Edexcel M1 June 2014 – Increased Difficulty Paper

1) A particle of weight W newtons is attached at C to two light inextensible strings AC and BC. The other ends of the strings are attached to fixed points A and B on a horizontal ceiling. The particle hangs in equilibrium with AC and BC inclined to the horizontal at $30°$ and $50°$ respectively. Given that the tension in BC is $6N$, find the weight W.

2) A rough plane is inclined at $40°$ to the horizontal. Two points A and B lie on the line of greatest slope of the inclined plane, 3 metres apart. The point A is above the point B. A particle of mass m kg is held at rest on the plane at A. The coefficient of friction between the particle, P, and the plane is $\frac{1}{2}$. The particle is then released. Find the speed of the particle as it passes through the point B.

3) A ball of mass 0.3 kg is released from rest at a point which is 2 m above horizontal ground. The ball moves freely under gravity. After striking the ground, the ball rebounds vertically and rises to a maximum height of 1.5 m above the ground, before falling to the ground again. The ball is modelled as a particle.

   a) Find the magnitude of the impulse on the ball in the first impact with the ground.
   b) Sketch a velocity-time graph for the motion of the ball from the instant when it is released until the instant when it strikes the ground for the second time.
   c) Find the time between the instant when the ball is released and the instant when it strikes the ground for the second time.

4) A beam AB has weight W newtons and length 4 m. The beam is held in equilibrium in a horizontal position by two vertical ropes which are attached to the beam. One rope is attached to A and the other is attached to a point C on the beam, where $AC = d$ metres. The beam is modelled as a uniform rod and the ropes as light inextensible strings. The tension in the rope attached at C is double the tension in the rope attached at A.
   a) What is the significance of the assumption that the ropes are light and inextensible?
   b) Find the value of d.

   A small load of weight kW newtons is attached to the beam at B. The beam remains in equilibrium in a horizontal position. The load is modelled as a particle. The tension in the rope attached at C is now four times the tension in the rope attached at A.
   c) Find the value of k.

5) A particle P of mass 0.5 kg is moving under the action of a single force $(3\boldsymbol{i} - 2\boldsymbol{j})$ N. At time $t = 0$ the particle P has velocity $(\boldsymbol{i} + 3\boldsymbol{j})\ ms^{-1}$.
   a) Find the magnitude of the acceleration of P
   b) Find the velocity of P at time $t = 2$ seconds.

   Another particle Q moves with constant velocity $\boldsymbol{v} = (2\boldsymbol{i} - \boldsymbol{j})\ ms^{-1}$
   c) Find the distance moved by Q in 2 seconds.
   d) Show that at time $t = 3.5$ seconds both particles are moving in the same direction.

6) Two forces $\boldsymbol{P}$ and $\boldsymbol{Q}$ act on a particle at O. The angle between the lines of action of $\boldsymbol{P}$ and $\boldsymbol{Q}$ is $120°$. The force $\boldsymbol{P}$ has magnitude 20 N and the force $\boldsymbol{Q}$ has magnitude X newtons. The resultant of $\boldsymbol{P}$ and $\boldsymbol{Q}$ is the force $\boldsymbol{R}$**.** Given that the magnitude of $\boldsymbol{R}$ is $3X$ newtons, find the magnitude of $\boldsymbol{P} - \boldsymbol{Q}$. Give your answer to 3 significant figures.

7) Three particles A, B and C have masses $3m, 2m$ and $2m$ respectively. Particle C is attached to particle B. Particles A and B are connected by a light inextensible string which passes over a smooth light fixed pulley. The system is held at rest with the string taut and the hanging parts of the string vertical. The system is released from rest and A moves upwards.
   a) Find the tension in the string as A ascends.

   At the instant when A is 0.7 m above its original position, C separates from B and falls away. In the subsequent motion, given that A does not reach the pulley.
   b) Find the speed of A at the instant when it is 0.7m above its original position.
   c) Find the greatest height reached by A above its original position.