PQ 6c

Questions and Answers

Q1

The initial velocity of a car moving on a straight road is 2.0 m s^{-1} and becomes 8.0 m s^{-1} after travelling for 2.0 s under constant acceleration. What is the acceleration?

$v = u + at$. So $8.0 = 2.0 + a \times 2.0 \Rightarrow a = \dfrac{8.0 - 2.0}{2.0} = 3.0 \text{ m s}^{-2}$

Q2

A plane starting from rest takes 15.0 s to take off after speeding over a distance of 450.0 m on the runway with constant acceleration. With what velocity does it take off?

$s = ut + \frac{1}{2}at^2$. So $450 = \frac{1}{2}a \times 15.0^2 \Rightarrow a = \frac{900}{225} = 4.00 \text{ m s}^{-2}$. Then from $v = u + at$, $v = 4.00 \times 15.0 = 60.0 \text{ m s}^{-1}$.

Q3

The acceleration of a car is assumed constant at 1.5 m s^{-2}. How long will it take the car to accelerate from 5.0 m s^{-1} to 11 m s^{-1}?

From $v = u + at$, $11 = 5.0 + 1.5 \times t \Rightarrow t = \dfrac{11 - 5.0}{1.5} = 4.0\ s$.

Q4

A car accelerates from rest to 28 m s^{-1} in 9.0 s. What distance does it travel?

From $v = u + at$, $28 = 0 + a \times 9.0 \Rightarrow a = \frac{28}{9.0} = 3.1 \text{ m s}^{-2}$, hence from $s = ut + \frac{1}{2}at^2$ we have that $s = \frac{1}{2} 3.1 \times 9.0^2 = 126 \text{ m} \approx 130 \text{ m}$.

Q5

A body has an initial velocity of 12 m s^{-1} and is brought to rest over a distance of 45 m. What is the acceleration of the body?

From $v^2 = u^2 + 2as$ we get $0 = 12^2 + 2a \times 45 \Rightarrow a = -1.6 \text{ m s}^{-2}$.

Q6

A body has an initial velocity of 3.0 m s^{-1} and after travelling 24 m the velocity becomes 13 m s^{-1}. How long did this take?

Use $s = \frac{u+v}{2}t$ to get $24 = \frac{3.0+13}{2}t \Rightarrow t = \frac{48}{16} = 3.0\ \text{s}$.

Q7

What deceleration does a passenger of a car experience if his car, which is moving at 100.0 km h^{-1}, hits a wall and is brought to rest *in 0.100 s? Express the answer in* m s^{-2}.

The speed is $100 \times \frac{10^3}{3600} = 27.8 \text{ m s}^{-1}$. Then from $v = u + at$,

$0 = 27.8 + a \times 0.100 \Rightarrow a = -278 \text{ m s}^{-2}$.

Q8

A car is travelling at 40.0 m s^{-1}. The driver sees an emergency ahead and 0.50 s later slams on the brakes. The acceleration of the car is -4 m s^{-2}.

(a) What distance will the car travel before it stops?

(b) If the driver was able to apply the brakes instantaneously without a reaction time, over what distance would the car stop?

(c) Calculate the difference in your answers to (a) and (b).

(d) Assume now that the car was travelling at 30.0 m s^{-1} instead. Without performing any calculations, would the answer to (c) now be less than, equal to or larger than before? Explain your answer.

Q8 continued

a) The distance traveled before the brakes are applied is $s = 40.0 \times 0.50 = -20$ m. Once the brakes are applied the distance is given from $v^2 = u^2 + 2as$, i.e. $0 = 40^2 + 2 \times (-4.0) \times s \Rightarrow s = 200$ m. The total distance is thus 220 m. (b) 200 m as done in (a). (c) $s = 220 - 200 = 20$ m. (d) It would be less since the speed is less.

Q9

A ball is thrown upwards with a speed of $24.0\ m\ s^{-1}$.

(a) When is the velocity of the ball $12.0\ m\ s^{-1}$?

(b) When is the velocity of the ball $-12.0\ m\ s^{-1}$?

(c) What is the displacement of the ball at those times?

(d) What is the velocity of the ball 1.50 s after launch?

(e) What is the maximum height reached by the ball?

(Take the acceleration due to gravity to be $10.0\ m\ s^{-2}$.)

Q9 continued

(a) From $v = u + at$, $12 = 24 - 10 \times t \Rightarrow t = \frac{12}{10} = 1.2$ s. (b)

$-12 = 24 - 10 \times t \Rightarrow t = \frac{36}{10} = 3.6$ s. (c) At $t = 1.2$ s,

$s = ut + \frac{1}{2}at^2 = 24 \times 1.2 - 5.0 \times 1.2^2 = 21.6$ m and at $t = 3.6$ s,

$s = ut + \frac{1}{2}at^2 = 24 \times 3.6 - 5.0 \times 3.6^2 = 21.6$ m. (d) At $t = 1.50$ s,

$v = u + at = 24 - 10 \times 1.50 = 9.0$ m s^{-1}. (e) From $v^2 = u^2 + 2as$,

$0 = 24^2 - 2 \times 10 \times s \Rightarrow s = \frac{24^2}{20} = 28.8$ m ≈ 29 m.