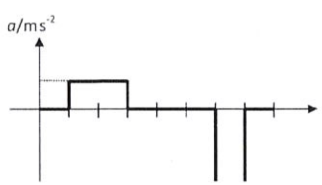
1 **Ans: C**

Reasoning:

One can plot the corresponding velocity-time graph and calculate its area to obtain the displacement of the object.

Within the first 3 s,
the object gains a speed of



$v = u + at$

$v = 0 + 1 \times 2$

$v = 2 \text{ m s}^{-1}$

For the next 3 s,
the object maintains the same speed.

Finally, between 6 s and 7 s,
it experiences deceleration.

$v = u + at$

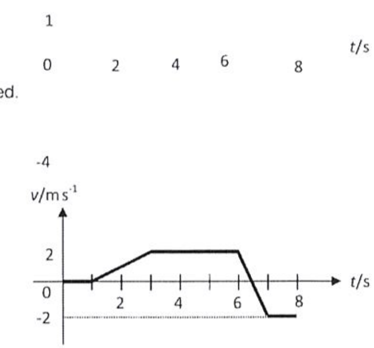
$v = 2 + (-4 \times 1)$

$v = -2 \text{ m s}^{-1}$

Total area under graph

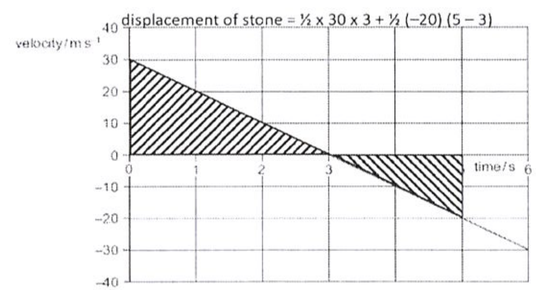
$= \frac{1}{2} \times 2 \times 2 + (3 \times 2) + (-2 \times 1)$

$= 6 \text{ m}$



2 **Ans: B**

Reasoning: area under velocity-time graph = displacement



3 **Ans: B**

Reasoning: The acceleration-time graph is obtained from the velocity-time graph. Point **B** is the turning point of the velocity-time graph and so is the maximum value.

4 **Ans: D**
Reasoning: According to the convention adopted, the velocity should be positive before the bounce and negative after the bounce.

5 **Ans: A**
Reasoning: Both balls are dropped 1 second apart, the ball dropped a second earlier would just have accelerated for a second more. The difference in velocity is a constant and the value (if you need to know) is 9.81 m s^{-1}

6 **Ans: C**
Reasoning:
After 2.0 s, the ball acquires a velocity of $v = u + at$
$= 0 + (4.9)(2.0)$
$= 9.8$ m s^{-1} upwards.

Taking the downward direction as positive and using $s = ut + (1/2)at^2$ and $a = g$ since the ball the acceleration due to gravity alone.

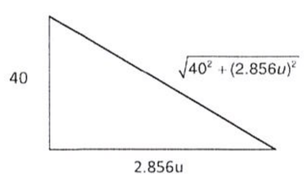
$1.2 = -9.8t + (1/2)gt^2$
$t = 2.1$ s

7 **Ans: D**
Reasoning: Given parameters s= 200 m, u = 10 m s^{-1} , v = 16 m s^{-1}
Using $v^2 = u^2 + 2as$
$16^2 = 10^2 + 2a(200) \rightarrow a = 0.39$ m s^{-2}

8 **Ans: A**
Reasoning:

$$s = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2(40)}{9.81}} = 2.856 \text{ s}$$

$$v_{sound} = 343 = \frac{\sqrt{40^2 + (2.856u)^2}}{(3.00 - 2.856)}$$



$$u = \frac{\sqrt{[(343)(3.00 - 2.856)]^2 - 40^2}}{2.856}$$

u = 10.2 m s^{-1}

9 **Ans: D**

Reasoning: Fraction = $\frac{(u\sin\theta)^2}{u^2} = \sin^2\theta$

10 **Ans: C**
Reasoning:
vertically,
$v_y^2 = u_y^2 + 2a_ys_y$
$v_y^2 = (-50.0 \sin 30.0°)^2 + 2(9.81)(30)$
$v_y = 34.8$ m s^{-1}

horizontally,
$v_x = (50.0 \cos 30.0°) = 43.3$ m s^{-1}

tan θ = 43.3/ 34.8
θ = 51.2°

11. (a) Vertical components:
$s = ut + \frac{1}{2}gt^2 = \frac{1}{2} \times 9.81 \times 2.2^2$
$s = 23.7$ m

(b) Vertical components:
$v_y = u_y + at = 9.81 \times 2.2$
$v_y = 21.6$ ms^{-1}

(c) To calculate the depth of the dive when he is brought to rest underwater:
Vertical components:
$v_y^2 = u_y^2 + 2as$
$s = \frac{v_y^2 - u_y^2}{2a} = \frac{0 - 21.582^2}{2(-25)}$
$s = 9.3$ m < 15 m
∴ the man will survive.

12 (a) **1.** Air resistance is negligible.
2. The acceleration of free fall is uniform.

(b)(i) Taking upwards as positive and the time of collision to be t. The displacement is considered to be zero at the gun level.

$s_y = (v_o \sin\theta)t - \frac{1}{2}gt^2$

$s_x = (v_o \cos\theta)t$

(ii) Taking upwards as positive and the time of collision to be t. The displacement is considered to be zero at the gun level and the target's initial vertical displacement is d.

$$s_y' = d - \frac{1}{2}gt^2$$

(iii) Hence show that the projectile will hit the target.

For the projectile to hit the target, $s_y = s_y'$. Which means by comparison,

$(v_o \sin\theta)\,t = d$

Since $s_x = (v_o \cos\theta)\,t$, $t = \dfrac{s_x}{v_o \cos\theta}$

Since the horizontal displacement is s_x and the vertical initial vertical displacement of target is *d*, $\tan\theta = \dfrac{d}{s_x}$

$(v_o \sin\theta)\,t = (v_o \sin\theta)\dfrac{s_x}{v_o \cos\theta} = s_x \tan\theta = s_x(\dfrac{d}{s_x}) = d$ (Shown)

13 (a) Neglecting air resistance, the velocity at which the ball leaves the hand and the velocity when it returns to the same hand are equal in magnitude but opposite in direction. Hence, v = -u.

Using	v = u + at	and taking upwards as +.
we have	-u = u + (-9.81)(3.5)	
therefore	2u = 34.3	
⇒	u = 17.2 m s^{-1}.	

Therefore, initial speed of the ball is 1.2 m s^{-1}.

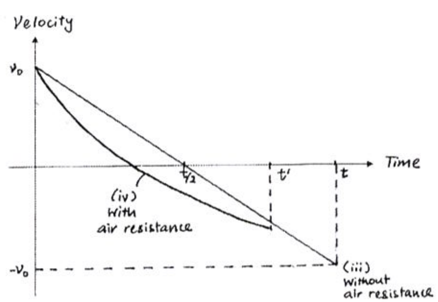
Note: The value of u can be negative if downwards displacement is taken to be +ve. But the answer for speed has to be positive.

(b) At maximum height, $v = 0$ m s^{-1}

Using $v^2 - u^2 = 2as$

$$\Rightarrow \quad s = \frac{v^2 - u^2}{2a} = \frac{(0 ms^{-1})^2 - (17.2 ms^{-1})^2}{2(-9.81 ms^{-2})} = 15.0 \text{ m}$$

(c) & (d)



14 **(a)** *s* = area under the velocity-time graph

s = area of trapezium = $\dfrac{(a+b)}{2}h$ or $s = ut + \dfrac{(v-u)}{2}t$

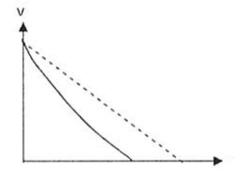
$s = \dfrac{(u+v)}{2}t$

(b)

(i) height = area under graph = $\dfrac{1}{2} \times 25 \times 2.5$

= 12.5 = 13 m (2 s.f.)

(ii)



Shape of graph
Time taken is shorter

15.(a)

(i)

(ii)

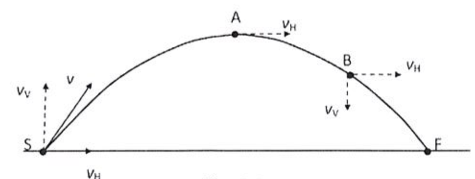
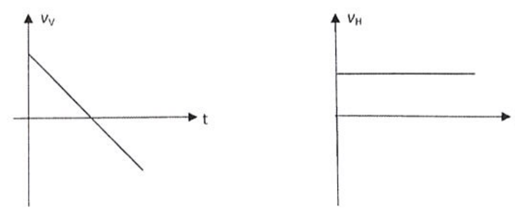


Fig. 2.2

Magnitude of v_H should remain constant. v_v at B is shorter than that at S.

Taking upwards as positive

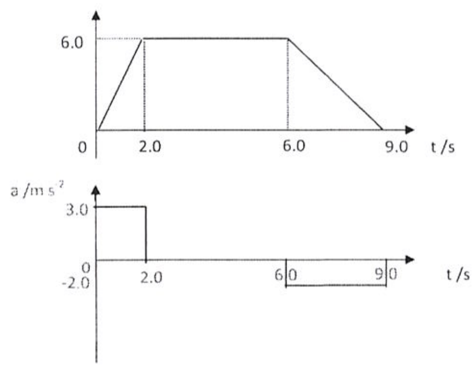
(b)(i)



Area under the graph should be same for upwards and downwards motion.

(b)(ii) The gradient of the v_v against t graph will increase at first and then decrease. The graph will be a curve. Air resistance will increase the deceleration of the ball when it is moving upwards, and decrease the acceleration when it is moving downwards. The v_v will reach zero velocity at a shorter time and the area under graph before v_v = 0 will be smaller.

16 (a)



(b) (i). Vertically:
Using $s = ut + \frac{1}{2} gt^2$ [u = 0 as bomb is released]

$3000 = \frac{1}{2} (9.81)\, t^2$
t = 24.7 s

ii) Consider bomb horizontally:
S = ut
= 150 x 24.7
= 3.71 km OR 3705 m

Consider vessel horizontally:
S = ut
(4000 – 3710) = u (24.7)
u = 11.7 m s^{-1}

OR (4000 – 3705) = u (24.7) = 11.9 m s^{-1}

(iii) Consider vessel horizontally:
$S = ut + \frac{1}{2} at^2$
$= 11.7 (24.7) + \frac{1}{2} (1.2)(24.7)^2$
= 655 m

OR $S = ut + \frac{1}{2} at^2$
$= 11.9 (24.7) + \frac{1}{2} (1.2)(24.7)^2$
= 660 m

the vessel will be just 655 -(4000 – 3710) = 365 m passed the bomb, which is out of the diameter of 50 m.
therefore the vessel will be able to escape damage.
OR
the vessel will be just 660 -(4000 – 3705) = 365 m passed the bomb, which is out of the diameter of 50 m.
therefore the vessel will be able to escape damage.

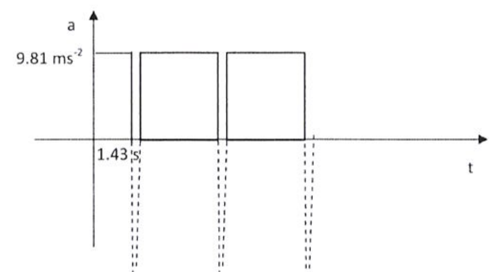
17

(a) Using $s = ut + \frac{1}{2}at^2$ where s = 10.0 m, u = 0 m s^{-1} and a = 9.81 m s^{-2}

$10.0 = \frac{1}{2}(9.81)t^2$

t = 1.43 s → Time taken is 1.43 s

(b)



(c) The horizontal part of the graph will get shorter with each consecutive bounce. The peak negative acceleration gets smaller.

18 **(a)** The student should record to 1 decimal place as the uncertainty in time is 0.1 s.

(b) Triangle B. The area under the graph represents the vertical displacement of the projectile. Triangle A represents the distance between the top of the table and the top of the path while triangle B represents the distance between the top of the path and the ground. Since the distance between the top of the path and the ground is larger than the distance between the top of the path and the table top, triangle B has the bigger area.

(c) (2 values of R such that the average of the 5 values will not be too close to 37.5 m and the individual values are close to each other. The explanation should be along the same line.)

(d) Air resistance may have caused the actual R to be smaller.

19 (a) (i) 0.2 s

(ii) Human reaction time

(b) (i) Find max value. Max velocity ≈ 9.9 ms^{-1}

(ii) Find max gradient, occurs initially. Max acceleration ≈ 9.0 ms^{-2}

(iii) Find area under graph from 4.0 s to 8.0 s. Distance ≈ 39.2 m

(c)
- Ten persons are to be stationed at points 10 m apart along the running track.
- When race starts, all ten to start timing and record the time the athlete passes them
- Plot distance-time graph.
- From distance-time graph, find gradient at 10 s (or smaller) intervals.
- Plot velocity-time graph.