Leave blank

2. A firework rocket starts from rest at ground level and moves vertically. In the first 3 s of its motion, the rocket rises 27 m. The rocket is modelled as a particle moving with constant acceleration a m s^{-2}. Find

(a) the value of a,

(2)

(b) the speed of the rocket 3 s after it has left the ground.

(2)

After 3 s, the rocket burns out. The motion of the rocket is now modelled as that of a particle moving freely under gravity.

(c) Find the height of the rocket above the ground 5 s after it has left the ground.

(4)

a) $s = 27\text{m}$, $t = 3\text{s}$, $u = 0$

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

$27 = 0 + \frac{1}{2}a(3)^2$

$27 = \frac{9}{2}a$

$a = \frac{27 \times 2}{9} = 6\ \text{ms}^{-2}$

b) $v = u + at$ $\quad v = 0 + 6(3)$

$v = 18\ \text{ms}^{-1}$

c) Restart clock from $t = 3$ back to $t = 0$

$s - s_0 = ut + \frac{1}{2}at^2$ $\quad t = 2$

$s - 27 = 18(2) - 4.9(2)^2$

$s = 36 - 19.6 + 27$

$s = 43.4\text{ m}$ above ground

Leave blank

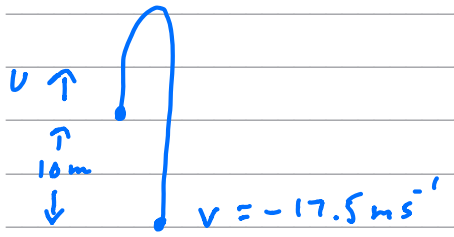
2. At time $t = 0$, a particle is projected vertically upwards with speed u m s^{-1} from a point 10 m above the ground. At time T seconds, the particle hits the ground with speed 17.5 m s^{-1} . Find

(a) the value of u,

(3)

(b) the value of T.

(4)



a) $v^2 = u^2 + 2a(s - s_0)$

$(-17.5)^2 = u^2 - 19.6(0-10)$

$306.25 = u^2 + 196$

$306.25 - 196 = u^2$

$110.25 = u^2$

$u = 10.5 \text{ ms}^{-1}$

b) $v = u + at$

$-17.5 = 10.5 - 9.8T$

$9.8T = 28$

$T = \frac{28}{9.8}$

$T = 2\frac{6}{7}$ s

Leave blank

2. A small ball is projected vertically upwards from ground level with speed u m s^{-1}. The ball takes 4 s to return to ground level.

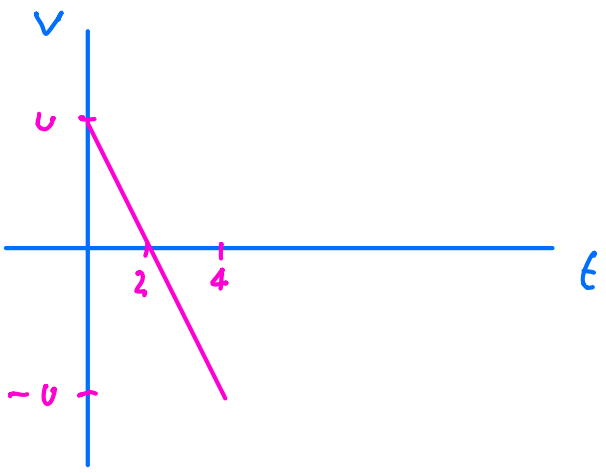
(a) Draw, in the space below, a velocity-time graph to represent the motion of the ball during the first 4 s.

(2)

(b) The maximum height of the ball above the ground during the first 4 s is 19.6 m. Find the value of u.

(3)

a)



b)

$a = -9.8$

$s = 19.6\text{m}$

$v = 0$

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

$0 = u^2 - 19.6(19.6)$

$19.6^2 = u^2$

$u = 19.6\ \text{ms}^{-1}$

Leave blank

6. A ball is projected vertically upwards with a speed of 14.7 m s^{-1} from a point which is 49 m above horizontal ground. Modelling the ball as a particle moving freely under gravity, find

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

(4)

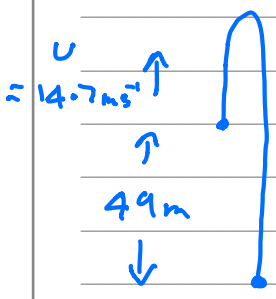
(b) the speed with which the ball first strikes the ground,

(3)

(c) the total time from when the ball is projected to when it first strikes the ground.

(3)

a)



$v^2 = u^2 + 2a(s - s_0)$

At top $v = 0$

$0 = 14.7^2 - 19.6(s - 49)$

$19.6(s - 49) = 14.7^2$

$s = \frac{14.7^2}{19.6} + 49 \quad = 60.0 \text{ m}$

b)

$v^2 = u^2 + 2a(s - s_0)$ $\quad v^2 = 14.7^2 - 19.6(0 - 49)$

$v^2 = 14.7^2 + 19.6 \times 49$

$v^2 = 1176.49$

speed $\quad v = 34.3 \text{ ms}^{-1}$

c) $v = u + at$

$34.3 = 14.7 - 9.8t$

$9.8t = 14.7 + 34.3$

$t = \frac{49}{9.8} = 5 \text{ s}$ $\quad t = 5 \text{ s}$