Projectiles

2011

3. A particle is projected from a point on horizontal ground with an initial speed of $58\ \text{m s}^{-1}$ at an angle β to the horizontal, where $\tan\beta = \frac{20}{21}$.

(i) Find the initial velocity of the particle in terms of $\vec{i}$ and $\vec{j}$.

(ii) Calculate the time taken to reach the maximum height.

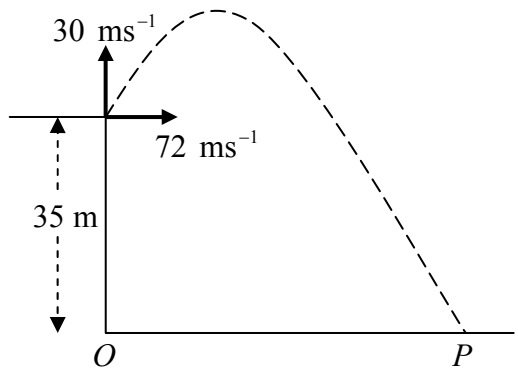
(iii) Calculate the maximum height of the particle above ground level.

(iv) Find the range.

(v) Find the two times at which the height of the particle is 75 m.

2010

3. A particle is projected with initial velocity $72\ \vec{i} + 30\ \vec{j}\ \text{ms}^{-1}$ from the top of a straight vertical cliff of height 35 m. It strikes the horizontal ground at P.



Find

(i) the time taken to reach the maximum height

(ii) the maximum height of the particle above ground level

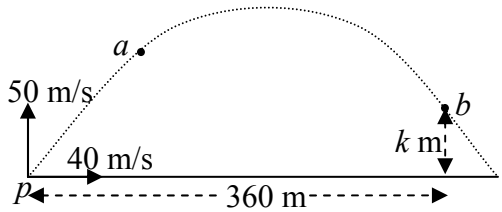
(iii) the time of flight

(iv) $|OP|$, the distance from O to P

(v) the speed of the particle as it strikes the ground.

2009

3. **(a)** A particle is projected with initial velocity $40\ \vec{i} + 50\ \vec{j}$ m/s from point p on a horizontal plane.



a and b are two points on on the trajectory (path) of the particle.

The particle reaches point a after 2 seconds of motion.

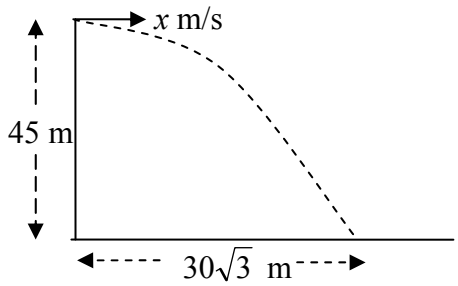
The displacement of point b from p is $360\ \vec{i} + k\ \vec{j}$ metres.

Find **(i)** the velocity of the particle at a in terms of $\vec{i}$ and $\vec{j}$

(ii) the speed and direction of the particle at a

(iii) the value of k.

(b) A straight vertical cliff is 45 m high.
A projectile is fired horizontally with an initial speed of x m/s from the top of the cliff.
It strikes the level ground at a distance of $30\sqrt{3}$ m from the foot of the cliff.



Find the value of x, correct to one decimal place.

2008

3. A particle is projected from a point on horizontal ground with an initial speed of 25 m/s at an angle β^0 to the horizontal where $\tan\beta = \frac{4}{3}$.

(i) Find the initial velocity of the particle in terms of $\vec{i}$ and $\vec{j}$.

(ii) Calculate the time taken to reach the maximum height.

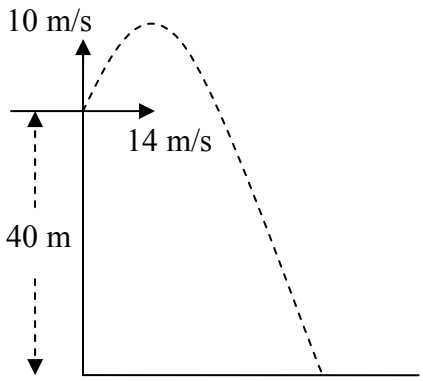
(iii) Calculate the maximum height of the particle above ground level.

(iv) Find the range.

(v) Find the speed and direction of the particle after 3 seconds of motion.

2007

3. A projectile is fired with initial velocity $14\vec{i} + 10\vec{j}$ m/s from the top of a vertical cliff of height 40 m.



(i) Calculate the time taken to reach the maximum height.

(ii) Calculate the maximum height of the projectile above ground level.

(iii) Calculate the time it takes the projectile to travel from the maximum height to the ground.

(iv) Find the range.

(v) Find the speed of the projectile as it strikes the ground.

2006

3. A particle is projected from a point on a level horizontal plane with initial velocity $10\vec{i} + 35\vec{j}$ m/s, where $\vec{i}$ and $\vec{j}$ are unit perpendicular vectors in the horizontal and vertical directions respectively.

Find **(i)** the time it takes to reach the maximum height

(ii) the maximum height

(iii) the two times when the particle is at a height of 50 m

(iv) the speed with which the particle strikes the plane.

2005

3. **(a)** A particle is projected from a point *o* on level horizontal ground with an initial speed of $50\sqrt{3}$ m/s at an angle β to the horizontal.
It strikes the level ground at *p* after 15 seconds.

(i) Find the angle β.

(ii) Find $|op|$, the distance from *o* to *p*. Give your answer to the nearest metre.

(b) A straight vertical cliff is 125 m high.
A projectile is fired horizontally with an initial speed of *u* m/s from the top of the cliff.
It strikes the level ground at a distance $375\sqrt{3}$ m from the foot of the cliff.

Find the value of *u*, correct to one decimal place.

2004

3. **(a)** A smooth rectangular box is fixed to the horizontal ground.
A ball is moving with constant speed u m/s on the top of the box.
The ball is moving parallel to a side of the box.
The ball rolls a distance 2 m in a time of 0.5 seconds before falling over an edge of the box.

(i) Find the value of u.

(ii) The ball strikes the horizontal ground at a distance of $\frac{4}{\sqrt{5}}$ m from the bottom of the box.
Find the height of the box.

(b) A golf ball is struck from a point r on the horizontal ground with a speed of 20 m/s at an angle θ to the horizontal ground. After $2\sqrt{2}$ seconds, the ball strikes the ground at a point which is a horizontal distance of 40 m from r.

(i) Find the initial velocity of the ball, in terms of $\vec{i}$ and $\vec{j}$ and θ.

(ii) Find the angle θ.

2003

3. A particle is projected from a point p on level horizontal ground with an initial speed of 50 m/s at an angle β to the horizontal,
where $\tan\beta = \frac{3}{4}$.

(i) Find the initial velocity of the particle in terms of $\vec{i}$ and $\vec{j}$.

After 4 seconds in flight, the particle hits a target which is above the ground.

(ii) Show that the distance from the point p to the target is $40\sqrt{17}$ m.

(iii) How far below the highest point reached by the particle is the target?

(iv) Find, correct to the nearest m/s, the speed with which the particle hits the target.

2002

3. A straight vertical cliff is 80 m high.
Projectile P is fired horizontally directly out to sea from the top of the cliff with a speed of x m/s. Projectile P hits the sea at a distance of 80 m from the foot of the cliff.

(i) Find the time it takes projectile P to hit the sea.

(ii) Find the value of x.

Another projectile, Q, is fired upwards at an angle α to the horizontal and with an initial speed of 15 m/s directly out to sea from the top of the cliff.
Projectile Q takes takes one second longer than projectile P to hit the sea.

(iii) Show that $\sin\alpha = \frac{3}{5}$.

(iv) How far from the foot of the cliff does projectile Q hit the sea?

2001

3. A straight vertical cliff is 45 m high.
Projectile P is fired horizontally directly out to sea from the top of the cliff with a speed of 20 m/s.

How long does it take projectile P to hit the sea ?
At what distance from the foot of the cliff does projectile P hit the sea ?

Projectile Q is also fired directly out to sea from the top of the cliff with a velocity of $x\vec{i} + y\vec{j}$ m/s, that is, with horizontal velocity component of x m/s and vertical velocity component of y m/s.
Projectile Q takes twice as long to hit the sea as projectile P did.
Projectile Q hits the sea three times as far from the foot of the cliff as projectile P did.

Show that the value of x is 30 and find the value of y.

3. A particle is projected from a point p on level horizontal ground with an initial speed of 50 m/s inclined at an angle α to the horizontal where $\tan a = \frac{3}{4}$.

The particle strikes the ground at the point q on the same horizontal level as p.

Find

(i) the maximum height reached by the particle

(ii) the time of flight

(iii) $|pq|$, the distance from p to q.

Solutions

2011
(i) 42i+40j
(ii) t=4sec
(iii) 80m
(iv)336 m
(v) t=3 or t=5sec

2010
(vi)t = 3 s
(vii) distance = 80 m
(viii) t = 7 s
(ix) $|OP| = 504$ m
(x) v = 82.4 m s^{-1}

2009 (a)
(i) V = 40 i + 30 j
(ii) Speed = 50 m s^{-1}, $\theta = 36.87^0$
(iii)k = 45

2009 (b)
x = 17.3

2008
(i) v = 15 i + 20 j
(ii) t = 2 s
(iii)s = 20 m
(iv)range = 60 m
(v) speed = 18.0 m s^{-1}, $\theta = 33.69^0$

2007
(i) t = 1 s
(ii) Max height = 45 m
(iii)t = 3 s
(iv)Range = 56 m
(v) Speed = 33.11 m s^{-1}

2006
(i) t = 3.5 s
(ii) maximum height = 61.25 m
(iii)t = 2 s and t = 5 s
(iv)Speed = 36.4 m s^{-1}

2005 (a)
(i) $= 60^0$
(ii) $|op| = 650$ m

2005 (b)
u = 129.9 m s^{-1}

2004 (a)
(i) u = 4 m s^{-1}
(ii) h = 1 m

2004 (b)
(i) Initial velocity = 20 cosθ i + 20 sinθ j
(ii) = 45^0

2003
(i) Initial velocity = 40 i + 30 j
(ii)
(iii)5 m
(iv)Speed = 41 m s^{-1}

2002
(i) t = 4 s
(ii) x = 20 m s^{-1}
(iii)
(iv)Range = 60 m

2001
(i) t = 3 s
(ii) Distance = 60 m
(iii)y = 22.5 m

2000 (a)
S = 45 m
T = 6 s
$|pq|$ = 240 m