$

(a) $v = u + at$; $-40 = 40 - 9.8t$; $t = 80/9.8 = 8.16$ s

(b) $v^2 = u^2 + 2as$; $0 = 40^2 - 2 \times 9.8 \times s$; $s = 40^2/2 \times 9.8 = 81.6$ m

(c) $s = ut + \frac{1}{2}gt^2 = 40 \times 3 - 0.5 \times 9.8 \times 3^2 = 75.9$ m

(d) $s = ut + \frac{1}{2}gt^2$; $50 = 40t - 4.9t^2$; $4.9t^2 - 40t + 50 = 0$; $t = 1.54$ s or 6.62 s

i.e. at times 1.5 s (on the way up) and 6.6 s (on the way down)