End of Chapter Revision Sheet: Uniform Acceleration 5th Year

Equations of Motion,Velocity/Time Graph Problems:

Q1. A lorry starts from rest with uniform acceleration. In the eighth second of its motion, it travels $5.625\ m$.

(i) Find the acceleration of the lorry.

(ii) Find the distance travelled by the lorry in $20\ s$ from rest.

Q2. A tram starts from rest at one station and comes to a stop $1\ min$ later at the next station. It accelerates uniformly at $2\ m/s^2$ until it reaches a speed of $20\ m/s$. It travels at this constant speed for a certain time until it decelerates back to rest at $4\ m/s^2$. Find the average velocity of the tram over the whole journey.

Q3. A lorry accelerates uniformly along a straight level road from rest at $0.5\ m/s^2$, until it has travelled $256\ m$. It then travels at the constant speed reached for $800\ m$, before braking and decelerating uniformly to rest at $2\ m/s^2$.

(i) Sketch a velocity/time graph of the motion of the lorry.

(ii) Find the maximum speed reached by the lorry.

(iii) Find the total time for the journey.

(iv) Find the total distance travelled in kilometres.

Q4. Two points P and Q lie on a straight level road. A car passes point P with a constant speed of $20\ m/s$ and continues at this speed for 12 seconds. The car then accelerates uniformly for 5 seconds to a speed of $30\ m/s$. Finally, the car decelerates uniformly from $30\ m/s$ to rest at point Q. The car travels $75\ m$ while decelerating. Sketch a velocity/time graph for the motion, and hence 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.

Q5. A racing car can accelerate at $6\ m/s^2$ and decelerate at $15\ m/s^2$. Find the shortest time in which it can travel $1\ km$ from rest to rest.

Q6. A car starts from rest and accelerates with constant acceleration a. It then travels with constant speed v for time t_2, and then comes to rest again with constant deceleration a. The total distance travelled is s and the total time taken is t.

(i) Show that $v = \frac{a}{2}(t - t_2)$.

(ii) Show that the time for which it travelled at constant speed is $\sqrt{\frac{at^2 - 4s}{a}}$.

Q7. A lift descends in a lift shaft, first with uniform acceleration $2f$ followed by uniform deceleration $3f$. It starts and finishes at rest. If the height of the lift shaft is h and the time taken is t, show that $h = \frac{3}{5}ft^2$.

Q8. A train accelerates uniformly from rest to a speed of $v\ m/s$ with uniform acceleration $a\ m/s^2$. It then decelerates uniformly to rest with uniform retardation $3a\ m/s^2$. The total distance travelled is s metres. If the average speed for the whole journey is $\sqrt{\frac{s}{2}}$, find the value of a.

Q9. The maximum acceleration of a car is $2\ m/s^2$, and its maximum retardation is $4\ m/s^2$. Its maximum speed is $40\ m/s$. Thinking about the shape of graph required in each case find:

(i) The minimum time for the car to travel $1\ km$ from rest to rest

(ii) The minimum time for the car to travel $384\ m$ from rest to rest.

Successive Posts Problems:

Q10. A particle moving in a straight line with constant acceleration takes $3\ s$ and $5\ s$ to cover two successive distances of $1\ m$. Find the acceleration and the initial velocity.

Q11. A stone is dropped from the top of a tower. In the last second of its motion, it falls through a distance which is $\frac{1}{4}$ of the height of the tower. Find the height of the tower to the nearest metre.

Overtaking/Colliding Problems:

Q12. A motorbike passes point A at a constant speed of $18\ m/s$. A second motorbike passes point B at the same instant at a speed of $10\ m/s$, and accelerating at $2\ m/s^2$.

(i) How long does it take the second bike to overtake the first bike, and at what distance from point A does this take place?

(ii) What is the furthest distance the first bike gets ahead of the second bike?

Q13. At a certain instant in a cycle race, Brian is $80\ m$ behind Alan. Alan is cycling at a constant speed of $15\ m/s$. Brian is cycling at $10\ m/s$ at that instant and is accelerating at $1\ m/s^2$.

(i) If Alan is only $250\ m$ from the finish line, show that Brian does not pass him before the finish.

(ii) How long after Alan finishes does Brian finish?

Gravity Problems:

Q14. A stone is thrown up from the top of a cliff with a velocity of $20\ m/s$. It lands in the water at the bottom of the cliff $5.5\ s$ later. Find the height of the cliff.

Q15. A balloon rises from the ground with an acceleration of $0.25\ m/s^2$.

(i) How far has it risen, and what is its velocity, $20\ s$ later?

(ii) If at this instant a stone is dropped from the balloon, how long will it take to reach the ground?

Q16. A stone is dropped from the top of a building while at the same time a second stone is thrown up from the base of the building at $30\ m/s$. The two stones pass each other after 4 seconds. Find the height of the building.

Q17. A stone is thrown up with a velocity of $25\ m/s$. Three seconds later a second stone is thrown up from the same point with a velocity of $20\ m/s$. At what height do the stones collide?

Q18. A particle falls from rest at a point A under gravity. After it has fallen a distance a, another particle is given a downward speed $\sqrt{8ga}$ from the same starting point A. Show that the two particles collide. Find the distance from A at which they collide.

Answers:

Q1. (i) $0.75\ m/s^2$ (ii) $150\ m$	Q2. $17.5\ m/s$	Q3. (ii) $16\ m/s$ (iii) $90\ s$ (iv) $1.12\ km$	
Q4. (i) $2\ m/s^2$ (ii) $6\ m/s^2$ (iii) $440\ m$ (iv) $20\ m/s$	Q5. $21.6\ s$	Q8. $\frac{4}{3}$	Q9. (i) $40\ s$ (ii) $24\ s$
Q10. $-\frac{1}{30}\ m/s^2, \frac{23}{60}\ m/s$	Q11. $273\ m$	Q12. (i) $8\ s, 144\ m$ (ii) $16\ m$	Q13. (ii) $0.9\ s$
Q14. $38.225\ m$	Q15. (i) $50\ m, 5\ m/s$ (ii) $2.72\ s$	Q16. $120\ m$	Q17. $17.5\ m$
Q18. $\frac{9a}{4}$			

Past Exam Questions:

2010 Q1

1. **(a)** A car is travelling at a uniform speed of 14 ms^{-1} when the driver notices a traffic light turning red 98 m ahead.

Find the minimum constant deceleration required to stop the car at the traffic light,

(i) if the driver immediately applies the brake

(ii) if the driver hesitates for 1 second before applying the brake.

(b) A particle passes P with speed 20 ms^{-1} and moves in a straight line to Q with uniform acceleration.

In the first second of its motion after passing P it travels 25 m.

In the last 3 seconds of its motion before reaching Q it travels $\frac{13}{20}$ of $|PQ|$.

Find the distance from P to Q.

2011 Q1

1. **(a)** A particle is released from rest at A and falls vertically passing two points B and C.

It reaches B after t seconds and takes $\frac{2t}{7}$ seconds to fall from B to C, a distance of 2.45 m.

Find the value of t.

(b) A car accelerates uniformly from rest to a speed v in t_1 seconds. It continues at this constant speed for t seconds and then decelerates uniformly to rest in t_2 seconds.

The average speed for the journey is $\frac{3v}{4}$.

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

(ii) Find $t_1 + t_2$ in terms of t.

(iii) If a speed limit of $\frac{2v}{3}$ were to be applied, find in terms of t the least time the journey would have taken, assuming the same acceleration and deceleration as in part (ii).

2015 Q1

1. **(a)** A particle starts from rest and moves with constant acceleration.

If the particle travels 39 m in the seventh second, find the distance travelled in the tenth second.

(b) A train of length 66.5 m is travelling with uniform acceleration $\frac{4}{7}$ m s^{-2}.

It meets another train of length 91 m travelling on a parallel track in the opposite direction with uniform acceleration $\frac{8}{7}$ m s^{-2}.

Their speeds at this moment are 18 m s^{-1} and 24 m s^{-1} respectively.

(i) Find the time taken for the trains to pass each other.

(ii) Find the distance between the trains 1 second later.

2016 Q1

1. **(a)** A car has an initial speed of u m s^{-1}. It moves in a straight line with constant acceleration f for 4 seconds. It travels 40 m while accelerating.
The car then moves with uniform speed and travels 45 m in 3 seconds.
It is then brought to rest by a constant retardation $2f$.

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

(ii) Find the value of u.

(iii) Find the total distance travelled.

(b) A particle is projected vertically upwards with a velocity of u m s^{-1}.
After an interval of $2t$ seconds a second particle is projected vertically upwards from the same point and with the same initial velocity.

They meet at a height of h m.

Show that $h = \dfrac{u^2 - g^2t^2}{2g}$.

2018 Q1(b)

(b) A car C moves with uniform acceleration a from rest to a maximum speed u.
It then travels at uniform speed u.
Just as car C starts, it is overtaken by a car D moving in the same direction with constant speed $\frac{3u}{4}$.
Car C catches up with car D when car C has travelled a distance d.

(i) Show that, at the instant car C catches up with car D, car C has been travelling with speed u for a time $\dfrac{4d}{3u} - \dfrac{u}{a}$.

(ii) Find d in terms of u and a.

2024 Q1(c)

John is cycling on a straight horizontal road at a constant velocity of 10 m s^{-1} and is 21 m behind another cyclist, Kevin, who is cycling at a constant velocity of 4 m s^{-1} in the same direction. John begins to accelerate at 2 m s^{-2}. One second later, Kevin begins to accelerate at 4 m s^{-2}.

Calculate the times when John and Kevin overtake each other.

2024 Q5(b)

(b) A train departs from Connolly Station and accelerates uniformly from rest for t_1 seconds until it reaches a speed of v. The train maintains this speed for t_2 seconds, where $t_2 = 2t_1$.
The train then decelerates to rest at Pearse Station in a time of t_3 seconds.

The total time taken for the journey is $T = t_1 + t_2 + t_3$.

(i) Show that $T = \frac{2d - t_2 v}{v}$, where d is the distance between Connolly Station and Pearse Station.

(ii) If the average speed for the entire journey is $\frac{2v}{3}$, show that $T = 6t_1$.

Past Exam Questions:

2010: (a)(i) $1\ m/s^2$ (ii) $1.17\ m/s^2$ (b) $300\ m$	2011: (a) $\frac{7}{8}\ s$ (b) (ii) t (iii) $\frac{31}{12}t$	
2015: (a) $57\ m$ (b)(i) $3.5\ s$ (ii) $48.86\ m$	2016: (a)(ii) $5\ m/s$ (iii) $107.5\ m$	2018: (b)(ii) $d = \frac{3u^2}{2a}$
2024: Q1(c) $5 \pm \sqrt{2}\ s$		