| Y | Q | Equations of Motion |
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| 18 | 1 | A boat accelerates steadily from a speed of $10\,m\,s^{-1}$ to $14\,m\,s^{-1}$ over a distance of 1·2 kilometres.<br>The boat continues to accelerate at the same rate for a further two minutes.<br>The engines are then put into reverse to produce an immediate deceleration of the same magnitude as the previous acceleration. This brings the boat to rest.<br>Calculate the total distance travelled by the boat since it started to accelerate. **5** |
| 18 | 16 | Two runners are taking part in a relay race and preparing to hand over the baton. They are running in the same straight line when they exchange the baton.<br>Runner *P* is running at a constant speed of $12\,m\,s^{-1}$ when he decelerates at $4\,m\,s^{-2}$ in preparation for the baton change, at which point he must be travelling at $9\,m\,s^{-1}$. He continues to decelerate at the same rate until he comes to rest.<br>Runner *Q* takes the baton 3 seconds after starting running with a constant acceleration. He has achieved a speed of $9\,m\,s^{-1}$ when the baton is exchanged and continues to accelerate to a maximum speed of $12\,m\,s^{-1}$.<br>(a) (i) Sketch a velocity/time graph to represent both runners, annotating all relevant points on your graph. **2**<br>(ii) For how many seconds has *P* decelerated before baton change? **1**<br>(b) At the point when the baton is exchanged, *Q* is 0·8 metres ahead of *P*.<br>How far is *P* behind *Q* when *Q* starts to run? **5** |
| 16 | 6 | A remote controlled aircraft is flown from point A to point B. It accelerates for 10 seconds at a constant rate from rest to a take-off speed of $15\,m\,s^{-1}$.<br>Once airborne, it accelerates for a further 20 seconds at a slower constant rate to a cruising speed of $u\,m\,s^{-1}$.<br>It maintains this speed for 60 seconds until it lands.<br>The aircraft then decelerates for 10 seconds to a complete stop.<br>(a) Sketch a speed-time graph of the journey, clearly showing all the important information. **2**<br>(b) (i) If the distance travelled from A to B is 1·725 km, calculate the value of $u$. **2**<br>(ii) State one assumption you have made about the path of the aircraft during your calculations. **1** |
| 16 (Sp) | 4 | A train travels from Glasgow to Stirling. It starts from rest and accelerates uniformly for the first 9 km of its journey. It then travels for 46·8 km at a uniform velocity, before decelerating uniformly to rest in 7·2 km. The total journey time is 33 minutes.<br>(a) Sketch a velocity-time graph with appropriate units to represent this journey. **2**<br>(b) Calculate, in $km\,h^{-1}$, the maximum speed reached by the train. **4**<br>(c) State **one** assumption you have made in answering this question. **1** |