Checkpoints Chapter 1 Motion Basics

Question 1

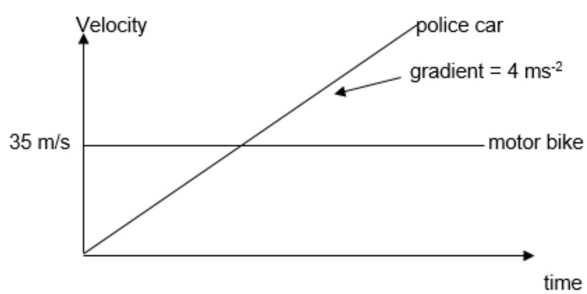
$$\text{Speed} = \frac{\text{distance travelled (km)}}{\text{time taken (hours)}}$$

$$= \frac{2.5}{\frac{92}{60 \times 60}}$$

= 97.8 = **98 km/hr (ANS)**

Question 2

This is one of the many questions that are best done from a graph. You will always try to draw a velocity time graph, because they give you the most information.



The distance travelled is the area under the graph. So this question requires you to find the time 't' when the areas under both graphs are the same.
For the motorbike the area is given by 35 × t.
For the police car, the area is a triangle, $\frac{1}{2}bh$, where b = 't' and h = a × 't'. Because the velocity v = u + at, gives v = at when u = 0.
When the areas are the same then

$\therefore 35t = \frac{1}{2}at^2$

$\therefore 35 = \frac{1}{2} \times 4 \times t$

$\therefore 35 = 2t$

$\therefore t = 17.5$ secs.

The distance that the police car travels must be the same that the motorbike travels, which is

35 × 17.5 = 612.5m, = 613 m

From a sig. fig point of view the answer should be **6×10^2 m (ANS)**

Question 3

17.5 secs (ANS) See answer to question 2.

Question 4

You need to know your formulae to decide which one is best to use. You are given 'a', 'u', 'x' and you want to find 'v'. The only equation to link these is $v^2 - u^2 = 2ax$.
So $v^2 = u^2 - 2ax$ (the equation has a - sign because the ball is slowing down, giving a negative acceleration)

$\therefore v^2 = 6^2 - 2 \times 0.7 \times 24$

$\therefore v^2 = 2.4$

$\therefore v = 1.55$ m/s.

this speed is less than 2 m/s so the ball will drop into the hole.

Question 5

'u' = 0m/s, 'a' = 8.0ms^{-2}, 'x' = 50m, 't' = ??
Use $x = ut + \frac{1}{2}at^2$

$\therefore 50 = 0 + \frac{1}{2} \times 8 \times t^2$

$\therefore t^2 = \frac{50}{4}$

$\therefore t^2 = 12.5$

$\therefore$ **t = 3.5 sec (ANS)**

Question 6

Use $v^2 - u^2 = 2ax$. This equation is best because it is not relying on your answer to the previous question.

$v^2 = 0 + 2 \times 8 \times 50$

$\therefore v^2 = 800$

$\therefore v = 28.3 = 28$ m/s

You need to convert this to km/hr, so multiply by 3.6

$\therefore 28.3 \times 3.6 =$ **102 km/hr (ANS)**

Question 7

The initial velocity = 9 m/s. the final velocity = 0 m/s. 'x' = 4m.
Use $v^2 - u^2 = 2ax$.

$\therefore 0^2 - 9^2 = 2 \times a \times 4$

$\therefore a = -10.125$

= **10.1 ms^{-2} (ANS)**

The minus sign is not really required because it is only showing that the player is slowing down.

Question 8

Use v = u - at $\therefore$ 0 = 9 - 10.1 × t
$\therefore$ t = 0.89
$\therefore$ t = 0.9 secs (ANS)

Question 9

Whenever you see a graph, the first thing you must do is to look at the axes to see what type of graph it is. This is a velocity time graph, so we know that the gradient will give us the acceleration and the area under the graph will tell us the distance travelled.
To find the velocity, you just read it off the graph.
So the speeding car is travelling at 35 m/s. We would expect that this is greater than 90 km/hr, otherwise the car wouldn't be speeding.
To convert from m/s to km/hr, you multiply by 3.6.
So 35 m/s = 35 × 3.6 = 126 km/hr.
The car is speeding by 126 - 90
= **36 km/hr. (ANS)**
(This is great enough for the driver to lose their licence)

Question 10

The acceleration is the gradient of the graph. You always use 'good points' to determine a gradient, ie. points where they are very easy to get the true values.
So use Δt to be from 10 to 70, and Δv to be from 0 to 50 m/s.

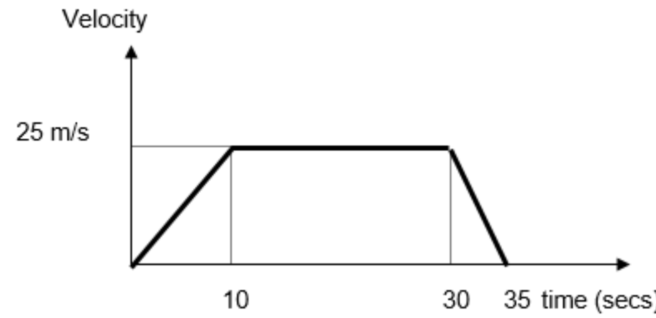
So a = $\frac{\Delta v}{\Delta t} = \frac{50}{60}$ = **0.83 ms^{-2} (ANS)**

Question 11

After 100 secs the car has travelled 35 × 100 = 3.5 km.
After 100 secs the police car has travelled ($\frac{1}{2}$ × 60 × 50) + (50 × 30) = 3.0 km.
So the police car is still 500 m behind the speeding car. (ANS)

Question 12

This question asks you to draw the graph, it must be to scale.



If the cyclist accelerates at 2.5 ms^{-2} for 10 secs, then the maximum speed will be 25 m/s

Question 13

The braking deceleration is the gradient of the graph, note that you are asked for the magnitude, so the sign is not required.

So a = $\frac{\Delta v}{\Delta t} = \frac{25}{5}$ = **5 ms^{-2} (ANS)**

Question 14

This is the area under the graph, and it is
($\frac{1}{2}$ × 25 × 10) + (25 × 20) + ($\frac{1}{2}$ × 25 × 5)
= 687.5
= 690 m (ANS)

Question 15

This is an acceleration v time graph, so the area under the graph is the change in velocity. This means that the question is just asking you to find the area under the graph from
t = 0 to t = 2

Area = $\frac{3+1}{2}$ × 2 = **4 m/s (ANS)**

Question 16

When the speed is constant, implies that the acceleration is zero.
This occurs when **7 < t ≤ 10 secs**. **(ANS)**

This question relies on you understanding the vertical axis, because a common mistake is to say that the velocity is constant when the gradient of the graph is zero, but this is only true if it is a velocity vs time graph.

Question 17

This is the area under the graph from 0 to 10 secs.

From 0 to 2 secs Δv = 4 m/s
From 2 to 6 secs Δv = 4 m/s
From 6 to 7 secs Δv = 0.5 m/s
From 7 to 10 secs Δv = 0 m/s
$\therefore \Delta v$ **= 8.5 m/s (ANS)**

Question 18

You need to have on your cheat sheet some common values of speed in both km/hr and m/s.
Eg. 60 km/hr = 16.7 m/s 100 km/hr = 27.8 m/s

So this question is asking you to find the time when the speed is 16.7 m/s. You are only going to be able to get an approximate answer for this question.
$\approx$ **2.4 ± 0.2 secs (ANS)**
Make sure that you read the horizontal scale accurately. Each division is 0.2 of a second.

Question 19

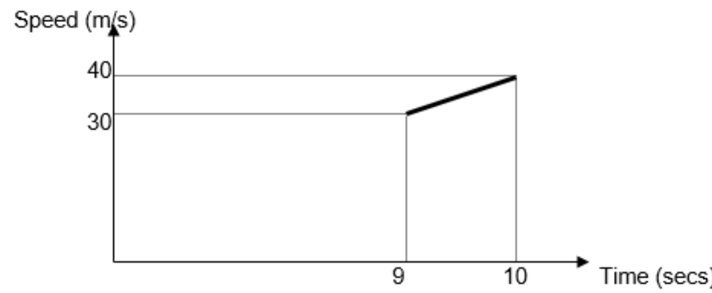
This is a speed vs time graph, so the distance travelled is the area under the graph. You will need to either draw this as a series of straight line graphs, and then find the area of each trapezium, or you can work out the area of each square and count the squares.
To count the squares you need to only count each square that is $\geq \frac{1}{2}$ full.
The area of 8 squares is 5.0 × 1.0 = 5 m.
$\therefore$ 1 square = $\frac{5}{8}$ m.
I count 83 squares so the distance travelled is $83 \times \frac{5}{8}$ = **52 m (ANS)**

Question 20

This requires you to find the gradient of the line at the beginning of the graph. Fortunately it is relatively straight at this point, so the gradient is given by $\frac{\text{rise}}{\text{run}}$.
Draw the straight line and then pick a convenient point on the graph to use with the origin to find the gradient. Choose the point as far from the origin as practical. My line goes through the point 10 m/s at 1.2 secs.
So the gradient is 10 ÷ 1.2
= **8.3 ± 0.5 ms^{-2} (ANS)**

Question 21

Use the equation $x = \frac{(u+v)}{2}t$, but you need to calculate u. It comes from v = u + at.
$\therefore$ 40 = u + 10 × 1
$\therefore$ u = 30 m/s
$x = \frac{(u+v)}{2}t$, $= x = \frac{(30+40)}{2} \times 1$ = 35 m
You can also draw a graph to understand the process involved here.



The area under the graph from t = 9 to t = 10, is $\frac{(30+40)}{2} \times 1$ = **35 m (ANS)**

Question 22

The minimum speed will be zero. This is when the ball reaches the top of its flight. Even though it is still accelerating down at a rate of 10m/s^2. This acceleration is what has slowed the ball down (on the way up) and why it will 'fall' down to Earth again and not remain suspended in mid-air.
Using u= 10m/s, v = 0, a = -10m/s^2,
and v = u + at,
we get 0 = 10 – 10t.
$\therefore$ t = 1 sec.
You **must** make sure that you answer the question, so the answer is **0 m/s** at t = 1 sec.

Question 23

The acceleration at the highest point is **10 m/s^2 down**. The answer in the back of the book is incomplete. You must state a direction for the acceleration, as it is a vector.
I advise against using -10 m/s^2, unless you specifically state that up is the positive direction.

Question 24

Assume that the fact that the ball just reaches the hole, (note it doesn't say that it falls in), means that the velocity after 32m is zero.
$v^2 = u^2 - 2ax$. The negative in the equation is because the acceleration must be negative, otherwise the ball would speed up.

$\therefore\ 0 = u^2 - 2 \times 1 \times 32$

$\therefore\ u^2 - 64 = 0$

$\therefore$ **u = 8 m/s (ANS)**

Question 25 (2013 Q1, 2m, 75%)

There are two ways of answering this question.

Method 1

Use $a = g\sin\theta$

$\therefore\ a = 10 \times \sin 10$

$\therefore$ **a = 1.7 ms^{-2} (ANS)**

Method 2

Use $x = ut + \frac{1}{2}at^2$

$\therefore\ 3.5 = \frac{1}{2} \times a \times 2^2$

$\therefore\ a = 1.75\ ms^{-2}$ **(ANS)**

Both methods and both answers were acceptable.

Question 26 (2014 Q1a, 2m, 83%)

Use $x = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2} \times 0.2 \times 5^2$

$= 0.5 \times 0.2 \times 25$

$= 2.5$ m

$\therefore$ **x = 2.5 m (ANS)**
