Mechanics 4 – Vertical Motion

Please **complete** this homework by _____. Start it early. If you can't do a question you will then have time to ask your teacher for help or go to a drop in session.

Section 1 – Review of previous topics. Please underline complete all questions.

A particle is travelling in a straight line. It passes point A with velocity 10ms^{-1}. Immediately after passing A, it accelerates at 4ms^{-2} for x metres up to a velocity of 50ms^{-1}, then decelerates at 10ms^{-2} for y metres to point B. It passes B with velocity 10ms^{-1} .The particle takes T seconds to travel between A and B.

   a) Show the particle's motion between A and B on a velocity-time graph.
   b) Find the area under the graph in terms of T.
   c) Calculate the values of x, y and t.

Section 2 – Consolidation of this week's topic. Please complete all questions.

1) A pebble is dropped down a well. It takes 1.8 seconds until it hits the water. Find the distance travelled by the pebble before it hits the water. **(3 marks)**

2) A ball is thrown vertically downwards at 7ms^{-1} and strikes the ground at 15ms^{-1}. From how high above the ground was the ball thrown? **(3 marks)**

3) A rocket is launched vertically upwards from a cliff at a speed of 39.2ms^{-1}. It hits the ground at the foot of the cliff 10 seconds later.

   a) Find the height of the cliff.
   b) Find the maximum height reached by the rocket.
   c) Find the time taken to reach the maximum height.
   d) Find the speed at which the rocket hits the ground.
   e) Find the time taken for the rocket to return to the same height at which it was launched. **(10 marks)**

4) A golf ball is thrown vertically upwards from the ground with a velocity of 42ms^{-1}. For how long is it more than 87.5m above the ground? **(4 marks)**

5) A stone is dropped from the top of a castle. One second later, another stone is thrown downwards from the same height at 14ms^{-1}. If both stones hit the moat at the same time, find the height of the castle. **(5 marks)**

6) A skydiver leapt from a plane. Her descent is modelled as spending the first 45 seconds in free fall, then immediately deploying her parachute, descending to the ground at a steady speed of $8ms^{-1}$ for 3 minutes.
   a) Draw a velocity-time graph for her descent.
   b) Draw a distance-time graph for her descent.
   c) Draw an acceleration-time graph for her descent.
   d) Calculate the total distance of the descent in metres given by this model.
   e) Comment on how realistic the model is. **(10 marks)**

Total for section 2 : 35 marks

Section 3 – Extension question. If you are aiming for a top grade, you should attempt this question.

1) A particle moves along the straight line EFGH with a constant acceleration. It takes 7 seconds to travel from E to F, 3 seconds to travel the 66m from F to G and 4 seconds to travel from G to H, where it comes to rest.
   a) Find the deceleration of the particle.
   b) Find the velocity of the particle at E.

   (Hint: draw a velocity-time graph and let the velocities at E, F and G be v_1, v_2, v_3)

2) After a windy night, a road has a pile of debris blocking the way. A motorist driving towards the debris notices it when he is 80m away, travelling at $20ms^{-1}$ and with a constant acceleration of $2ms^{-2}$. As soon as he engages the brakes, he will decelerate at a constant $4ms^{-2}$.
   a) If the motorist reacts immediately, how far will he stop from the debris?
   b) If he takes two seconds to react, at what speed will he be driving when he hits the debris?