Answers to examination-style questions

Answers	Marks	Examiner's tips
1 **(a)** 100 km $h^{-1} = \frac{100 \times 1000}{3600} = 27.8$ m s^{-1}	1	Consistent units must be substituted in the uniform acceleration equations.
using $v = u + a\,t$ gives $27.8 = 0 + 5.8\,a$	1	100 km h^{-1} must be changed into m s^{-1}.
∴ acceleration $a = 4.8$ m s^{-2}	1	
(b) using $s = \frac{1}{2}(u + v)t$ gives $s = \frac{1}{2}(0 + 27.8) \times 5.8$	1	When using the uniform acceleration equations, it is safest to summarise all the quantities you know at the start and identify the ones you need to calculate. This makes it easier to choose the most appropriate equation.
∴ distance $s = 81$ m	1	
2 **(a)** AB: uniform acceleration	1	Acceleration is the gradient of a v-t graph; here it is positive and constant.
BC: constant velocity	1	The gradient is zero, and so the acceleration is zero and the velocity is not changing.
CD: uniform deceleration	1	The gradient is negative and constant; the velocity is decreasing uniformly with time.
DE: stationary	1	The gradient is zero **and** the velocity is also zero.
EF: uniform acceleration in the opposite direction	1	The gradient is negative and constant, whilst the velocity is negative and increasing uniformly.
(b) displacement is equal to the area enclosed by the graphs and the time axis	1	This is another feature of a v-t graph that you need to know.
(c) distance is a scalar and is represented by the total area under both the positive and negative portions of the graph	1	The toy train travels a certain distance forward and stops. It then travels an equal distance backwards, returning to its starting point. Its displacement from the starting point is zero but it has travelled a distance out, and the same distance back.
whereas displacement is a vector and the areas above and below the $v = 0$ line are equal and therefore cancel	1	
3 **(a)** using $v = u + a\,t$ gives $12 = 4 + 6.0\,a$	1	**Or** use $\frac{\Delta v}{\Delta t}$.
∴ acceleration $a = 1.3$ m s^{-2}	1	
(b) *Graph to show*: • axes labelled 'speed/m s^{-1}' (vertically) and 'time/s' (horizontally) with points (0, 4) and (6, 12) both marked • these two points joined by a straight line	2	By convention, time is plotted horizontally. You are told that the acceleration is uniform, meaning that the line must have a constant gradient (i.e. be straight).
(c) distance travelled = area under graph	1	In this example the area is that of a trapezium instead of a simple triangle. This solution is equivalent to using $s = \frac{1}{2}(u + v)t$.
= area of trapezium with vertical sides of 4 m s^{-1} and 12 m s^{-1} $= \frac{1}{2} \times (4 + 12) \times 6.0$ = 48 m	1	

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4 (a) (i) using $v = u + a\,t$ gives $0 = 4.5 + 3600\,a$	**1**	Note that 1 h = 3600 s. A deceleration is a negative acceleration. A negative value for a (which comes from a correct substitution into $v = u + a\,t$) leads to a positive value for deceleration.
∴ acceleration $a = -1.3 \times 10^{-3}$ m s^{-2} and deceleration = 1.3×10^{-3} m s^{-2}	**1**	
(ii) using $s = \frac{1}{2}(u + v)t$ gives $s = \frac{1}{2}(4.5 + 0) \times 3600$	**1**	'While slowing to a stop' means 'until its final speed v is 0'.
∴ distance $s = 8100$ m	**1**	
(b) *Graph to show*: • axes labelled 'distance/m' (vertically) and 'time/s' (horizontally) and line showing distance increasing with time • gradual curve of decreasing slope	**2**	It is important to show clearly what you are plotting by labelling the axes properly. The speed of the tanker is assumed to decrease uniformly. Speed is equal to the gradient of a distance-time graph; hence the gradient decreases. If the line is drawn properly, the final part ought to be horizontal.
(c) *Relevant points include*: • gradient of graph = speed • speed decreases giving a decreasing gradient • gradient is zero when stationary	**2**	
5 (a) (i) using $v = u + a\,t$ gives $29 = 0 + 2.0\,a$	**1**	Part **a** gives further practice in the use of the uniform acceleration equations. In **(iii)** the cheetah is moving at constant speed, so the simpler equation 'distance = (speed) × (time)' suffices. Interestingly, the cheetah is accelerating at about 1.5 g.
∴ acceleration $a = 14.5$ m s^{-2}	**1**	
(ii) using $s = \frac{1}{2}(u + v)t$ gives $s = \frac{1}{2}(0 + 29) \times 2.0 = 29$ m	**1**	
(iii) using distance =(speed) × (time) gives s = 29 × 15 = 435 m	**1**	
(b) (i) *Second graph drawn to show*: • starting at 0.5 s (i.e. reaction time) • straight line from (0.5, 0) to (2.5, 25) • horizontal straight line beyond 2.5 s	**3**	This graph is of a similar shape to the original one, but it starts later and is lower, displaced to the right.
(ii) distance travelled by antelope in 17 s $= (\frac{1}{2} \times 2.0 \times 25) + (14.5 \times 25)$	**1**	Distance travelled = area under graph. The area under the graph consists of a triangle and a rectangle.
= 387.5 (= 390) m	**1**	
(iii) distance travelled by cheetah in 17 s $= (\frac{1}{2} \times 2.0 \times 29) + (15 \times 29) = 464$ m; distance apart = (100 + 387.5) – 464 = 23.5 (= 24) m	**1**	You have to do a lot of work for this last mark. The steps taken in **(ii)** are repeated, but this time for the cheetah, and then you must remember that the antelope was 100 m ahead of the cheetah at the start.
6 (a) Using $s = u\,t + \frac{1}{2}a\,t^2$ gives $35 = 0 + (\frac{1}{2} \times a \times 2.7^2)$	**1**	The lump of lead is released (not thrown downwards), telling you that its initial velocity u is zero. s and t are known; you have to find a.
∴ acceleration of free fall g (= a) = 9.6 m s^{-2}	**1**	

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(b) a lower value would be obtained for *g* because air resistance has a greater effect on the tennis ball resulting in a smaller resultant downwards force on the tennis ball	1 1 1	Strictly speaking, an object is in free fall only if there is **no** air resistance. Although these two objects are the same size, air resistance has a much greater effect on the tennis ball because it is lighter.
(c) *Second graph to show*: • a curve of decreasing gradient, always below the original line • initial gradient the same as the original line, but second graph finishing at a later time	2	The tennis ball experiences a decreasing acceleration: hence its velocity continues to increase but by progressively smaller amounts. The tennis ball therefore takes a longer time to fall to the ground.
7 (i) horizontal velocity remains 70 m s^{-1}	1	If air resistance is ignored, the horizontal velocity must be unaffected.
(ii) using $v = u + a\,t$ gives vertical velocity $v_V = 0 + (9.81 \times 2.0)$ $= 19.6$ m s^{-1}	1 1	The vertical motion is accelerated at *g*, which is constant. The uniform acceleration equations can therefore be applied.
(iii) resultant velocity $V = \sqrt{(v_v{}^2 + v_H{}^2)}$ $= \sqrt{(19.6^2 + 70^2)} = 73$ m s^{-1} direction is given by $\tan\theta = \frac{19.6}{70}$ from which $\theta = 15.6°$ to the horizontal	1 1	The resultant velocity is found by adding its vector components. A quick sketch of the vectors may help you to see which trigonometric ratio to use.