M1 – KINEMATICS PPQ's

PART A – Constant Acceleration FORMULAE

June 07

1. In taking off, an aircraft moves on a straight runway AB of length 1.2 km. The aircraft moves from A with initial speed 2 m s^{-1}. It moves with constant acceleration and 20 s later it leaves the runway at C with speed 74 m s^{-1}. Find

(*a*) the acceleration of the aircraft,

(2)

(*b*) the distance BC.

(4)

Jan 06

1. A stone is thrown vertically upwards with speed 16 m s^{-1} from a point h metres above the ground. The stone hits the ground 4 s later. Find

(*a*) the value of h,

(3)

(*b*) the speed of the stone as it hits the ground.

(3)

January 2007

5. A ball is projected vertically upwards with speed 21 m s^{-1} from a point A, which is 1.5 m above the ground. After projection, the ball moves freely under gravity until it reaches the ground. Modelling the ball as a particle, find

(a) the greatest height above A reached by the ball,

(3)

(b) the speed of the ball as it reaches the ground,

(3)

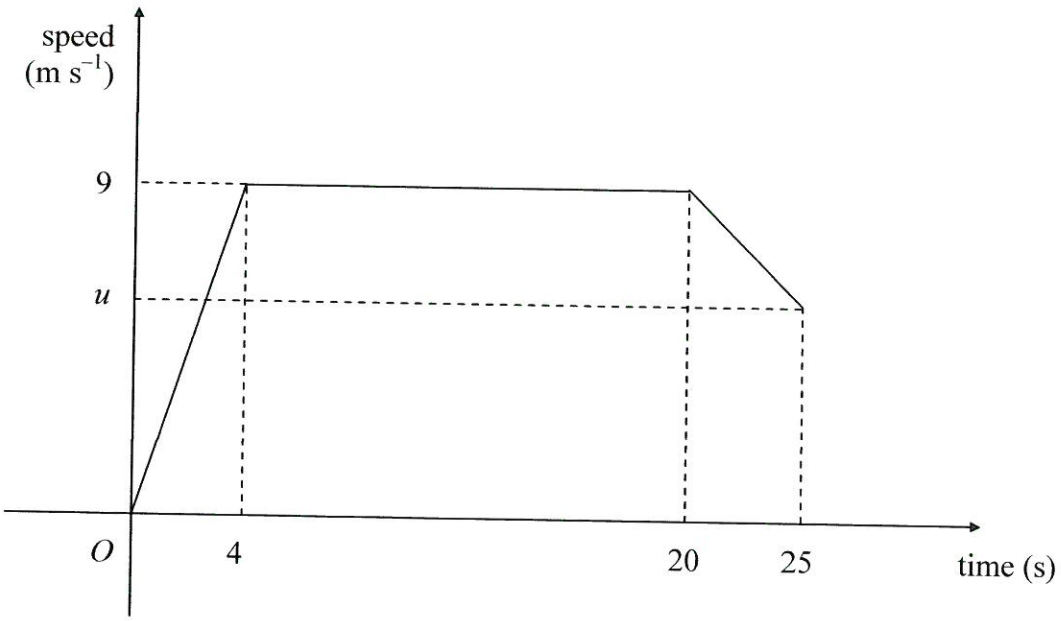
(c) the time between the instant when the ball is projected from A and the instant when the ball reaches the ground.

(4)

PART B - VELOCITY - TIME GRAPHS

3.

Figure 2



JANUARY 05

A sprinter runs a race of 200 m. Her total time for running the race is 25 s. Figure 2 is a sketch of the speed-time graph for the motion of the sprinter. She starts from rest and accelerates uniformly to a speed of 9 m s^{-1} in 4 s. The speed of 9 m s^{-1} is maintained for 16 s and she then decelerates uniformly to a speed of u m s^{-1} at the end of the race. Calculate

(*a*) the distance covered by the sprinter in the first 20 s of the race,

(2)

(*b*) the value of u,

(4)

(*c*) the deceleration of the sprinter in the last 5 s of the race.

(3)

5. A train is travelling at 10 m s^{-1} on a straight horizontal track. The driver sees a red signal 135 m ahead and immediately applies the brakes. The train immediately decelerates with constant deceleration for 12 s, reducing its speed to 3 m s^{-1}. The driver then releases the brakes and allows the train to travel at a constant speed of 3 m s^{-1} for a further 15 s. He then applies the brakes again and the train slows down with constant deceleration, coming to rest as it reaches the signal.

JUNE 2005

(*a*) Sketch a speed-time graph to show the motion of the train.

(3)

(*b*) Find the distance travelled by the train from the moment when the brakes are first applied to the moment when its speed first reaches 3 m s^{-1}.

(2)

(*c*) Find the total time from the moment when the brakes are first applied to the moment when the train comes to rest.

(5)

M1 KINEMATICS PPQ's.

JUNE 05 Q1

$u = 2 \quad v = 74 \quad t = 20 \quad s = 1200$

(a) $v = u + at$

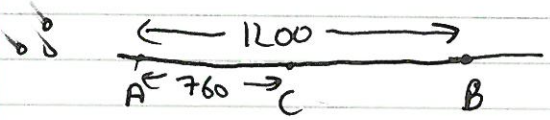
$74 = 2 + 20a$ M1

$a = \frac{72}{20} = 3.6 \text{ ms}^{-2}$ A1

(b) $s = ?$ $\quad s = ut + \frac{1}{2}at^2$

M1 A1

$s = (2 \times 20) + \frac{1}{2} \times 3.6 \times 20^2 = 760 \text{ m.}$ A1



$\therefore BC = 1200 - 760 = 440 \text{m.}$ B1

[6]

M1 JAN 06 Q1

(a) $u = 16 \uparrow$ $a = 9.8 \downarrow$ $s = h \downarrow$ $t = 4$

$= -16 \downarrow$

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

$h = (-16 \times 4) + \frac{1}{2} \times 9.8 \times 4^2$ M1 A1

$h = 14.4$ metres. A1

(b) $V = ? \downarrow$ $V = -16 + (9.8 \times 4) = 23.2 ms^{-1}$

M1 A1 A1

M/6

M1 JAN 06 Q5

(a) $u = 21\uparrow \quad a = 9.8\downarrow = -9.8\uparrow \quad V = 0 \quad s_{max} = ?\uparrow$

$v^2 = u^2 + 2as$

$0^2 = 21^2 + 2 \times -9.8 \times s_{max}$ M1 A1

$19.6 s_{max} = 21^2$

$s_{max} = \frac{21^2}{19.6} = 22.5$ metres A1

(b) $u = 21\uparrow \quad a = 9.8\downarrow \quad v = ?\downarrow \quad s = 1.5\downarrow$

$= -21\downarrow$

$v^2 = u^2 + 2as$

$v^2 = (-21)^2 + 2 \times 9.8 \times 1.5$ M1 A1

$v^2 = 470.4$

$v = 21.7\ ms^{-1}$ A1

(c) $u = 21\uparrow \quad v = 21.7\downarrow \quad a = 9.8\downarrow \quad t = ?$

$= -21\downarrow$

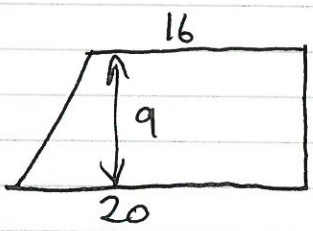
$v = u + at$

$21.7 = -21 + 9.8t$ M1 A1 A1

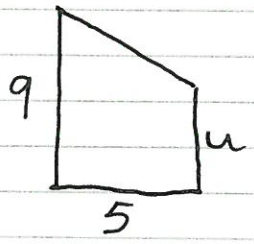
$t = 4.4$ seconds. A1

M/10

M1 Jan 07 Q3

(a) 

$\text{Dist} = \frac{(20+16)}{2} \times 9 = 162$ metres M1 A1

(b) 

Area: $200 - 162 = 38$ M1

$38 = \frac{(9+u)}{2} \times 5$ M1 A1

$\frac{76}{5} = 9+u$

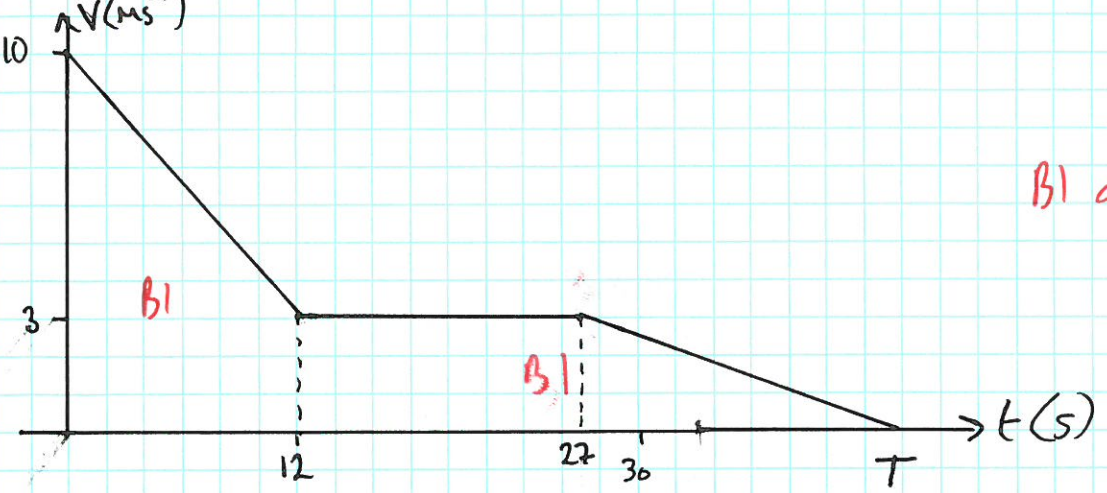
$u = 15.2 - 9 = 6.2\ ms^{-1}$ A1

(c) decel = gradient = $\frac{9-6.2}{5} = 0.56\ ms^{-2}$ M1 A1 A1

(M/9).

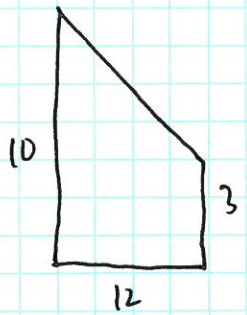
M1 JUNE 05 Q5

(a)



B1 axes labels

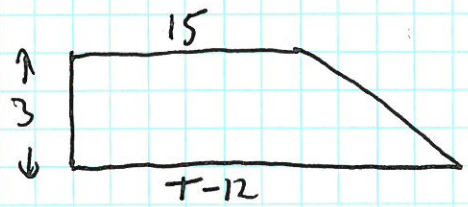
(b)



Distance = Area = $\frac{(10+3)}{2} \times 12 = 78$ metres. M1 A1

(c) Total Dist travelled = 135m

∴ Remaining Dist = 135 − 78 = 57m. B1



$57 = \frac{(15 + T - 12)}{2} \times 3$ M1 A1

$\frac{57 \times 2}{3} = T + 3$ A1

$T = 38 - 3 = 35$ sec. A1

M/10.