Class : 11th

Subject : Physics

Chapter : 2

Force and Motion

Multiple Choice Questions (MCQs)

Choose the correct answer:

2.1 The angle at which dot product becomes equal to cross product is:

(a) 65°
(b) 45° ✓
(c) 76°
(d) 30°

✓ **Explanation:**
Dot product: $A \cdot B = AB\cos$
Cross product: $A \times B = AB\sin$
If $\cos\theta = \sin\theta$, then = $\sin\theta = 45^\circ$

2.2 The projectile gains its maximum height at an angle of:

(a) 0°
(b) 45° ✓
(c) 60°
(d) 90°

✓ **Explanation:**
Maximum height is part of maximum **range** condition, which is at **45**°.

2.3 The scalar product of two vectors is maximum if they are:

(a) perpendicular
(b) parallel ✓
(c) at 30°
(d) at 45°

✓ **Explanation:**
Scalar (dot) product is maximum when $\cos\theta=1$ i.e., $\theta=0\circ$ vectors are **parallel**.

2.4 The range of projectile is same for two angles which are mutually:

(a) perpendicular
(b) supplementary
(c) complementary ✓
(d) 270°

✓ **Explanation:**
Range $R=v2\sin(2\theta) / g$

So, if $\theta1+\theta2=90\circ$ then $\sin(2\theta1)=\sin(2\theta2)$ → **complementary** angles.

2.5 The acceleration at the top of a trajectory of projectile is:

(a) maximum
(b) minimum
(c) zero
(d) g ✓

✓ **Explanation:**
Acceleration due to gravity **acts constantly downward** with magnitude ggg, even at the top.

2.6 SI unit of impulse is:

(a) $kg\cdot m/s^2$
(b) $N\cdot m$

(c) N·s ✓
(d) N·m/s

✓ **Explanation:**
Impulse = Force × Time = N × s = **N·s**

2.7 The rate of change of momentum is:

(a) force ✓
(b) impulse
(c) acceleration
(d) power

✓ **Explanation:**

F=dp / dt⇒Force is the rate of change of momentum

2.8 As rocket moves upward during its journey, then its acceleration goes on:

(a) increasing ✓
(b) decreasing
(c) remains same
(d) moves with uniform velocity

✓ **Explanation:**
As fuel burns, **mass decreases** while **thrust remains**, so acceleration **increases**.

2.9 Elastic collision involves:

(a) loss of energy
(b) gain of energy
(c) no gain, no loss of energy ✓
(d) no relation between energy and elastic collision

✓ **Explanation:**
In an **elastic collision**, both **momentum and kinetic energy are conserved**.

Short Answer Questions

2.1 – State Right Hand Rule for Two Vectors (Vector Product)

📌 **Answer:**
The **Right-Hand Rule** is used to determine the **direction of the vector product** (cross product) of two vectors.

- Point the **fingers** of your right hand in the direction of the **first vector (A)**.
- Rotate them toward the **second vector (B)** through the **smallest angle**.
- Your **thumb** will point in the direction of the **resultant vector (A × B)**.

✳□ Cross product is **perpendicular** to both vectors.

2.2 – Define Impulse and Show How It is Related to Momentum

📌 **Answer:**

Impulse:
Impulse is the product of **force** and the **time interval** during which the force acts.

$$\text{Impulse} = F \cdot \Delta t$$

Relation with Momentum:
According to Newton's second law:

$$F = \Delta p / \Delta t \Rightarrow F \cdot \Delta t = \Delta p$$

✓ So,

$$\text{Impulse} = \text{Change in Momentum}$$

2.3 – Differentiate Between Elastic and Inelastic Collision

📌 **Answer:**

Property	Elastic Collision	Inelastic Collision
Kinetic Energy	Conserved	**Not Conserved**
Momentum	Conserved	Conserved
Example	Billiard balls	Car crash, clay hitting wall

Post-Collision Motion Objects may rebound Objects may stick together

---

2.4 – Show That Rate of Change in Momentum is Equal to Force & State Newton's 2nd Law

📌 **Answer:**

From Newton's Second Law:

F=dpdtF = \frac{dp}{dt}F=dtdp

Where:

- F = Force
- p=mv = Momentum

This means:
✅ **Force is equal to the rate of change of momentum**.

Newton's Second Law (in terms of momentum):
"The force acting on a body is equal to the **rate of change of momentum** produced in the body."

2.5 – State Law of Conservation of Linear Momentum and Condition for Its Validity

📌 **Answer:**

Law of Conservation of Linear Momentum:
"The total linear momentum of an isolated system remains **constant**, if no **external force** acts on it."

Initial Momentum=Final Momentum

✅ **Condition:**
This law holds only when the system is **closed and isolated** — i.e., **no external force** is acting on the system.

2.6 – Show that Range of Projectile is Maximum at 45°

📌 **Answer:**

The formula for range:

$R=u^2\sin(2\theta)/ g$

✓ Range depends on sin(2θ) which is **maximum when sin(2θ)=1**

This happens when:

$2\theta=90^\circ \Rightarrow \theta=45^\circ$

🔍 **Therefore,** the range of a projectile is **maximum** at an angle of **45**°.

2.7 – Find Time of Flight to Reach Maximum Height

📌 **Answer:**

Time to reach maximum height is **half of total time of flight**:

$T=u\sin\theta / g$

Where:

- u = initial velocity
- θ = angle of projection
- g = acceleration due to gravity

✓ Time to **reach max height** = $T=u\sin\theta / g$

2.8 – Max Range is 800 m, Find Height at 60°

📌 **Given:**

- $R_{max}=800$ m
- Angle $\theta=60^\circ$

🔹 Use the formula:

$H=R_{max} / 4 \ . \tan\theta$

$H=800/ 4 \ \cdot\tan(60^\circ)=200 \cdot \sqrt{3}\approx 346.4$ m

✅ **Height attained ≈ 346.4 m**

📄 Constructed Response Questions

2.1 – Why Does a Hunter Miss the Bird When Aiming Directly at It?

📌 **Answer:**

Because of **gravity**, the bullet or projectile follows a **curved path**, while the bird may **fly away** or stay still.

✅ So, aiming directly results in **the bullet falling below the target**.
That's why hunters aim slightly **above** the bird.

2.2 – Why Does a Person Fall Safely on Sand, but Not on Concrete?

📌 **Answer:**

Sand increases the **time of impact**, reducing the **rate of momentum change**, hence reducing **force** (as per impulse-momentum theorem).

```
F=Δp / ΔtF
```

✅ Sand gives **more time**, so **less force** is felt.

2.3 – Conditions for Birds to Fly in Air

📌 **Answer:**

Birds fly due to **Newton's 3rd law**:

- They **push air downward** with their wings.
- The air gives an **equal and opposite upward lift**.
- The **lift force** must **balance the bird's weight** for steady flight.

2.4 – Describe Situations with v = 0, a = 0, etc.

📌 **Answer:**

1. **v=0 but a≠0**
   A ball at the top of its projectile path — velocity momentarily zero, but gravity is acting.
2. **a=0 , but v≠0**
   A vehicle moving at **constant speed** in a straight line — no acceleration.
3. **v⊥a:**
   In **uniform circular motion**, **velocity is tangential** and **acceleration (centripetal)** is toward the center → **perpendicular**.

2.5 – Effect of Air Resistance on Range of Projectile

📌 **Answer:**

Air resistance:

- **Reduces the horizontal component** of velocity.
- **Decreases the total range**.
- Makes trajectory **asymmetric** — descent is steeper.

✅ Actual range is **less than theoretical range** (without air).

Comprehensive Questions

2.1 – Define and Explain Scalar Product. Write Its Characteristics

📌 **Answer:**

Scalar Product (Dot Product):
The scalar (or dot) product of two vectors **A** and **B** is given by:

$$A \cdot B = AB\cos\theta$$

Where:

- A and B are magnitudes of vectors
- θ is the angle between them
- Result is a **scalar** quantity

🔹 **Characteristics:**

1. $A \cdot B = B \cdot A$ → **Commutative**
2. $A \cdot B = 0$ if vectors are **perpendicular**
3. $A \cdot A = |A|2$
4. Result is **maximum** when $\theta = 0^\circ$

2.2 – Define and Explain Vector Product. Characteristics of Vector Product

📌 **Answer:**

Vector Product (Cross Product):

$A \times B = AB\sin\theta\ \hat{n}$

Where $\hat{n}$ is a **unit vector** perpendicular to both A and B (right-hand rule).

🔷 **Characteristics:**

1. $A \times B = -B \times A$ → **Anti-commutative**
2. $A \times A = 0$
3. Result is a **vector perpendicular** to plane of A and B
4. **Maximum** when angle is 90°

2.3 – Derive Three Equations of Motion (Graphical Method)

📌 **Answer:**

Using velocity-time graph:

1. First Equation:

$v = u + at$

2. Second Equation:

Displacement = Area under v–t graph

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

3. Third Equation:

Eliminate time ttt:

V^2=u^2+2as

2.4 – What is Projectile Motion? Explain.

📌 **Answer:**

Projectile Motion:
The curved path followed by an object thrown near Earth's surface under **gravity** alone is called **projectile motion**.

- Horizontal velocity is **constant**
- Vertical motion is like **free fall**
- Path is a **parabola**

2.5 – Derive Expressions for Projectile Motion

(i) Time of Flight

T=2usinθ / g

(ii) Maximum Height

H=u^2sin^2θ / 2g

(iii) Range

R=u^2sin(2θ) / g

2.6 – Explain Elastic Collision in 1D & Relative Velocities

📌 **Answer:**

Elastic Collision (1D):
Both **momentum** and **kinetic energy** are conserved.

🔹 **Condition:**

m1u1+m2u2=m1v1+m2v2(momentum)

1 / 2 m1u1^2+ 1 / 2 m2u2^2= 1 / 2 m1v1^2+ 1 / 2 m2v2^2(KE

✅ **Relative Velocity Before = After (Reversed):**

u1−u2=−(v1−v2)

2.7 – Derive Momentum & Energy Conservation in 2D Collision

📌 **Answer:**

Let two particles collide with masses m1m_1m1 and m2m_2m2, and split motion into x and y components:

◆ **Momentum in x-direction:**

m1u1x+m2u2x=m1v1x+m2v2x

◆ **Momentum in y-direction:**

m1u1y+m2u2y=m1v1y+m2v2y

◆ **Kinetic Energy (Elastic Collision Only):**

1 / 2m1u1^2+1 / 2m2u2^2=1 / 2m1v1^2+1 / 2m2v2^2

2.8 – Explain Inelastic Collision in Two Dimensions

📌 **Answer:**

- In **inelastic collisions**, **momentum is conserved**, but **kinetic energy is not**.
- Bodies may stick together or move separately with **energy loss** (sound, heat, deformation).

🔹 Apply conservation of momentum in both axes:

- m1u1x+m2u2x=(m1+m2)vx
- m1u1y+m2u2y=(m1+m2)vy

✅ KE is **not conserved**, unlike elastic collisions.