Higher Equations of Motion Questions

1. a) State the **three** equations of motion.

b) List the **five** quantities with their units, which are involved **in the** three **equations of motion**.

2. A car initially travelling at **14ms^{-1}** then accelerates at **1.2ms^{-2}** for **6 seconds**.

Calculate the **final speed** of the car.

3. **How far** will a vehicle travel if it accelerates at **1.8ms^{-2}** from an initial speed of **8ms^{-1}** to a final speed of **17ms^{-1}**.

4. **Calculate how far** a vehicle will travel if, it has an initial velocity of **9ms^{-1}** and accelerates at **1.7ms^{-2}** for **4 seconds**.

5. a) What is meant by the term **'acceleration'**?

b) **Describe how** you would use the equipment below to measure the acceleration of a trolley down a ramp.

A trolley with card attached, a ramp, two light gates with timers and a metre ruler are used in the experiment.

6. An object is initially travelling at **3ms^{-1}** and then it accelerates at **1.4ms^{-2}** for the next **4s.**

It then accelerates at **2.2ms^{-2}** for the next **5 seconds.**

Plot this information onto a velocity-time graph and find:

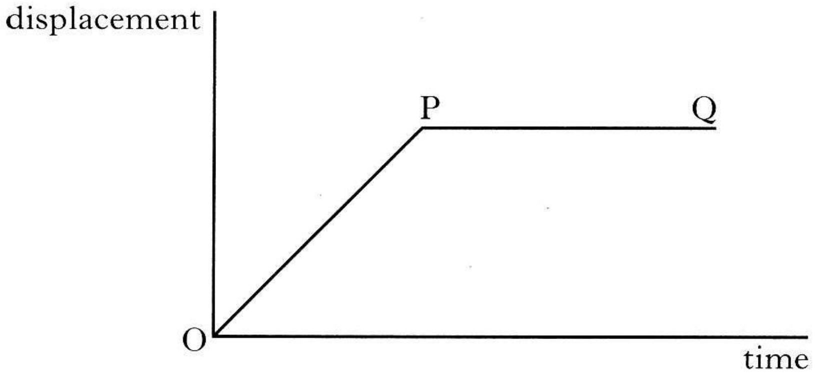
a) **Velocity** of the object after **9 seconds**.

b) **Displacement** of the object after **9 seconds**.

7. An object has a constant acceleration of **$4ms^{-2}$**.

What does this mean?

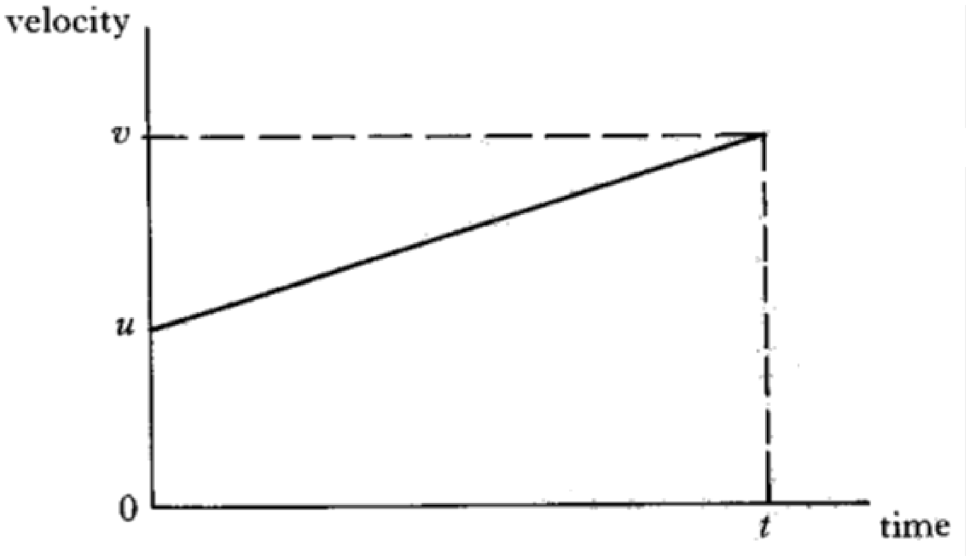
8. The following graph shows how displacement of an object varies with time.



Describe the motion of the object between:

a) OP.
b) PQ.

9. The velocity–time graph shown below is for an object moving with a **constant acceleration a**.

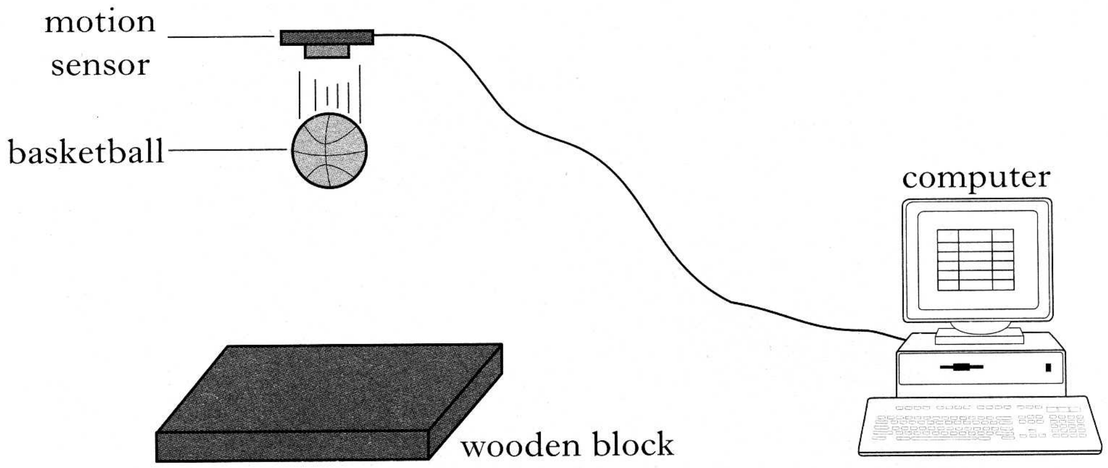


Show that during the **time interval t** the object moves through a **displacement s** given by

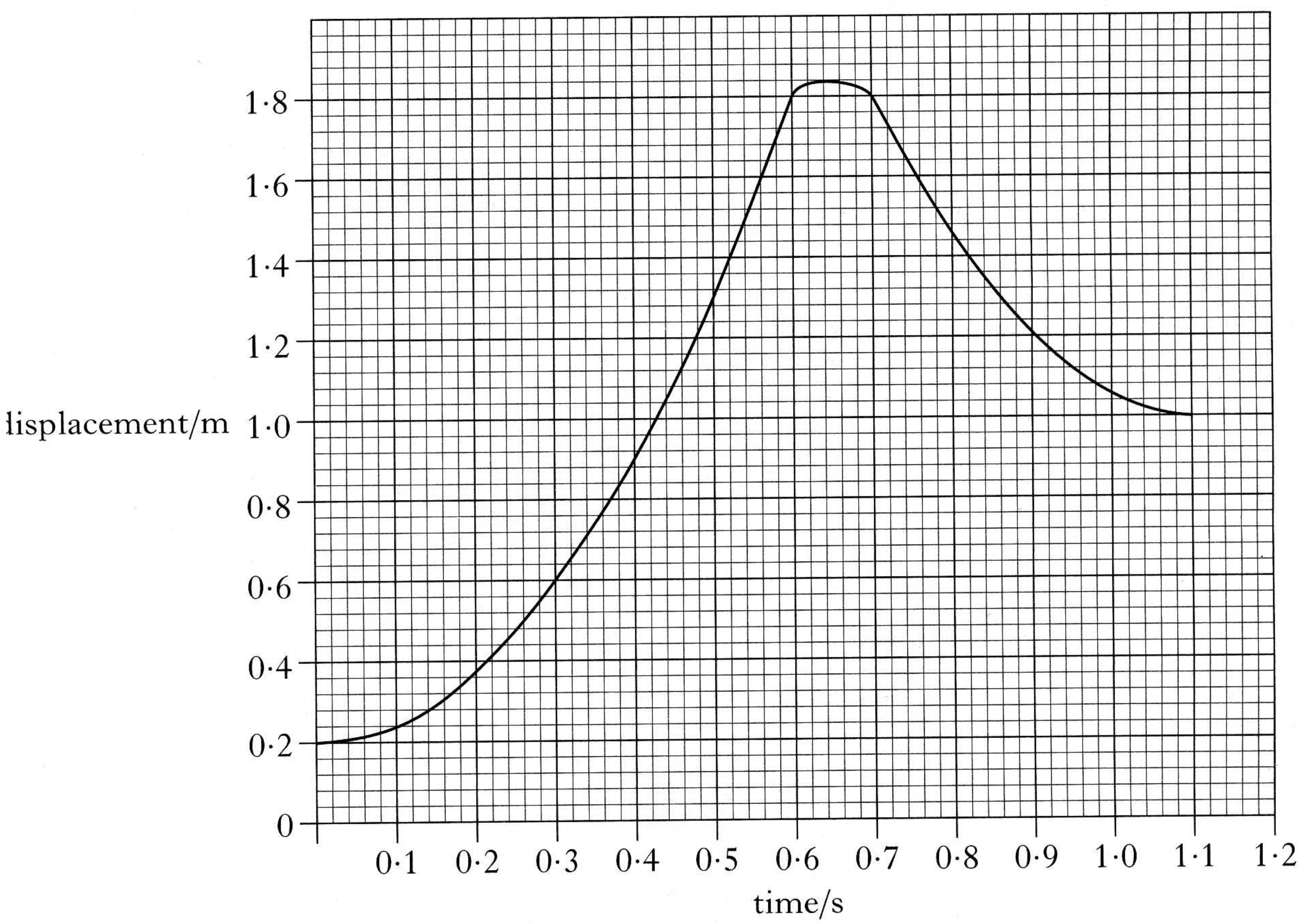
$s = ut + \frac{1}{2} at^2$.

10.

A basketball is held below a motion sensor. The basketball is released from rest and falls onto a wooden block. The motion sensor is connected to a computer so that graphs of the motion of the basketball can be displayed.



A displacement-time graph for the motion of the basketball from the instant of its release is shown.



10. Continued

(*a*) (i) What is the distance between the motion sensor and the top of the basketball when it is released?

(ii) How far does the basketball fall before it hits the wooden block?

(iii) Show, by calculation, that the acceleration of the basketball as it falls is $8{\cdot}9\,\text{m s}^{-2}$.

(*b*) The basketball is now dropped several times from the same height. The following values are obtained for the acceleration of the basketball.

$8{\cdot}9\,\text{m s}^{-2}$ $9{\cdot}1\,\text{m s}^{-2}$ $8{\cdot}4\,\text{m s}^{-2}$ $8{\cdot}5\,\text{m s}^{-2}$ $9{\cdot}0\,\text{m s}^{-2}$

Calculate:

(i) the mean of these values;

(ii) the approximate random uncertainty in the mean.

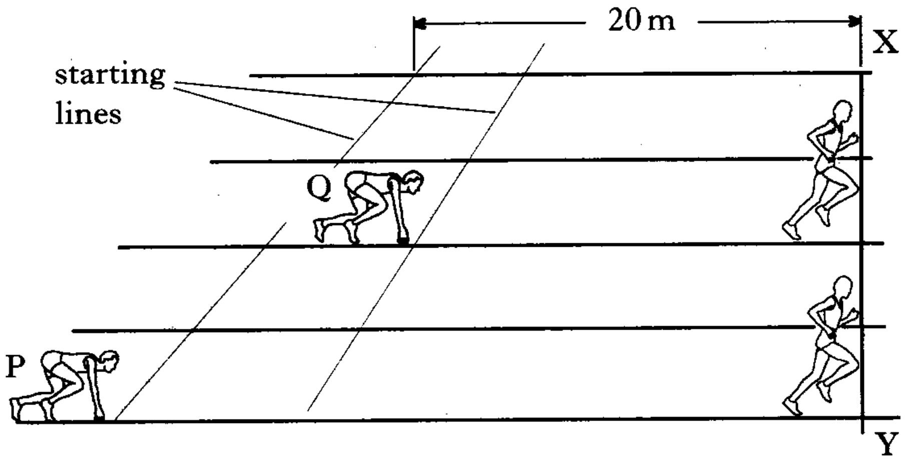
(*c*) The wooden block is replaced by a block of sponge of the same dimensions. The experiment is repeated and a new graph obtained.

Describe and explain any **two** differences between this graph and the original graph.

11.

In a "handicap" sprint race, sprinters P and Q both start the race at the same time but from different starting lines on the track.

The handicapping is such that both sprinters reach the line XY, as shown below, at the same time.



Sprinter P has a constant acceleration of $1{\cdot}6\,\text{m s}^{-2}$ from the start line to the line XY. Sprinter Q has a constant acceleration of $1{\cdot}2\,\text{m s}^{-2}$ from the start line to XY.

(*a*) Calculate the time taken by the sprinters to reach line XY.

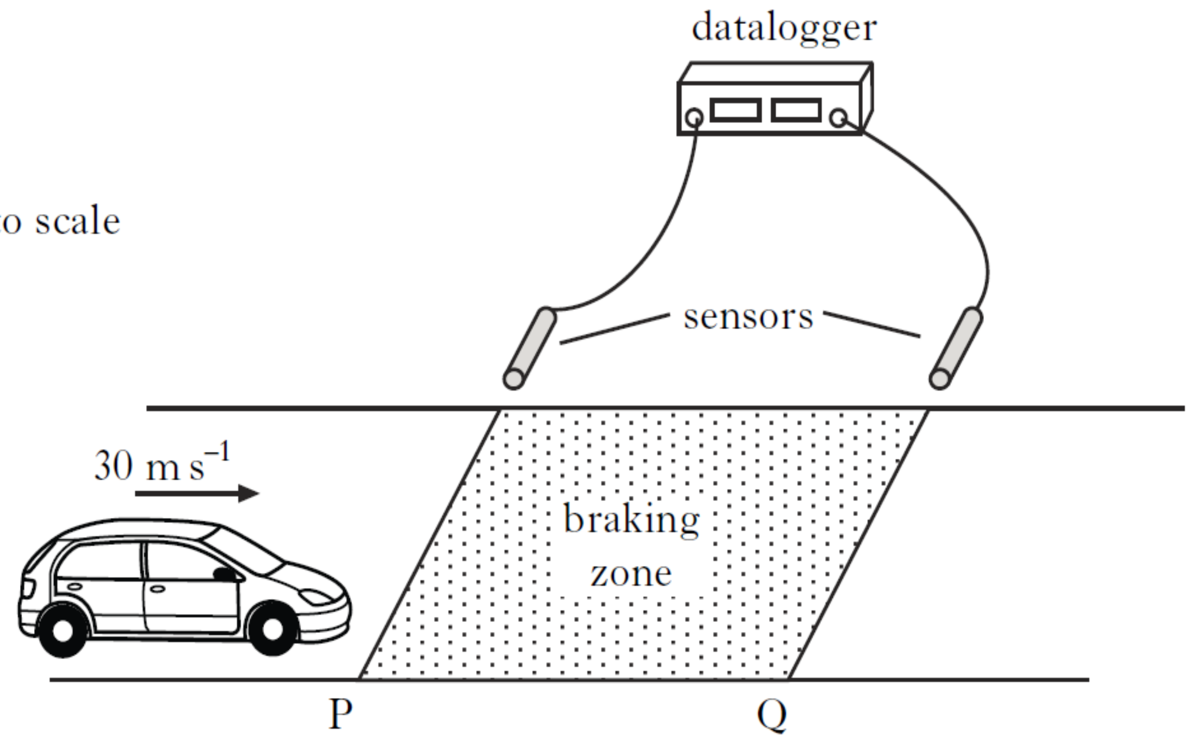
(*b*) Find the speed of **each** sprinter at this line.

(c) Calculate the distance between the starting lines for sprinters P and Q.

12.

To test the braking system of cars, a test track is set up as shown.

not to scale



The sensors are connected to a datalogger which records the speed of a car at both P and Q.

A car is driven at a constant speed of $30\ m\,s^{-1}$ until it reaches the start of the braking zone at P. The brakes are then applied.

(*a*) In one test, the datalogger records the speed at P as $30\ m\,s^{-1}$ and the speed at Q as $12\ m\,s^{-1}$. The car slows down at a constant rate of $9{\cdot}0\ m\,s^{-2}$ between P and Q.

Calculate the length of the braking zone.

(*b*) The test is repeated. The same car is used but now with passengers in the car. The speed at P is again recorded as $30\ m\,s^{-1}$.

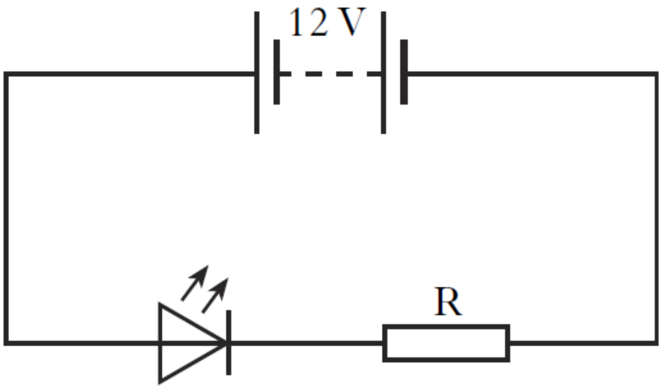
The same braking force is applied to the car as in part (*a*).

How does the speed of the car at Q compare with its speed at Q in part (*a*)? Justify your answer.

12. Continued

(*c*) The brake lights of the car consist of a number of very bright LEDs.

An LED from the brake lights is forward biased by connecting it to a 12 V car battery as shown.



The battery has negligible internal resistance.

(i) Explain, in terms of charge carriers, how the LED emits light.

(ii) The LED is operating at its rated values of 5·0 V and 2·2 W.

Calculate the value of resistor R.