Chapter 9 Special Relativity: time and motion. Revision Questions page 269-271 – MCQ Answers

Q	Ans	Explanation
1	B	Light travels at a speed *c* in all inertial frames of reference, so all observers will measure the same value for the speed of light.
2	B	This is postulate 1 (see page 251)
3	D	These may all vary depending on the relative motion of the observers.
4	A	Special theory of relativity deals only with inertial frames of reference.
5	A	All four options are true about muons but only option A is about confirming relativity. Option D requires special relativity for an explanation but only option A provides the mechanism.
6	C	Light travels at a speed c in all inertial frames of reference, so all observers will measure the same value for the speed of light.
7	D	The flashes of light are 1 second apart as measured by an observer stationary with respect to the rail crossing and the lights so that observer measures proper time (t_0). An observer on the train is moving relative to the flashes of light so measures relativistic or dilated time (t). Dilated time is bigger so the time between flashes will appear longer to an observer on the train. The fact that the train is going close to the speed of light means the time dilation will be 'great' so a 'greater' time than one second will be noted.
8	D	The question asks about time 'interval' and that means the clocks will show that time has elapsed. Hence, option A is wrong as it says they have to be simultaneous; option B is also wrong for the same Explanation; option C is wrong as synchronised clocks are necessary to measure both proper time and relativistic time (but you just get different values). That leaves option D which is correct as proper time is defined as the time elapsed for events that occur in the same place to the observer. To a muon, the top of the mountain and the ground occur in the same place because the muon sees the mountain rushing past it – the muon – which sees itself is stationary. The observers at the top of the mountain see the muon go past and then observers at the bottom of the mountain see the muon at the ground – which is two different places.
9	A	The event is that the meteor is high in the atmosphere then later is on the Earth. To the meteor these two events occur in the same place as it sees the earth rushing past. The observer on the meteor measures proper time. To observers on the planet, they see the meteor high up in the atmosphere and then see it later on the ground. These are two different places so the observers on the planet measure relativistic time.
10	C	In Newtonian physics, a certain number of muons should have decayed given the mean lifetime of the muon and the distance they had to travel. However, in relativistic terms the distance from the mountain top to the ground is contracted according to the muon as the mountain is travelling past at high speed. So, if the distance is shorter to the muon, not as many will decay in the time it takes to get to the ground. Alternatively, the mean lifetime of the muon as measured by the observers on Earth will be longer (time dilation) so the muon can travel further before decaying.