**Applied Maths Induction Workshop 1 – Accelerated Linear Motion – Exercises**

## 2010 – Ordinary Level – Question 1

A car travels along a straight level road.
It passes a point $P$ at a speed of $12\,\text{m/s}$ and accelerates uniformly for 6 seconds to a speed of $30\,\text{m/s}$.
It then travels at a constant speed of $30\,\text{m/s}$ for 15 seconds.
Finally the car decelerates uniformly from $30\,\text{m/s}$ to rest at a point $Q$.
The car travels 45 metres while decelerating.

Find (i) the acceleration
(ii) the deceleration
(iii) $|PQ|$, the distance from $P$ to $Q$
(iv) the average speed of the car as it travels from $P$ to $Q$.

## 2007 – Ordinary Level – Question 1

A car travels from $p$ to $q$ along a straight level road.
It starts from rest at $p$ and accelerates uniformly for 5 seconds to a speed of $15\,\text{m/s}$.
It then moves at a constant speed of $15\,\text{m/s}$ for 20 seconds.
Finally the car decelerates uniformly from $15\,\text{m/s}$ to rest at $q$ in 3 seconds.

(i) Draw a speed-time graph of the motion of the car from $p$ to $q$.
(ii) Find the uniform acceleration of the car.
(iii) Find the uniform deceleration of the car.
(iv) Find $|pq|$, the distance from $p$ to $q$.
(v) Find the speed of the car when it is $13{\cdot}5$ metres from $p$.

**2007 – Higher Level – Question 1(b)**

A train accelerates uniformly from rest to a speed $v\,\text{m/s}$.

It then continues at this speed for a period of time and then decelerates uniformly to rest.

In travelling a total distance $d$ metres the train accelerates through a distance $pd$ metres and decelerates through a distance $qd$ metres, where $p<1$ and $q<1$.

(i) Draw a speed-time graph for the motion of the train.

(ii) If the average speed of the train for the whole journey is $\frac{v}{p+q+b}$, find the value of $b$.

**1999 – Higher Level – Question 1(b)**

A particle travels in a straight line with constant acceleration $f$ for $2t$ seconds and covers 15 metres. The particle then travels a further 55 metres at constant speed in $5t$ seconds. Finally the particle is brought to rest by a constant retardation $3f$.

(i) Draw a speed-time graph for the motion of the particle.

(ii) Find the initial velocity of the particle in terms of $t$.

(iii) Find the total distance travelled in metres, correct to two decimal places.

**2009 – Higher Level – Question 1(b)**

A train accelerates uniformly from rest to a speed $v\,\text{m/s}$ with uniform acceleration $f\,\text{m/s}^2$.

It then decelerates uniformly to rest with uniform retardation $2f\,\text{m/s}^2$.

The total distance travelled is $d$ metres.

(i) Draw a speed-time graph for the motion of the train.

(ii) If the average speed of the train for the whole journey is $\sqrt{\frac{d}{3}}$, find the value of $f$.

**2006 – Higher Level – Question 1(a)**

A lift starts from rest. For the first part of its descent it travels with uniform acceleration $f$. It then travels with uniform retardation $3f$ and comes to rest. The total distance travelled is $d$ and the total time taken is $t$.

(i) Draw a speed-time graph for the motion.

(ii) Find $d$ in terms of $f$ and $t$.

**2008 – Higher Level – Question 1(a)**

A ball is thrown vertically upwards with an initial velocity of $39{\cdot}2\,\text{m/s}$.

Find (i) the time taken to reach the maximum height

(ii) the distance travelled in 5 seconds.

**2002 – Higher Level – Question 1(a)**

A stone is thrown vertically upwards under gravity with a speed of $u\,\text{m/s}$ from a point 30 metres above the horizontal ground.
The stone hits the ground 5 seconds later.

(i) Find the value of $u$.

(ii) Find the speed with which the stone hits the ground.

**2008 – Higher Level – Question 1(b)**

Two particles $P$ and $Q$, each having constant acceleration, are moving in the same direction along parallel lines. When $P$ passes $Q$ the speeds are $23\,\text{m/s}$ and $5{\cdot}5\,\text{m/s}$, respectively. Two minutes later $Q$ passes $P$, and $Q$ is then moving at $65{\cdot}5\,\text{m/s}$.

Find (i) the acceleration of $P$ and the acceleration of $Q$

(ii) the speed of $P$ when $Q$ overtakes it

(iii) the distance $P$ is ahead of $Q$ when they are moving with equal speeds.

## 2005 – Higher Level – Question 1(a)

Car $A$ and car $B$ travel in the same direction along a horizontal straight road.
Each car is travelling at a uniform speed of $20\,\text{m/s}$.
Car $A$ is at a distance of $d$ metres in front of car $B$.
At a certain instant car $A$ starts to brake with a constant retardation of $6\,\text{m/s}^2$.
$0{\cdot}5\,\text{s}$ later car $B$ starts to brake with a constant retardation of $3\,\text{m/s}^2$.

Find (i) the distance travelled by car $A$ before it comes to rest.

(ii) the minimum value of $d$ for car $B$ not to collide with car $A$.

## 2008 – Ordinary Level – Question 1

Four points $a$, $b$, $c$ and $d$ lie on a straight level road.
A car, travelling with uniform retardation, passes point $a$ with a speed of $30\,\text{m/s}$ and passes point $b$ with a speed of $20\,\text{m/s}$.
The distance from $a$ to $b$ is 100 m. The car comes to rest at $d$.

Find (i) the uniform retardation of the car

(ii) the time taken to travel from $a$ to $b$

(iii) the distance from $b$ to $d$

(iv) the speed of the car at $c$, where $c$ is the midpoint of $[bd]$.

## 2004 – Ordinary Level – Question 1

Three points $a$, $b$ and $c$, lie on a straight level road such that $|ab| = |bc| = 100\text{ m}$.
A car, travelling with uniform retardation, passes point $a$ with a speed of $20\,\text{m/s}$ and passes point $b$ with a speed of $15\,\text{m/s}$.

(i) Find the uniform retardation of the car.

(ii) Find the time it takes the car to travel from $a$ to $b$, giving your answer as a fraction.

(iii) Find the speed of the car as it passes $c$, giving your answer in the form $p\sqrt{q}$, where $p, q \in \mathbb{N}$.

(iv) How much further, after passing $c$, will the car travel before coming to rest?
Give your answer to the nearest metre.

## 2003 – Higher Level – Question 1(a)

The points $p$, $q$ and $r$ all lie in a straight line.

A train passes point $p$ with speed $u$ m/s. The train is travelling with uniform retardation $f$ m/s$^2$. The train takes 10 seconds to travel from $p$ to $q$ and 15 seconds to travel from $q$ to $r$, where $|pq| = |qr| = 125$ metres.

(i) Show that $f = \frac{1}{3}$.

(ii) The train comes to rest $s$ metres after passing $r$.
Find $s$, giving your answer correct to the nearest metre.