(1) Fred and Katie have tennis balls.

Fred is standing at the top of a skate park ramp directly above Katie who is standing on the ground.

Fred and Katie both throw their empty tennis balls at the same time in disgust. Fred throws his downwards with speed ums^{-1} and Katie throws hers upwards with speed $5ums^{-1}$. As Katie vape reaches its maximum height the tennis balls instantaneously collide.

Modelling the tennis balls as particles, prove that the height of the skate park ramp is $\frac{30u^2}{g}$ metres above the ground.

(2) Tom and John run from a fixed point. Tom runs out the of the shop and heads directly east from rest. After 10 seconds he is running with velocity ums^{-1}. He maintains this speed for T seconds before decelerating to rest in a further 8 seconds. John follows Tom two seconds later. From rest John reaches a speed of $1.5ums^{-1}$ in 4 seconds. He maintains this speed for $T - 5$ seconds before decelerating to rest. Tom and John both stop in the same place at the same time.

Modelling Tom and John as particles travelling with constant acceleration along the x axis:
(a) Sketch a velocity time graph for each person on the same set of axes.
(b) Find the time Tom and John were both running for.

(3) Particle A passes through origin heading in the positive x direction with speed $8ms^{-1}$ and deceleration ams^{-2}. Particle B passes the origin heading in the negative x direction with speed $1ms^{-1}$ and acceleration $1ms^{-2}$. Particle A and Particle B collide after t seconds.

Prove that t satisfies the equation $t = \frac{18}{a-1}$

You can assume the particles move with constant acceleration.