PHYU12

No. of Printed Pages: 4

Register Number

11

PART – III

(இயற்பியல் / **PHYSICS**)

(English Version)

Time Allowed : 2.00 Hours] [Maximum Marks : 50

Instructions: (1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.

(2) Use **Blue** or **Black** ink to write and underline and pencil to draw diagrams.

Note : (i) Answer **all** the questions. 10x1=10

(ii) Choose the most appropriate answer from the given **four** alternatives and write the **option code** and the **corresponding answer**.

1. Round of the following number 19.95 into three significant figures.

(a) 19.9 (b) 20.0 (c) 20.1 (d) 19.5

2. Plane angle and solid angle have

(a) Units but no dimensions (b) Dimensions but no units

(c) No units and no d mensions (d) Both units and dimensions

3. If a par icle has negative velocity and negative acceleration, its speed

(a) increases (b) decreases (c) remains same (d) zero

4 Parsec is the unit of

(a) time (b) distance (c) frequency (d) acceleration

[Turn over

5. A train of 150 m length is going towa ds North direction at a speed of 10m/s. A parrot flies at the speed of 5m/s towards South direction parallel to the railways tract. The t me taken by the parrot to cross the train is

(a) 12 s (b) 8 s (c) 15 s (d) 10 s

6. If the velocity is $\vec{v} = 2\hat{\imath} + t^2\hat{\jmath} - 9\hat{k}$, then the magnitude of acceleration at t = 0.5 s is

(a) 1m s^{-2} (b) 2 m s^{-2} (c) zero (d) -1 m s^{-2}

7. If a particle executes uniform circular motion in the xy plane in clock wise direction, then the angular velocity is in

(a) +y direction (b) +z direction (c) -z direction (d) -x direction

8. Which of the following pairs of physical quantities have not same dimension?

(a) force and torque (b) torque and energy

(c) work and energy (d) Stress and pressure

9. An object is dropped in an unknown planet from height 50 m, it reaches the ground in 2 s . The acceleration due to gravity in this unknown planet is

(a) g = 20 m s^{2} (b) g = 25 m s^{-2} (c) g = 15 m s^{-2} (d) g = 30 m s^{-2}

10. The velocity of a particle v at an instant t is given by v = at +bt^2. The dimensions of b is

(a) [L] (b) [LT^{-1}] (c) [LT^{-2}] (d) [LT^{-3}]

PART – II

Note : Answer **any five** questions. Question No. **18** is **compulsory.** 5x2=10

11. Give some examples for projectile motion.

12. Define light year.

13. Write down the kinematic equations for angular motion.

14. What are the uses of dimensional analysis?

15. What is meant by equal vectors?

16. Write principle of homogeneity of dimensions.

17. Write the assumptions need to study about the projectile motion.

18. From a point on the ground, the top of a tree is seen to have an angle of elevation 45^0. The distance between the tree and a point is 50 m. Calculate the height of the tree?

PART – III

Note : Answer **any five** questions. Question No **26** is compulsory. 5x3=15

19. Check the correctness of the equation $\frac{1}{2}mv^2 = mgh$ using dimensional analysis method.

20. Two vectors are given as $\vec{r} = 2\vec{\imath} + 3\vec{\jmath} + 5\vec{k}$ and $\vec{F} = 3\vec{\imath} - 2\vec{\jmath} + 4\vec{k}$. Find the resultant vector $\vec{\tau} = \vec{r} \times \vec{F}$

21. Write any three rules for determining significant figures with examples.

[Turn over

22. Explain the subtraction of vectors

23. What are the limita ions of dimensional analysis?

24. Derive the relation between linear velocity and angular velocity.

25. Explain the propagation of errors in addition.

26. The velocity of three particles A, B, C are given below. Which particle travels at the greatest speed? $\bar{v}_A = 3\vec{i} - 5\vec{j} + 2\vec{k}$; $\bar{v}_B = \vec{i} + 2\vec{j} + 3\vec{k}$; $\bar{v}_C = 5\vec{i} + 3\vec{j} + 4\vec{k}$

PART – IV

Note : Answer **all** the questions. 3x5=15

27 Convert 76 cm of mercury pressure into Nm ^{2} using the method of dimensions.

(OR)

Write a note on triangulation method and radar method to measure larger distances.

28. Explain in detail the various types of errors

(OR)

Discuss any five properties of scalar and vector products.

29. Explain in detail the triangle law of addition.

(OR)

Derive the kinematic equations of motion for constant acceleration.

$-\infty \pm \infty\Phi\infty\Psi\infty\Omega\infty -$

HIGHER SECONDARY FIRST YEAR: FIRST MID – TERM TEST: AUGUST 2022

PHYSICS ANSWER KEY

Note:

1. Answers written with **Blue** or **Black ink** only to be evaluated.
2. Choose the most suitable answer in Part A from the given alternatives and write the **option code** and the **corresponding answer**.
3. For answers in Part-II, Part-III and Part-IV like reasoning, explanation, narration, description and listing of points, students may write in their own words but without changing the concepts and without skipping any point.
4. In numerical problems, if formula is not written, marks should be given for the remaining correct steps.
5. In graphical representation, physical variables for X-axis and Y-axis should be marked.

PART – I

Answer all the questions. **10x1=10**

Q. No.	Answer	Q. No.	Answer
1	(b) 20.0	6	(a) 1m s^{-2}
2	(a) Units but no dimensions	7	(c) -z direction
3	(a) increases	8	(a) force and torque
4	(b) distance	9	(b) g = 25 m s^{-2}
5	(d) 10 s	10	(d) $[LT^{-3}]$

PART – II

Answer **any five** questions. Question numbe **18 is compulsory**. 5x2=10

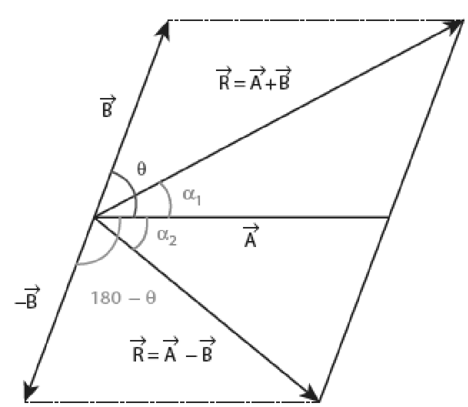
11	**Examples for projectile motion.** 1. An object dropped from window of a moving train 2. A bullet fired from a rifle. 3. A ball thrown in any direction. 4. A javelin or shot put thrown by an athlete 5. A jet of water issuing from a hole near the bottom of a water tank.	Any 4x½ =2
12	Light year (**Distance travelled by light in vacuum in one year**) **1 Light Year = 9.467 × 10^{15} m**	2

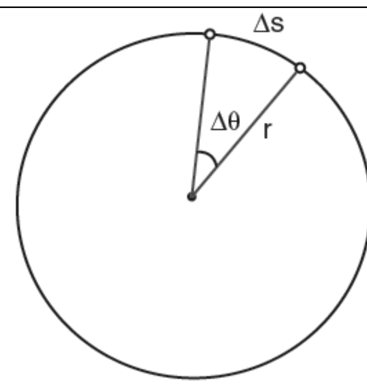
13	1. $\omega = \omega_0 + \alpha t$ 2. $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ 3. $\omega^2 = \omega_0^2 + 2\alpha\theta$ 4. $\theta = \frac{(\omega + \omega_0)t}{2}$	2
14	**Uses of dimensional analysis** 1. Convert a physical quantity from **one system of units to another**. 2. **Check the dimensional correctness** of a given physical equation 3. Establish **relations among various physical quantities**	2
15	Two vectors $\vec{A}$ and $\vec{B}$ are said to be equal when they have equal **magnitude and same direction** and represent the same physical quantity.	2
16	**Principle of homogeneity of dimensions.** The principle of homogeneity of dimensions' states that the **dimensions of all the terms in a physical expression should be the same.** For example, in the physical **expression $v^2 = u^2 + 2as$**, the dimensions of v^2, u^2 and 2 as are the same and equal to **$[L^2T^{-2}]$.**	2
17	**Assumptions need to study about the projectile motion.** i) **Air** resistance is neglected. ii) The effect due **to rotation of Earth and curvature of Earth** is negligible. iii) The **acceleration due to gravity is constant** in magnitude and direction at all points of the motion of the projectile.	2
18	$\theta = 45^0$, The distance between the ree and a point $x = 50$ m, Height of the tree (h)=? For triangulation method $\tan\theta = \frac{h}{x}$ **$h = x \tan\theta$** ---------- 1 Mark; $= 50 \times \tan 45^0$; $= 50 \times 1$ ---------- ½ Mark h = 50.0 m; **The height of the tree is 50.0 m.** ---------- ½ Mark	2

PART – III

Answer **any five** questions. Question number **26 is compulsory**. 5x3=15

19	Dimensional formula for ½ $mv^2 = [M][LT^{-1}]^2 = [ML^2T^{-2}]$ ---------- 1 Mark Dimensional formula for $mgh = [M][LT^{-2}][L] = [ML^2T^{-2}]$ ---------- 1 Mark **$[ML^2T^{-2}] = [ML^2T^{-2}]$** ---------- 1 Mark **Both sides are dimensionally the same, hence the equations ½ $mv^2 = mgh$ is dimensionally correct.**	3
20	$\vec{\tau} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & 5 \\ 3 & -2 & 4 \end{vmatrix}$ ---------- 1 Ma k $= (12-(-10))\hat{i} + (15-8)\hat{j} + (-4-9)\hat{k}$; ---------- 1 Mark **$\vec{\tau} = 22\hat{i} + 7\hat{j} - 13\hat{k}$** ---------- 1 Mark	3

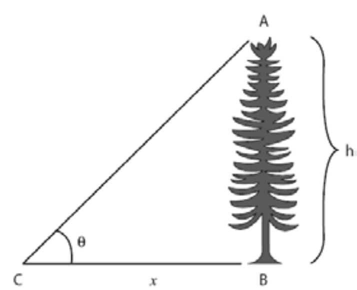
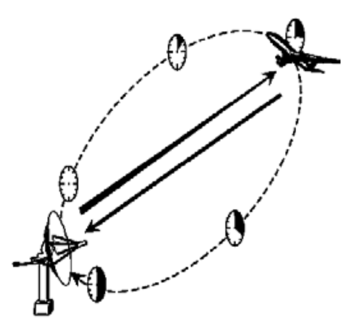
21	**Significant figures.** 1. All **non-zero digits** are significant. Ex.**1342** has **four** significant figures 2. All **zeros between two non-zero** digits are significant. Ex. **2008 has four** signif cant figures. 3. All **zeros to the right of a non-zero** digit but to the left of a decimal point are significant. Ex. **30700. has five** significant figures 4. The **number without a decimal point**, the terminal or trailing zero(s) are not significant. Ex. **30700 has three** significant figures. All zeros are significant if they come from a measurement Ex. **30700 m** has **five** significant figures 5. If the number is **less than 1,** he zero (s) on the right of the decimal point but to left of the **first non-zero digit are not significant.** Ex. **0 00345** has **three** significant figures. 6. All zeros to the right of a decimal point and to the right of non-zero digit are significant. Ex. **40.00 has four** significant figures and **0.030400** has **five** significant figures. 7. The number of significant figures **does not depend on the system of units** used 1.53 cm, 0.0153 m, 0.0000153 km, all have **three** significant figures.	Any 3x1=3
22	i) For two non-zero vectors $\vec{A}$ and $\vec{B}$ which are inclined to each other at an angle θ, the difference $\vec{A} - \vec{B}$ is obtained as follows. First obtain $-\vec{B}$ as in Figure. The angle between $\vec{A}$ and $-\vec{B}$ is 180 − θ. The difference $\vec{A} - \vec{B}$ is the same as the resultant o $\vec{A}$ and $-\vec{B}$.  We can write $\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$ and using the equat on, we have ii) $\lvert\vec{A}+\vec{B}\rvert = \sqrt{A^2+B^2+2AB\,\mathrm{Cos}\theta}$, we -----------1 Mark have $\lvert\vec{A}-\vec{B}\rvert = \sqrt{A^2+B^2+2AB\,\mathrm{Cos}(180-\theta)}$ iii) since, cos (180 − θ) = −cosθ. we get, $\lvert\vec{A}-\vec{B}\rvert = \sqrt{A^2+B^2-2AB\,\mathrm{Cos}\theta}$ ----------1 Mark Again from the Figure 2 19, and using an equation similar to equation $\tan\alpha_2 = \frac{B\sin(180-\theta)}{A+B\cos(180-\theta)}$ -----------1 Mark iv) But sin(180 − θ) = sinθ, hence we get, $\tan\alpha_2 = \frac{B\sin\theta}{A-B\ \ \mathrm{os}\theta}$	3

23	**Limitations of dimensional analysis** 1. This method gives **no information about the dimensionless constants** in the formula like 1, 2, …… .π,e, etc. 2. This method **cannot decide whether the given quantity** is a **vector or a scalar.** 3. This method is **not suitable to derive relations** involving **trigonometric, exponential and logarithmic functions.** 4. It **cannot be applied** to an equation involving **more than three physical quantities.** 5. It can only **check on whether a physical relation** is **dimensionally correct** but not the correctness of the relation. For example, using dimensional analysis, $s = ut + \frac{1}{3}at^2$ is dimensionally correct whereas the correct relation is $s = ut + \frac{1}{2}at^2$	3
24	1) Consider an object moving along a circle of radius r. In a time Δt, the object travels. An arc distance Δs as shown in Figure. The corresponding angle subtended is $\Delta\theta$  2) The Δs can be written in terms of $\Delta\theta$ as, $\Delta s = r\Delta\theta$ In a time Δt, we have $\frac{\Delta s}{\Delta t} = r\frac{\Delta\theta}{\Delta t}$ In the limit $\Delta t \to 0$, the above equation becomes $\frac{ds}{dt} = r\omega$ ----------(1) 3) Here $\frac{ds}{dt}$ is linear speed (v) which is tangential to the circle and ω is angular speed. So equation (1) becomes $v = r\omega$. Which gives the relation between linear speed and angular speed.	3
25	**Error in the sum of two quantities:** Let ΔA and ΔB be the absolute errors in the two quantities A and B respectively. Then, Measured value of A = $A \pm \Delta A$; Measured value of B = $B \pm \Delta B$ Consider the sum, $Z = A + B$ The error ΔZ in Z is then given by $Z \pm \Delta Z = (A \pm \Delta A) + (B \pm \Delta B)$; $= (A + B) \pm (\Delta A + \Delta B)$ $= Z \pm (\Delta A + \Delta B)$ (or) $\Delta Z = \Delta A + \Delta B$ The maximum possible error in the sum of two quantities is equal to the sum of the absolute errors in the individual quantities.	3

26	Speed of A = $\lvert\bar{v}_A\rvert = \sqrt{(3)^2+(-5)^2+(2)^2}$; $= \sqrt{9+25+4}$; ; $= \sqrt{38}$ ms^{-1} Speed of B = $\lvert\bar{v}_B\rvert = \sqrt{(1)^2+(2)^2+(3)^2}$; $= \sqrt{1+4+9}$; ; $= \sqrt{14}$ ms^{-1} Speed of C = $\lvert\bar{v}_C\rvert = \sqrt{(5)^2+(3)^2+(4)}$; $= \sqrt{25+9+16}$; ; $= \sqrt{50}$ ms^{-1} **The particle C has the greatest speed $\sqrt{50} > \sqrt{38} > \sqrt{14}$**	3 x1=3

PART – IV

Answer **all** the questions. 3x5=15

27	In cgs system 76 cm of mercury pressure = 76 × 13.6 × 980 dyne cm^{-2} The dimensional formula of pressure P is $[ML^{-1}T^{-2}]$ --------1 Mark $P_1[M_1^a\, L_1^b\, T_1^c] = P_2[M_2^a\, L_2^b\, T_2^c]$; $P_2 = P_1\left[\frac{M_1}{M_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c$- -------1 Mark M_1 = 1g M_2 = 1kg; L_1 = 1 cm, L_2 = 1m; T_1 = 1 s, T_2 = 1s As a =1, b= -1, and c = -2 ; Then $P_2 = 76 \times 13.6 \times 980 \left[\frac{1kg}{1kg}\right]^1 \left[\frac{1cm}{1m}\right]^{-1} \left[\frac{1s}{1s}\right]^{-2}$ --------1 Mark $= 76 \times 13.6 \times 980 \left[\frac{10^{-3}kg}{1kg}\right]^1 \left[\frac{10^{-2}m}{1m}\right]^{-1} \left[\frac{1s}{1s}\right]^{-2}$ --------1 Mark = 76 × 13 6 × 980 × $[10^{-3}] \times 10^2$ **$P_2 = 1.01 \times 10^5$ Nm^{-2}** --------1 Mark	5
	(OR) **Triangulation method for the height of an accessible object: (2 ½ Marks)** Let **AB = h be the height of the tree** or tower to be measured. Let C be the point of observation at distance *x* from B. Place a range finder at C and measure the angle of elevation, ∠ACB = θ as shown in Figure. From right angled triangle **ABC,** **tanθ = $\frac{AB}{BC} = \frac{h}{x}$** (or) **height h = x tan θ**  Knowing the distance *x*, the height h can be determined. **RADAR method: (2 ½ Marks)** The word RADAR stands for **Radio Detection and Ranging.** Radar can be used **to measure accurately the distance of a nearby planet** such as Mars In this method, **radio waves are sent from transmitters which, after reflection from the planet, are detected by the receiver**. 	5

	By measuring, the time interval (t) between the instants the radio waves are sent and received, the distance of the planet can be determined as d= $\frac{v \times t}{2}$. where **v is the speed of the radio wave**. As the time taken (t) is for the distance covered during the forward and backward path of the radio waves, it is divided by 2 to get the actual distance of the object. This method can also be **used to determine the height, at which an aero-plane flies from the ground.**	
28	**Systematic errors:** Systematic errors are reproducible inaccuracies that are consistently in the same direction. **Instrumental errors:** When an **instrument is not calibrated properly** at the time of manufacture, these erro s can be corrected by **choosing the instrument carefully.** **Imperfections in experimental technique or procedure:** These errors **arise due to the limitations in the experimental** arrangement. To overcome these, necessary correction has to be applied. **Personal errors:** These errors are due to individuals performing the experiment, may be due to **incorrect initial setting up of the experiment or carelessness** of the individual making the observation due to improper precautions **Errors due to external causes:** The **change in the external conditions** during an experiment can cause error in measurement. For example, **changes in temperature, humidity, or pressure during measurements** may affect the esult of the measurement. **Least count error:** Least count is the smallest value that can be measured by the measuring instrument, and the error due to this measurement is least count error **Random errors:** Random errors may arise due to **random and unpredictable variations** in experimental conditions like pressure, temperature, voltage supply etc. Errors may also be due to **personal errors** by the observer who performs the experiment. Random errors are sometimes called **"chance error"** It can be minimized by **repeating the observations a large number of measurements** are made and then the arithmetic mean is taken. **Gross Error:** The error caused due to the shear **carelessness of an observer** is called gross error. These errors can be minimized only when an observer is **careful and mentally alert**.	Any 5 5x1=5

Properties of scalar products

1) The product quantity $\vec{\mathbf{A}}\,.\,\vec{\mathbf{B}}$ **is always a scalar**. It is positive if the angle between the vectors is acute (i e., < 90°) and negative if the angle between them is obtuse (i.e. 90°<θ< 180°).

2) The **scalar product is commutative**, i.e. $\vec{A}\,.\,\vec{B} = \vec{B}\,.\,\vec{A}$

3) T e **vectors obey distributive law** i.e. $\vec{A}\,.\,(\vec{B} + \vec{C}) = \vec{A}\,.\,\vec{B} + \vec{A}\,.\,\vec{C}$

4) The angle between the vectors θ = cos–1$\left[\frac{\vec{A}\,.\,\vec{B}}{AB}\right]$

5) The **scalar product of two vectors will be maximum** when Cos θ = 1, i.e. θ = 0^0, i.e., when the vectors are parallel; $(\vec{A}\,.\,\vec{B})_{max}$ = AB

6) The **scalar product of two vectors will be minimum**, when Cos θ = –1, i.e. θ = 180^0 $(\vec{A}\ \ \vec{B}$ $_{m\,n}$ = – AB when the vectors are anti-parallel

7) If **two vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$, are perpendicular** to each other than their sca ar Product $\vec{A}\,.\,\vec{B}$ = 0 , because Cos 90^0 =0. Then he vectors $\vec{A}$ and $\vec{B}$. are said to be mutually orthogonal.

8) The scalar product of a vector with itself is termed as self–dot product and is given by $(\vec{A})^2 = \vec{A}\,.\,\vec{A}$ = AA Cos θ = A^2 . Here angle θ = 0°

The **magnitude or norm of the vector $\vec{\mathbf{A}}$ is $|\vec{\mathbf{A}}|$ = A = $\sqrt{\vec{\mathbf{A}}.\vec{\mathbf{A}}}$**

Any 5x1=5

9) In case of a unit vector $\hat{n}$, $\hat{n}\,.\,\hat{n}$ = 1 x 1 x Cos 0 = 1.
For example, $\hat{\imath}.\,\hat{\imath} = \hat{\jmath}.\,\hat{\jmath} = \hat{k}.\,\hat{k}$= 1

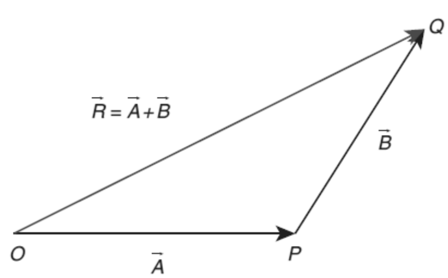
10) In the case of **orthogonal unit vectors** $\hat{\imath}$, $\hat{\jmath}$ and $\hat{k}$ $\hat{\imath}\,.\,\hat{\jmath} = \hat{\jmath}\ \ \hat{k} = \hat{k}.\,\hat{\imath}$ = 1.1 Cos90^0 = 0

11) In terms of components the scalar product of $\vec{A}$ and $\vec{B}$ can be written
As $\vec{A}\,.\,\vec{B} = (A_x\hat{\imath} + A_y\hat{\jmath} + A_z\hat{k})\,.\,(B_x\hat{\imath} + B_y\hat{\jmath} + B_z\hat{k})$
$= A_xB_x + A_yB_y + A_zB_z$ with all other terms zero.
The magnitude of vecto $|\vec{A}|$ is given by $|\vec{A}| = A = \sqrt{A_x^2 + A_y^2 + A_z^2}$

Properties of vector (cross) product.

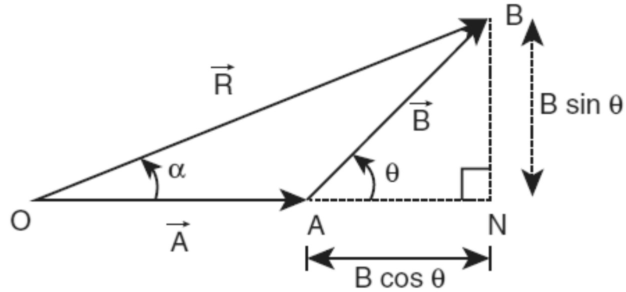
1) T e vector product of any two vectors is always a other vector whose direction is **perpendicular to the plane** containing these two vectors, i.e., orthogonal to both the vectors $\vec{A}$ and $\vec{B}$, even though the vectors $\vec{A}$ and $\vec{B}$ may or may not be mutually orthogonal.

2) The **vector product of two vectors is not commutative**, i.e., $\vec{A}x\vec{B} \neq \vec{B}x\vec{A}$
But, $\vec{A}x\vec{B} = -[\vec{B}\ x\ \vec{A}]$ Here it is worthwhile to note that
$|\vec{A}x\vec{B}| = |\vec{B}x\vec{A}|$ = AB Sin θ.
i.e in the case of the product vectors $\vec{A}x\vec{B}$ and $\vec{B}x\vec{A}$ the magnitudes are equal but directions are opposite to each other

	3) The **vector product of two vectors will have maximum magnitude** when $\sin\theta = 1$, i.e., $\theta = 90^0$ i.e., when the vectors $\vec{A}$ and $\vec{B}$, are orthogonal to each other. $(\vec{A} \times \vec{B})_{max} = AB\hat{n}$ 4) The **vector product of two non–zero vectors will be minimum** when $\sin\theta = 0$, i e.,$\theta = 0^0$ *or* 180^0 $[\vec{A} \times \vec{B}]_{min} = 0$ i.e., the vector product of two n n–zero vectors vanishes, if the vectors are either parallel or anti-parallel. 5) The self–cross product, i.e., **product of a vector with itself is the null vector $\vec{A} \times \vec{A} = AA$** $\sin\theta\, \hat{n} = \vec{0}$ In physics the null vector $\vec{0}$ is simply denoted as zero. 6) The self–vector products of unit vectors are thus zero. $\hat{\imath} \times \hat{\imath} = \hat{\jmath} \times \hat{\jmath} = \hat{k} \times \hat{k} = \vec{0}$ 7) In the case of orthogonal unit vectors, $\imath, \jmath, \hat{k}$ in accordance with the right hand screw rule: $\hat{\imath} \times \hat{\jmath} = \hat{k}$, $\hat{\jmath} \times \hat{k} = \hat{\imath}$, $\hat{k} \times \hat{\imath} = \hat{\jmath}$. Also, since **the cross product is not commutative,** $\hat{\jmath} \times \hat{\imath} = -\hat{k}$, $\hat{k} \times \hat{\jmath} = -\hat{\imath}$ and $\hat{\imath} \times \hat{k} = -\hat{\jmath}$ 8) In terms of components, the vector product of two vectors $\vec{A}$ and $\vec{B}$ $\vec{A} \times \vec{B} = \begin{vmatrix} \vec{\imath} & \vec{\jmath} & \vec{k} \\ A_X & A_Y & A_Z \\ B_X & B_Y & B_Z \end{vmatrix}$ $= \vec{\imath}\,(A_yB_z - A_zB_y) + \vec{\jmath}(A_zB_x - A_xB_z) + \vec{k}(A_xB_y - A_yB_x)$ 9) If two vectors $\vec{A}$ and $\vec{B}$ form adjacent sides in a parallelogram, then the **magnitude of $\lvert\vec{A} \times \vec{B}\rvert$ will give the area of the parallelogram** as represented graphically in Figure.	
29	1) Represent the vectors $\vec{A}$ and $\vec{B}$ by the two adjacent sides of a triangle taken in the same order Then the resultant is given by the third side of the triangle taken in the opposite order.  2) The **head of the first vector $\vec{A}$ is connected to the tail of the second vector $\vec{B}$. Let θ be the angle between $\vec{A}$ and $\vec{B}$. Then $\vec{R}$ is the resultant vector connecting the tail** of the first vector $\vec{A}$ to the head of the second vector $\vec{B}$ 3) The magnitude of $\vec{R}$ (resultant) is given geometrically by the length of $\vec{R}$ (OQ) and the direction of the resultant vector is he angle between $\vec{R}$ and $\vec{A}$ Thus we write $\vec{R} = \vec{A} + \vec{B}$. $\because \overrightarrow{OQ} = \overrightarrow{OP} + \overrightarrow{PQ}$	5

Magnitude of resultant vector:

4) Consider the triangle ABN, which is ob ained by extending the side OA to ON. ABN is a right angled triangle.



Cos θ = $\frac{AN}{B}$ ∴ AN = B Cos θ *and*

Sin θ = $\frac{BN}{B}$ ∴ BN = B Sin θ

For ΔOBN,

we have $OB^2 = ON^2 + BN^2$

$\Rightarrow R^2 = (A + B\ Cos\ \theta)^2 + (B\ S\ n\ \theta)^2$

$\Rightarrow R^2 = A^2 + B^2cos^2\theta + 2ABcos\theta + B^2sin^2\theta$

$\Rightarrow R^2 = A^2 + B^2\ (cos^2\theta + sin^2\theta\ )+ 2ABcos\theta$

$\Rightarrow$ **R =** $\sqrt{\mathbf{A^2 + B^2 + 2AB\ Cos\theta}}$

which is the magnitude of the resultant of *A* and *B*

Direction of resultant vectors:

5) If θ is the angle between $\vec{A}$ and $\vec{B}$, then

$|\vec{A} + \vec{B}| = \sqrt{A^2 + B^2 + 2AB\ Cos\theta}$

If $\vec{R}$ makes an angle α with $\vec{A}$, then in ΔOBN, tan $\alpha = \frac{BN}{ON} = \frac{BN}{OA+AN}$

tan $\boldsymbol{\alpha}$ = $\left(\frac{\mathbf{B\ Sin\theta}}{\mathbf{A+B\ Cos\theta}}\right)$; $\boldsymbol{\alpha}$ = tan^{-1} $\left(\frac{\mathbf{B\ Sin\theta}}{\mathbf{A+B\ Cos\theta}}\right)$

(OR)

Velocity - time relation: ……… 1½ Marks

1) a = $\frac{dv}{dt}$ or dv = a .dt

Integrating both sides with the condition that as time changes from 0 to t, **the velocity changes from u to v**. For the constant acceleration,

$\int_u^v dv = \int_0^t a dt$

= a $\int_u^v dt \implies [v]_u^v$ = a $[t]_0^t$ --------(1)

v – u = at (or) v = u + at

Displacement – time relation: ……… 1½ Marks

2) v = $\frac{ds}{dt}$ or ds = v dt and since v = u + at We get ds = (u + at)dt .

Assume that initially at time t = 0, the particle started from the origin. At a later time, t, the particle displacement is s. Further assuming that acceleration is time independent, we have $\int_0^s ds$

$=\int_0 udt + \int_0^t atdt$ or s = ut + ½ at² --------------(2) 5

Velocity – displacement relation: ……… 1½ Marks

3) The acceleration is given by the **first derivative of velocity with respect to time**. a = $\frac{dv}{dt}$ = $\frac{dv}{d}\frac{d}{dt}$ = $\frac{dv}{ds}$ v [since ds / dt = v where s is distance traversed] This is rewritten as a = $\frac{1}{2}\frac{dv^2}{ds}$ or ds = $\frac{1}{2a}$ d(v^2)

4) Integrating the above equation, using the fact when the velocity changes from u^2 to v^2, displacement changes from 0 to s,

we get $\int_0^s ds$

= $\int_{\mathrm{u}}^{\mathrm{v}} \frac{1}{2\mathrm{a}} \mathrm{d}(\mathrm{v}^2)$; s = $\frac{1}{2a}$ ($v^2 - u^2$) ; $v^2 = u^2 + 2as$ ------------(3)

5) s = $\frac{(u+v)t}{2}$ ------------- ---(4) **……… ½ Mark**

The equations (1), (2) (3) and (4) are called kinematic equations of motion, and have a wide variety of practical applications.