Practice Probs Kinematics *[16 marks]*

Markscheme

1a. This question is about kinematics. *[3 marks]*

Fiona drops a stone from rest vertically down a water well. She hears the splash of the stone striking the water 1.6 s after the stone leaves her hand. Estimate the

(i) distance between Fiona's hand and the water surface.

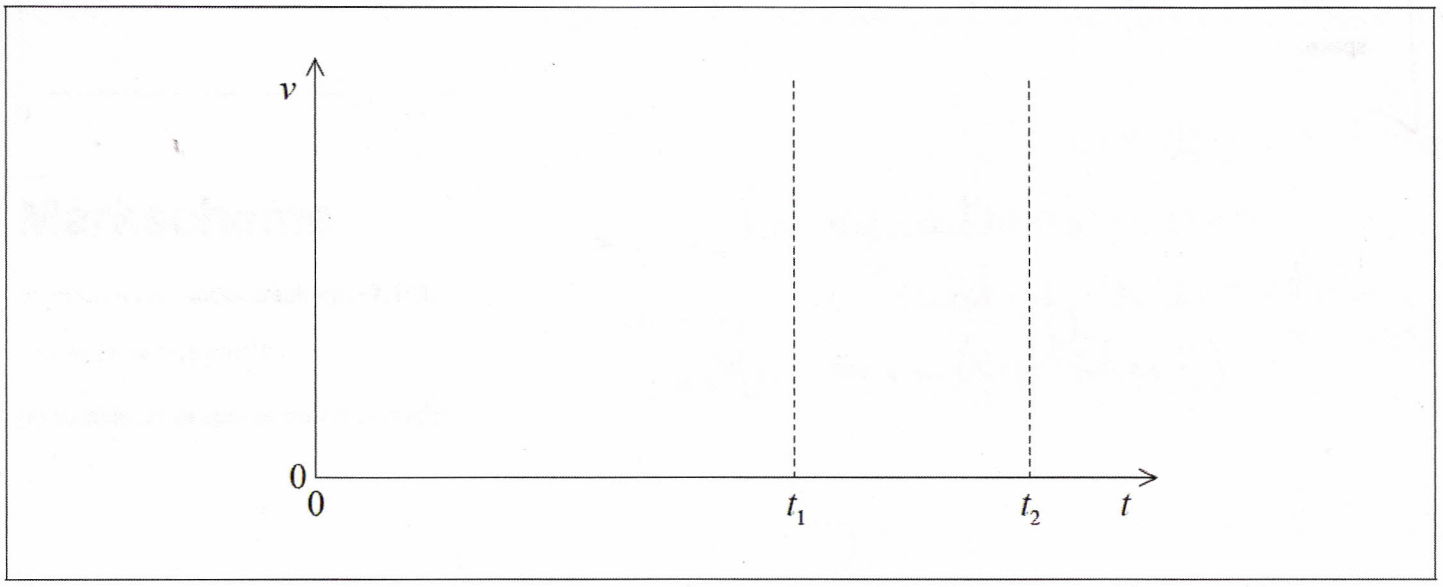
(ii) speed with which the stone hits the water.

Markscheme

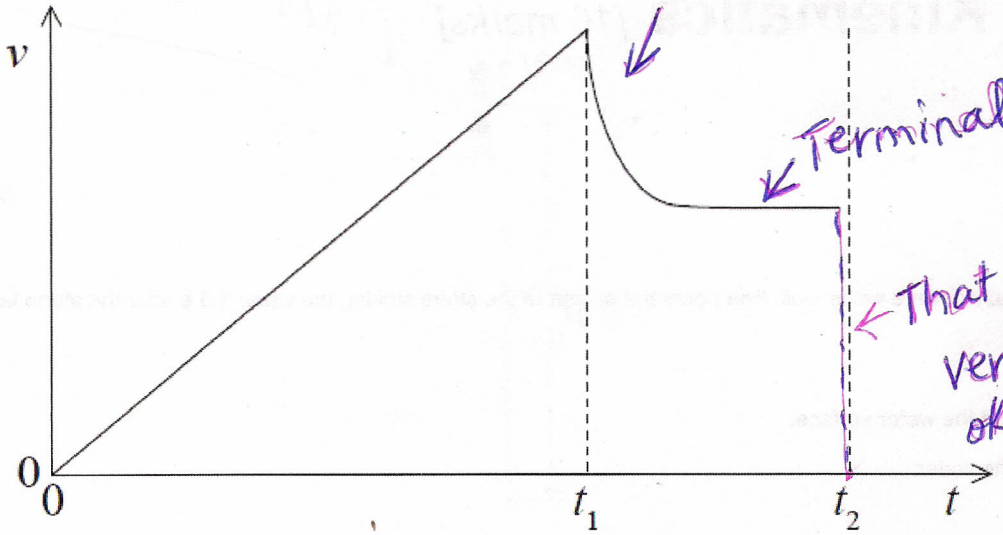
(i) s=12.5/12.6 (m);
Allow g =10ms^{-2} , answer is 12.8.

(ii) $v = \sqrt{2gs}$ ***or*** *gt; (allow any use of suvat equations)*
$= \left(\sqrt{2 \times 9.8 \times 12.5} =\right) 15.7\ (\text{ms}^{-1})$;
*Award **[2]** for a bald correct answer.*
Allow g = 10ms^{-2} answer is 16.0 ms^{-1}.
Allow ECF from (a)(i)

1b. After the stone in (a) hits the water surface it rapidly reaches a terminal speed as it falls through the water. The stone leaves *[3 marks]*
Fiona's hand at time $t = 0$. It hits the water surface at t_1 and it comes to rest at the bottom of the water at t_2. Using the axes below, sketch a graph to show how the speed v of the stone varies from time $t = 0$ to just before $t = t_2$. (There is no need to add any values to the axes.)



Markscheme



Slowing down

Terminal Velocity

That nearly vertical line is okay, too, but not necessary for full marks

1b

straight line to water surface; *(allow a slight curve within 10 % of t_1)* clear decrease after hitting surface; (*allow straight line or concave curve as shown, do not allow convex curve*)

constant non-zero speed reached smaller than maximum; (*speed must be less than maximum velocity*)

Do not penalize answers where a curve is drawn to the dotted lines as there should not be a discontinuity at the two lines. Do not penalize if the line continues to t_2 or zero velocity shown at t_2.

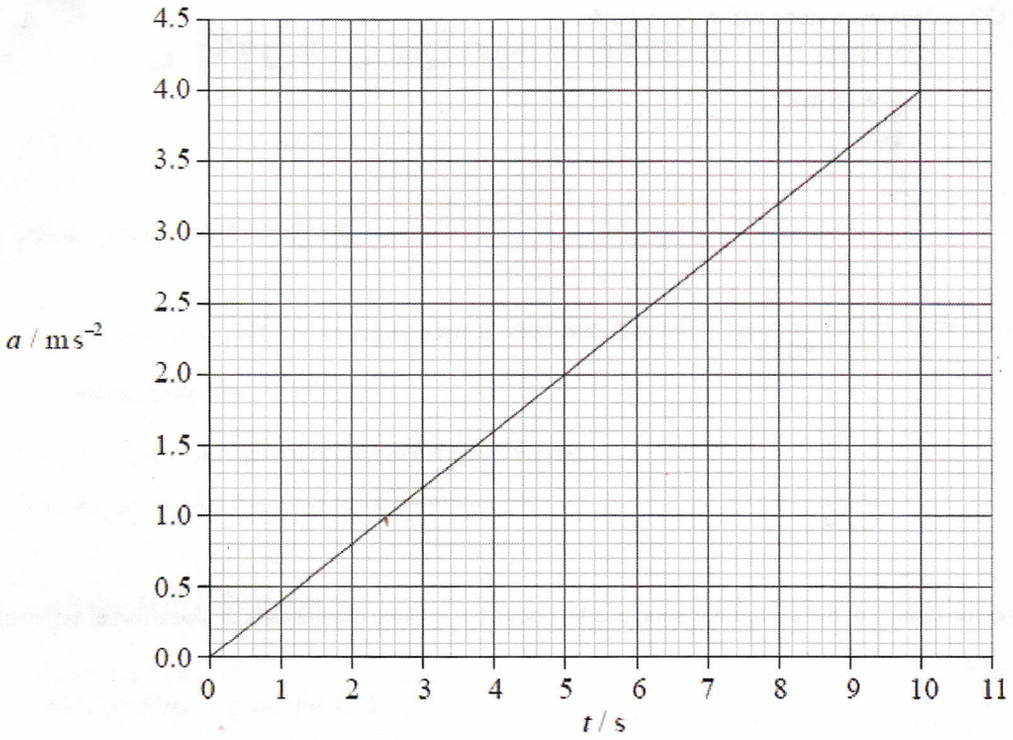
2a. This question is about kinematics. *[2 marks]*

State the difference between average speed and instantaneous speed.

Markscheme

average speed is the speed over a period of time/distance; instantaneous speed is the speed at a particular instant in time/point in space.

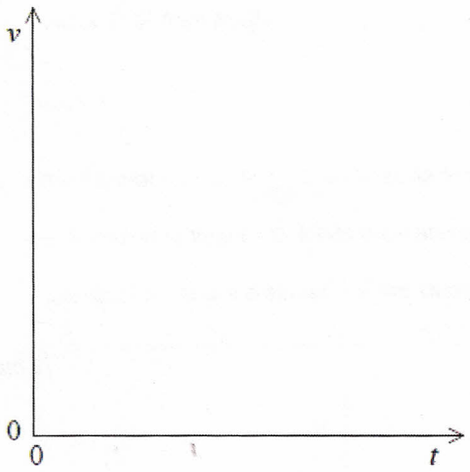
e graph shows how the acceleration a of a particle varies with time t. *[3 marks]*



At time $t = 0$ the instantaneous speed of the particle is zero.

(i) Calculate the instantaneous speed of the particle at $t = 7.5$ s.

(ii) Using the axes below, sketch a graph to show how the instantaneous speed v of the particle varies with t.



Markscheme

(i) speed=(area under graph =)½×7.5×3;

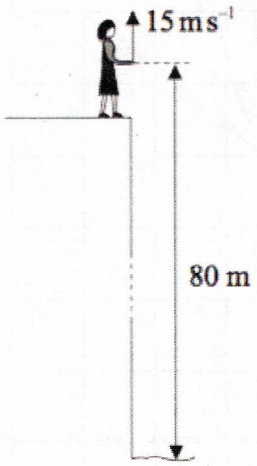
=10 ***or*** 11 ***or*** 11.3 (ms^{-1});

(ii) suitable curve approximating to $v=kt^2$;

Kinematic equations can only be used if acceleration is uniform (constant)

3a. This question is about kinematics. *[2 marks]*

Lucy stands on the edge of a vertical cliff and throws a stone vertically upwards.



The stone leaves her hand with a speed of 15ms^{-1} at the instant her hand is 80m above the surface of the sea. Air resistance is negligible and the acceleration of free fall is 10ms^{-2}.

Calculate the maximum height reached by the stone as measured from the point where it is thrown.

Markscheme

$h = \frac{v^2}{2g}$;

$= \left(\frac{225}{20} =\right) 11\text{m}$;

*Award **[1 max]** for 91m or 91.25m (candidate adds cliff height incorrectly).*

3b. Determine the time for the stone to reach the surface of the sea after leaving Lucy's hand. *[3 marks]*

Markscheme

time to reach maximum height=1.5s;

time to fall 91m=4.3s;

total time=5.8s;

Answer can be alternatively expressed as 3.0 (to return to hand) +2.8 (to fall 80m).

or

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

$80=-15t+5t^2$ or $-80=15t-5t^2$;

t=5.8s;