Module 4 Short and Conventional Questions

Krishnaraj Module 4 Conventional Answers

Krishnaraj Module 4 Short Answers

Module 4 Conventional Questions

Module 4 Short Questions

ANSWER ALL THE QUESTION WITH NEAT HANDWRITING.

Each question carries 5 marks.

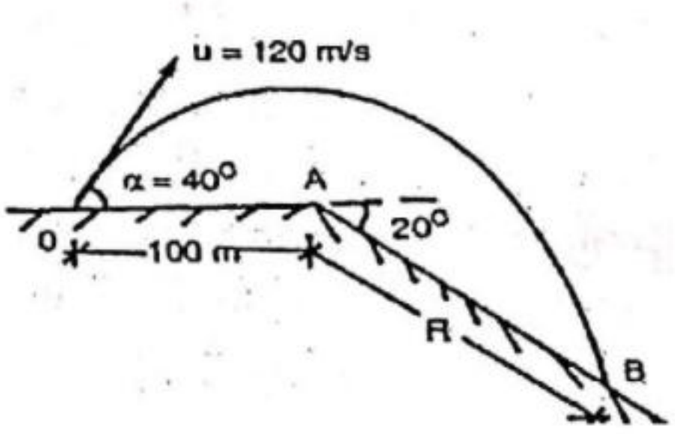
Question 1. At a certain instant, a ship INS Vikrant is at 100 km. East of ship INS Arihant. The ship INS Vikrant is moving at 50 kmph along a line with whole - circle bearing of 210°, while ship INS Arihant moves at 40 kmph along a line with whole-circle beaming 135°. Find the relative velocity of ship INS Arihant with respect to the ship INS Vikrant. What will be the minimum distance between the two ships?

(Ans. 53.284i + 15.017j kmph, 27.12556 km)

Question 2. The acceleration of a particle in rectilinear motion varies linearly from 2 m/s^2 to 4 m/s^2 as its position changes from x= 40mm to x = 120 mm. If the velocity of the particle at x = 40 mm is 0.4 m/s. determine the velocity at x = 120 mm. Find the value of x for which the velocity is 0.4 m/s.

(Ans. 0.8 m/s, 80 mm)

Question 3. A projectile is launched from point O as shown in figure. Find The range R and the total time of flight. (Ref. Fig.)



(Ans: At t= 22.21 Sec., R = 2066.37 m.

At t = 0.333 Sec., R = 73.8 m)

Question 4. A train enters a curved horizontal section of track at a speed of 100 km/h and slows down with constant deceleration to 50 km/h in 12 seconds. An accelerometer mounted inside the train records a horizontal acceleration of 2m/s^2 when the train is 6 seconds in the curve. Calculate the radius of curvature of the track at that instant.

(Ans: 266 m)

Module -4 Short questions

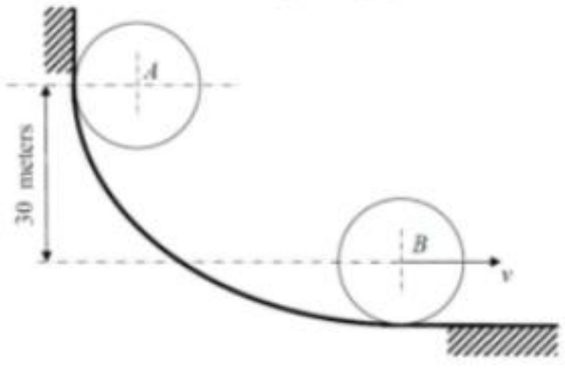
Due Nov 5 by 11:59pm **Points** 10

Answer all the questions and each carry *two* marks.

Question 1. A body moves, from rest with a constant acceleration of 5 m per sec. What is the distance covered in 5 sec

Question 2. A particle of unit mass is moving on a plane. Its trajectory, in polar coordinates, is given by $r(t) = t^2$, $\theta(t)=t$, where t is time. What is the kinetic energy of the particle at time t=2?

Question 3. A circular disc of radius 100 mm and mass 1 kg, initially at rest at position *A*, rolls without slipping down a curved path as shown in figure. The speed v of the disc when it reaches position *B* is _____ m/s. Acceleration due to gravity g = 10 m/s^2.

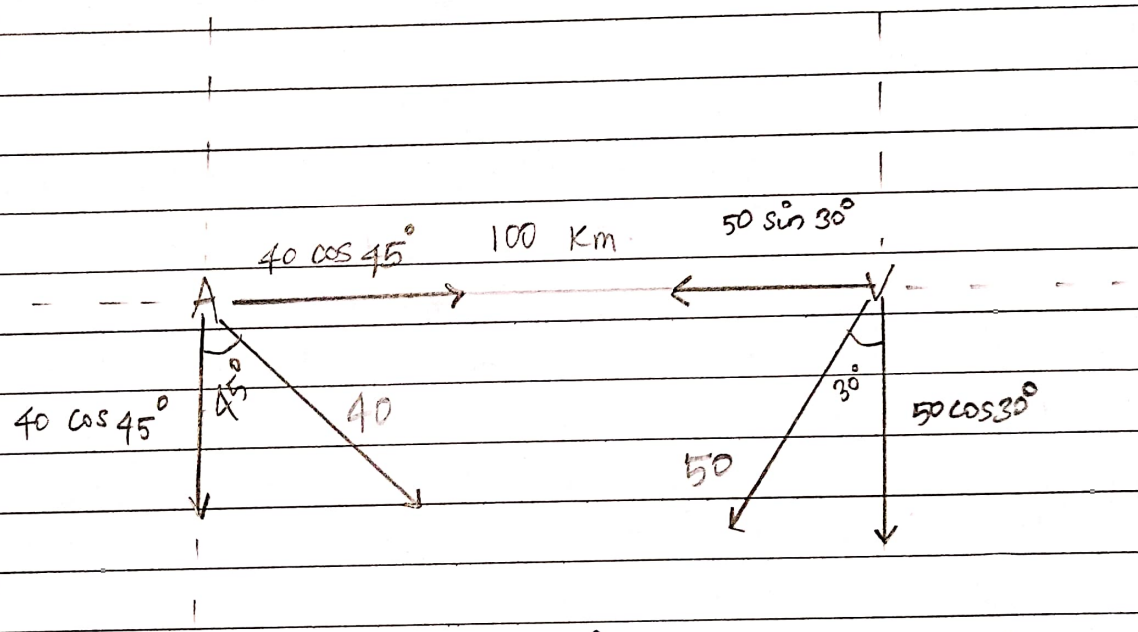


Question 4. A point mass is executing simple harmonic motion with an amplitude of 10 mm and frequency of 4 Hz. What is the maximum acceleration (m/s^2) of the mass?

Question 5. A railway coach having ordinary cross seat is moving at 3 m/s along the platform. A person runs at 4m/s on the platform in such a direction that he enters the railway coach parallel to cross seats. What is the direction of the velocity of the man?

MODULE - 4 - Conventional Questions

Q.1. At a certain instant, a ship INS Vikrant is 100 km east of ship INS Arihant. The ship INS Vikrant is moving 50 km/hr along a line with whole circle bearing of 210°, while INS Arihant moves at 40 km/h along a line with whole circle bearing 135°. Find the relative velocity of INS Arihant wrt INS Vikrant. What will be the minimum distance between the 2 ships?



V_{AV_x} = Relative velocity of Arihant with respect to Vikrant (x)

$= V_{A_x} - V_{V_x}$

$= 40\cos 45° - (-50 \sin 30°)$

$= 53.2840\ \hat{i}$

V_{AV_y} = Relative velocity of Arihant wrt Vikrant (y)

$= V_{A_y} - V_{V_y}$

$= -40\cos 45° - (-50\cos 30°)$

$= 15.0170\ \hat{j}$

Rainbow

Therefore, Relative velocity of INS Arihant with respect to INS Vikrant

$$V_{AV} = 53.28\,\hat{i} + 15.017\,\hat{j}$$

To find shortest distance, let us assume $t = 2$ hrs,

In 2 hrs, INS Arihant will travel 80 km in ~~due~~ WCB $\cong 135^\circ$

which means

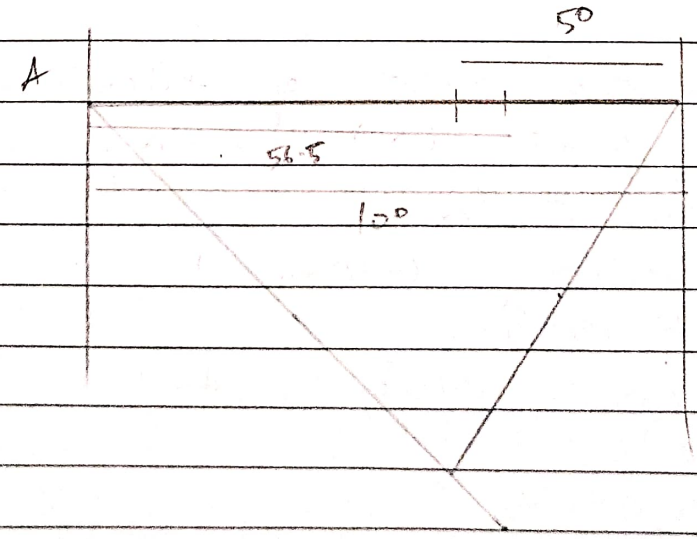
$80 \cos 45 = 56.5$ km linearly towards INS Vikrant.

INS Vikrant will travel 100 km WCB 210°

which means linearly

$100 \sin 30 = 50$ km

towards INS Arihant.

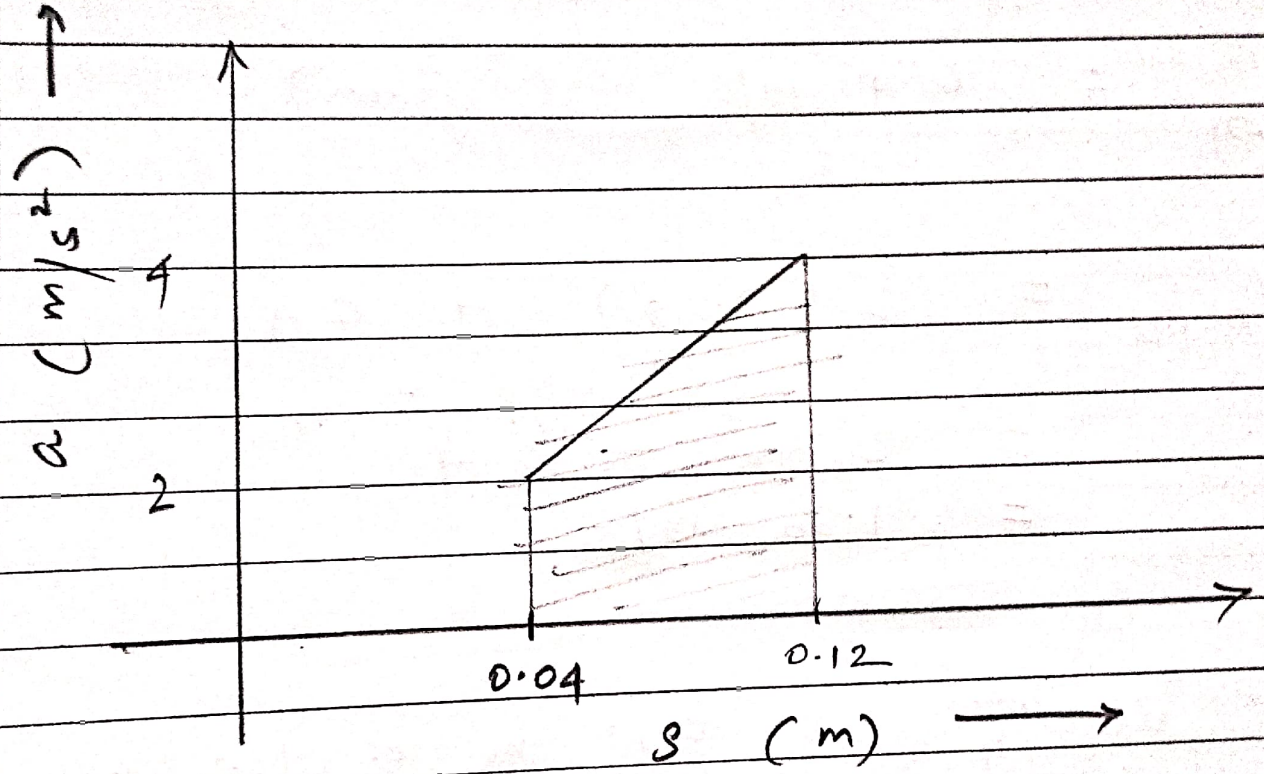


So shortest distance at ~~2hrs~~ will be approx 6.9 km. ~~Aft~~ After this, the ships distance will increase.

Rainbow

Q.2. The acceleration of a particle in rectilinear motion varies from 2 m/s² to 4 m/s². as X changes from 40 mm to 120 mm. V at 40 mm = 0.4 m/s. Find V at 120 mm.

→ Let us plot acceleration distance graph



$$a = \frac{dv}{dt} = \frac{dv}{dx} \cdot \frac{dx}{dt} = v\frac{dv}{dx}$$

$$\int_{0.04}^{0.12} a \cdot dx = \int_{0.4}^{v} v\,dv$$

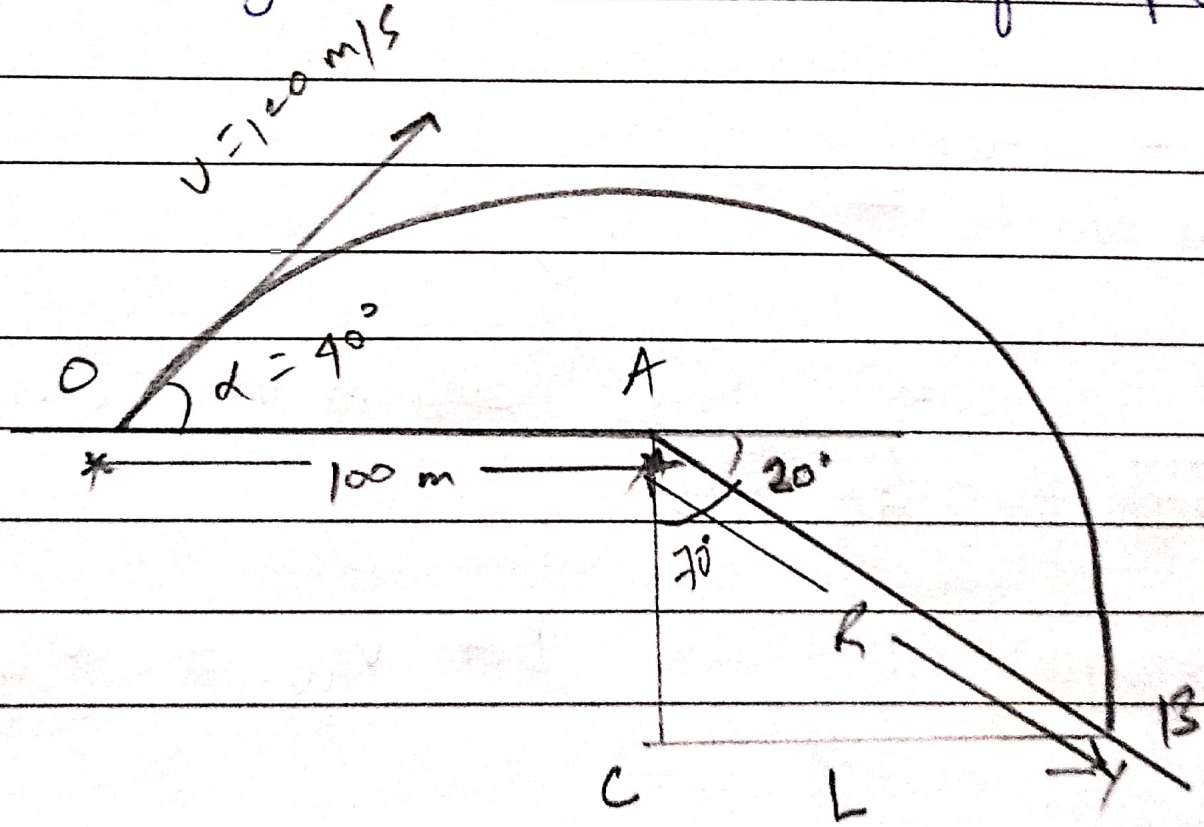
$$\frac{v^2}{2}\Big|_{0.4}^{v} = \frac{1}{2}(2)\left(\frac{80}{1000}\right) + 2\left(\frac{80}{1000}\right)$$

(area under graph)

$$\therefore \quad \frac{1}{2}\left(v^2 - (0.4)^2\right) = 0.24$$

$$v_{final} = \sqrt{0.64} = \underline{0.8\ m/s}$$

Q. 3. A projectile is launched from point O. Find the range R and time of flight



Rainbow

Let distance CB = L.

then, $y = L / \tan 40°$

we know, $(L = 2.74 \cdot y)$ — (1)

$u = 120$ m/s

$\theta = 40°$

x = Range $= 100 + L$

$= 100 + (2.74 \cdot y)$

Also, $-y = V_y \cdot t + \frac{1}{2}(-g)t^2$ — (2)

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

But ~~$t = \frac{2u \sin\theta}{g}$~~

x is also $= u_x \cdot t$

(as u_x does not change)

So $100 + L = u_x \cdot t$

$t = \frac{100 + L}{u_x} = \frac{100 + L}{91.9}$ — (3)

Putting (1) in (3),

$t = \frac{100 + 2.74y}{91.9}$ — (4)

Putting (4) in (2)

and subbing $V_y = u \sin 40 = 120 \cdot (0.6)$

$= 77.1$ m/s

we get:

$$-y = 77.1 \cdot \left(\frac{100 + 2.74 \cdot y}{91.9}\right) - 4.9 \left(\frac{100 + 2.74y}{91}\right)^2$$

Rainbow

$\Rightarrow$

$$-y = y(1.981 - 0.0043y) + 78.1$$

$\Rightarrow$ $$0.0043y^2 - 2.981y - 78.1 = 0$$

Solving the above quadratic equation, we get,

$$y = 710.8 \text{ m} \quad -(5)$$

Putting back (5) in (4),

$$t = \frac{100 + (2.74)(710)}{91.9}$$

$$= 22.24 \text{ s}$$

So now, Putting ~~$t = 22.24$ s is (3)~~ $y = 710.8$ m is (1)

$$L = (2.74)(710)$$
$$= 1947.59 \text{ m}$$

But $L = R \sin 70^\circ$ (from fig)

$$R = \frac{L}{\sin 70^\circ}$$
$$= \frac{1947.59}{0.93}$$
$$= 2094.1 \text{ m}$$

which is the required Range,
22.24 is the time of flight.

Rainbow

Q.4. A train enters a curved horizontal section of track at a speed of 100 km/h and slows down with constant deceleration to 50 km/h in 12 s. An accelerometer mounted on the inside of the train records horizontal acceleration of $2 m/s^2$ when the train is 6 s into the curve. Find radius of curvature of track at that instant

ans. Tangential acceleration

$$a_t = \left(\frac{(-50+100)}{3.6}\right) \div 12$$

$$= \frac{13.8}{12} = 1.1574 \ m/s^2$$

Radial component of acceleration

$$a_r = \sqrt{a^2 - a_t^2} = \sqrt{2^2 - 1.1574^2}$$

$$= 1.6311 \ m/s^2$$

But also, $V_{6s} = 75$ km/hr

$$= 75/3.6 = 20.8 \ m/s$$

$$a_r = \frac{v^2}{r} = \frac{20.8^2}{r}$$

$$r = \frac{(20.8)^2}{1.63} = 266.09 \ m$$

which is the radius at 6 m.

nbow

Module - 4 - Short Questions

Q.1 A body moves from rest with a constant acceleration of 5 m/s^2. Find distance covered in 5 seconds.

ans- $S = u + at$

$S = 0 + 5 \cdot 5$

$S = 25$ m. covered in 5 seconds

Q.2. A particle of unit mass lies on a plane. Its trajectory in polar co-ordinates is given by

$$r(t) = t^2, \quad \theta(t) = t.$$

($t \rightarrow$ time.)

Find KE at 2s.

ans $V_t = r \cdot \omega = t^2 \cdot \frac{d\theta}{dt} = t^2 = 4$

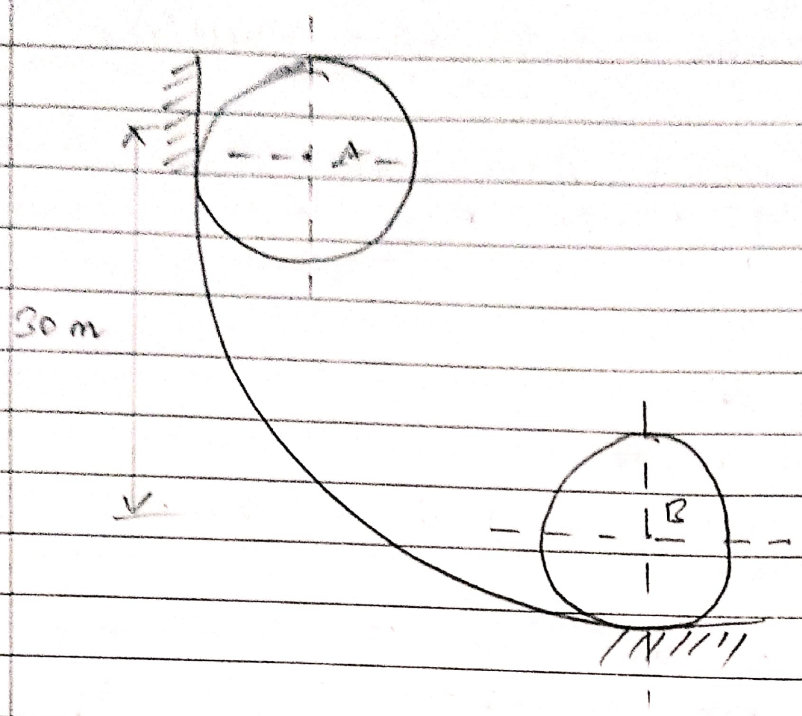
$V_r = \frac{dr}{dt} = 2t = 4$

$V = \sqrt{16 + 16} = \sqrt{32}$

$K.E = \frac{1}{2} \cdot 32 \times 1$

$= 16$ J

Q.3. A circular disk of radius 100 mm and mass 1 kg initially at rest at A rolls without slipping down a curved path. Find speed v of disk when it reaches B.



→ Loss in potential energy = gain in K.E

$$mgH = \frac{1}{2} I\omega^2 + \frac{1}{2} mV^2 \quad \text{(Rotational + translational)}$$

$$V = r \cdot \omega$$

$$mgH = \frac{1}{2} \times \frac{mr^2}{2} \times \frac{V^2}{r^2} + \frac{1}{2} mV^2$$

$$10 \times 30 = \frac{V^2 + 2V^2}{4}$$

$$300 \cdot (4) = 3V^2$$

$$3 \cdot V^2 = 1200$$

$$V = \sqrt{400}$$

$$V = 20 \text{ m/s}$$

⟹

Q.4. A point mass is executing simple harmonic motion with an amplitude of 10 mm and frequency of 4 Hz. Find max acceleration of mass.

ans. $a_{max} = A \cdot \omega^2$

$A = 10 \times 10^{-3} = 10^{-2}$ m.

$f = 4$ Hz.

$\omega = \frac{2\pi}{T} = 2\pi f = 2 \cdot \pi \cdot 4$

$= 8 \cdot \pi$

$= 25.12$ rad/s

$a_{max} = 10^{-2} \times 25.12$

$= 0.2512$ rad/s²

Q.5 A railway coach having ordinary cross seat is moving at 3 m/s along the platform. A person runs at 4 m/s along the platform in such a direction that he enters the railway coach parallel to coach seats. What is direction of velocity of man?

ans