7 A particle P moves in a straight line through a point O. The velocity $v\,\text{m s}^{-1}$ of P, at time t s after passing O, is given by

$$v = \frac{9}{4} + \frac{b}{(t+1)^2} - ct^2,$$

where b and c are positive constants. At $t = 5$, the velocity of P is zero and its acceleration is $-\frac{13}{12}\,\text{m s}^{-2}$.

(a) Show that $b = 9$ and find the value of c. [5]

(b) Given that the velocity of P is zero only at $t = 5$, find the distance travelled in the first 10 seconds of motion. [5]

4 A car starts from rest and moves in a straight line with constant acceleration $a\,\text{m s}^{-2}$ for a distance of 50 m. The car then travels with constant velocity for 500 m for a period of 25 s, before decelerating to rest. The magnitude of this deceleration is $2a\,\text{m s}^{-2}$.

(a) Sketch the velocity-time graph for the motion of the car. [1]

(b) Find the value of a. [3]

.....

.....

.....

.....

.....

.....

.....

(c) Find the total time for which the car is in motion. [3]

.....

.....

.....

.....

.....

.....

.....

4 A particle P travels in the positive direction along a straight line with constant acceleration. P travels a distance of 52 m during the 2nd second of its motion and a distance of 64 m during the 4th second of its motion.

(a) Find the initial speed and the acceleration of P. [5]

(b) Find the distance travelled by P during the first 10 seconds of its motion. [2]

4 A lorry of mass 15000 kg moves on a straight horizontal road in the direction from A to B. It passes A and B with speeds $20\,\text{m s}^{-1}$ and $25\,\text{m s}^{-1}$ respectively. The power of the lorry's engine is constant and there is a constant resistance to motion of magnitude 6000 N. The acceleration of the lorry at B is 0.5 times the acceleration of the lorry at A.

(a) Show that the power of the lorry's engine is 200 kW, and hence find the acceleration of the lorry when it is travelling at $20\,\text{m s}^{-1}$. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The lorry begins to ascend a straight hill inclined at 1° to the horizontal. It is given that the power of the lorry's engine and the resistance force do not change.

(b) Find the steady speed up the hill that the lorry could maintain. [2]

.....

.....

.....

.....

.....

.....

6 A particle travels in a straight line PQ. The velocity of the particle t s after leaving P is v m s^{-1}, where

$$v = 4.5 + 4t - 0.5t^2.$$

(a) Find the velocity of the particle at the instant when its acceleration is zero. [3]

The particle comes to instantaneous rest at Q.

(b) Find the distance PQ. [6]