Mark scheme for Extension Worksheet – Option H, Worksheet 1

1 The time for light to cover the distance of 600 m is $\frac{600}{3\times10^{8}} = 2.0\times10^{-6}$ s ; hence the time coordinate of the event is $4.0\times10^{-6} - 2.0\times10^{-6} = 2.0\times10^{-6}$ s [2]

2 Use $x' = x - vt$ and $t' = t$ to get $x' = 900 - 30\times6.0 = 720$ m ; and $t' = 6.0$ s [2]

3 No; because the speed of the 'moving' frame is so small compared to the speed of light so Galilean relativity is a good description of what goes on. [2]

4 **a** The length of an object measured when at rest with respect to the observer. [1]

b The observer inside the box as he/she is at rest with respect to the box. [1]

c Because for the observer in the box the light is emitted and then received at the same point in space. [2]

d The proper length of the box is $3.0\times10^{8}\times0.45\times10^{-9} = 13.5$ m ; the gamma factor is $\gamma = \frac{1.2\times10^{-9}}{0.90\times10^{-9}} = 1.33$; hence the length measured from the ground is $\frac{13.5}{1.33} = 10.15 \approx 10\,\text{m}$ [3]

e No they will not be the same; for example because the mirror moves away from the signal as the signal moves to the right so the outward trip will take less time. [2]

5 The explosions are simultaneous for the ground observer so he will receive light from the explosions at the same time because his distances from the two explosions are the same and the light form the explosions travels at the same speed; since the arrivals of the light signals are simultaneous for the ground observer and occur at the same point they are also simultaneous for the rocket observer; but for the rocket observer the ground observer moves away from the right signal and towards the left signal; since the speed of the two signals is the same, for the arrival to be at the same time, the right signal must have occurred first. [4]