

**PHY · PHYSICS**

02. Force & Motion

Official PMDC Solved Past Paper Topical Booklet · High-Yield Examination Series

© 137 Solved Questions

📅 2005 to 2024 Archive

📋 Boards: BUMHS, DUHS, ETEA, KU, MDCAT, NUMS

📄 Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

SZABMU 2024

The quantity of motion present in a body can be measured by ____.

- (A) Acceleration
- (B) Momentum
- (C) Speed
- (D) Velocity

Q2.

SZABMU 2024

The slope of velocity–time graph gradually decreases, then the body is said to be moving with

- (A) Negative acceleration
- (B) Positive acceleration
- (C) Uniform velocity
- (D) Variable acceleration

Q3.

SZABMU 2024

The acceleration can be determined by the gradient of ____

- (A) Displacement–time graph
- (B) Force–time graph
- (C) Speed–time graph
- (D) Velocity–time graph

Q4.

SZABMU 2024

The rate of change of linear momentum is equal to ____

- (A) Force
- (B) Impulse
- (C) Torque
- (D) Velocity

Q5.

SZABMU 2024

At what angle made by projectile with x–axis, we can get 1/4th value of maximum height achieved by

- (A) 30°
- (B) 45°
- (C) 60°
- (D) 90°

Q6.

KU 2024

Which of the following pairs correctly matches a physical quantity with its SI unit?

- (A) Energy Newton
- (B) Force Joule
- (C) Power Watt
- (D) Velocity m/s^2

Q7.

KU 2024

____ is the natural tendency of an object to remain at rest or in motion with constant velocity?

- (A) Friction
- (B) Inertia
- (C) Mass
- (D) Weight

Q8.

KU 2024

A car in motion hits and gets crashed into a tree trunk, what is NOT conserved?

- (A) Kinetic energy alone
- (B) Momentum alone
- (C) Momentum and kinetic energy both
- (D) Neither kinetic energy nor momentum

Q9.

KU 2024

The vertical and horizontal component of the projectile motion are

- (A) Correlated with each other
- (B) Dependent on each other
- (C) Independent of each other
- (D) Associated with each other

Q10.

UHS 2024

The range of projectile will be maximum if the factor $\sin(2\theta)$ becomes

- (A) Zero
- (B) 1
- (C) -1
- (D) 2

Q11.

UHS 2024

The two-dimensional motion under constant acceleration due to gravity is called:

- (A) Circular motion
- (B) Rotational motion
- (C) Projectile motion
- (D) Vibratory motion

Q12.

UHS 2024

In velocity time graph the area under graph is equal to the:

- (A) Speed of an object
- (B) Velocity of an object
- (C) Distance covered by object
- (D) Acceleration of an object

Q13.

NUMS 2024

If you stops your car quickly by wearing seat belts, chance of injury is greatly reduced because seat belt applied

- (A) Extra force
- (B) Perpendicular force
- (C) Opposite force
- (D) Zero force

Q14.

NUMS 2024

A ball with momentum 8 kg m/s hits a wall and bounces straight back without losing K.E. the change in momentum of this ball is:

- (A) 4 Ns
- (B) -16 Ns
- (C) 16 Ns
- (D) 8 Ns

Q15.

NUMS 2024

In projectile motion for which angle maximum height is half its range?

- (A) 73°
- (B) 65°
- (C) 63°
- (D) 68°

Q16.

NUMS 2024

The horizontal range of projectile will be maximum when?

- (A) $\sin \theta \approx 1$
- (B) $\sin(2\theta) \approx 1$
- (C) $\sin \theta \approx 0$
- (D) $\sin(2\theta) \approx 0$

Q17.

BUMHS 2024

Which of the following is a vector quantity?

- (A) Electric Flux
- (B) Work done
- (C) Electric Potential Energy
- (D) None of the given options

Q18.

BUMHS 2024

Which of the following believed in absolute time?

I Newton

II Galileo

- (A) I
- (B) II
- (C) Both I and II
- (D) Neither I nor II

Q19.

BUMHS 2024

A 40kg body starting from rest falls through a vertical distance of 125cm to ground. The velocity of the body just before it hits the ground is:

- (A) 250 m/s
- (B) (250) m/s
- (C) 25 m/s
- (D) 5 m/s

Q20.

BUMHS 2024

A person's life was saved in a car accident due to airbags system. During that car accident, airbags expanded in front of head of that person. If that car was not equipped with airbags then movement of head would be stopped by windshield in much faster time. Airbags saved life because it

- (A) causes much greater force for longer time
- (B) causes much greater force for smaller time
- (C) causes much smaller force for longer time
- (D) causes much smaller force for smaller time

Q21.

BUMHS 2024

Which of the following statements is absolutely correct:-

- I. Forces can stop or make objects move faster
- II. Forces can change the direction of movement

- (A) I
- (B) II
- (C) Both I and II
- (D) Neither I nor II

Q22.

BUMHS 2024

Gravitational mass of a body is

- (A) F/a
- (B) Fa
- (C) W/g
- (D) Wg

Q23.

BUMHS 2024

A set of coordinate axes in which measurements are made is called:

- (A) Cartesian coordinates
- (B) Rectangular coordinates
- (C) Spherical coordinates
- (D) Frame of reference

Q24.

UHS 2023

Which of the following is the correct definition of variable velocity?

- (A) Unequal distances are covered in equal intervals of time
- (B) Equal displacements are made in unequal intervals of time
- (C) Unequal displacements are made in equal intervals of time
- (D) Equal displacements are made in equal intervals of time

Q25.

UHS 2023

The velocity-time plot for a moving particle shows a straight line. This means:

- (A) The particle has constant acceleration
- (B) The particle has never turned around
- (C) The particle has zero displacement
- (D) The data is insufficient

Q26.

UHS 2023

A man is in a car that is moving with the velocity of 36km/hr. His speed with respect to the car is:

- (A) 10 m/s
- (B) 36 m/s
- (C) Zero
- (D) Infinite

Q27.

UHS 2023

On which car there is resultant force?

- (A) Car moving on a straight horizontal road
- (B) Car moving at constant around a bend
- (C) Car moving uphill at constant velocity
- (D) Car that is stationary

Q28.

UHS 2023

If two equal masses are in motion with same individual speeds, we can conclude that

- (A) Their momentums are same
- (B) Their momentums can be different from each other
- (C) Their kinetic energies are different from each other
- (D) Their total energies are same

Q29.

UHS 2023

In the displacement-time graph, if the slope is constant the velocity is

- (A) Variable
- (B) Constant
- (C) May be variable or constant
- (D) Infinite

Q30.

SZABMU 2023

The car is speeding up along negative y axis then acceleration will be along:

- (A) Positive x axis
- (B) Negative x axis
- (C) Positive y axis
- (D) Negative y axis

Q31.

SZABMU 2023

Momentum is product of mass and velocity, then momentum and velocity are:

- (A) Parallel
- (B) Perpendicular
- (C) Antiparallel
- (D) Independent

Q32.

SZABMU 2023

Which of the pair of two projectiles projected at different angles have same ranges:

- (A) $(30^\circ, 70^\circ)$
- (B) $(40^\circ, 50^\circ)$
- (C) $(35^\circ, 40^\circ)$
- (D) $(45^\circ, 40^\circ)$

Q33.

SZABMU 2023

The slope of velocity–time graph gives us:

- (A) Speed
- (B) Velocity
- (C) Acceleration
- (D) Distance

Q34.

SZABMU 2023

The time rate of change of linear momentum of a body is equal to:

- (A) Force
- (B) Momentum
- (C) Power
- (D) Acceleration

Q35.

SZABMU 2023

At what angle of projection of a projectile the range becomes half of its maximum value?

- (A) 15°
- (B) 20°
- (C) 30°
- (D) 40°

Q36.

ETEA 2023

Equal forces F act on isolated bodies A and B. The mass of B is $1/5$ times that of A. The magnitude of the acceleration of A is:

- (A) $1/5$ times that of B
- (B) $1/3$ times that of B
- (C) The same as B
- (D) Nine times that of B

Q37.

ETEA 2023

A body is moved through a displacement of 15m towards North, the total displacement will be zero when body covered the same displacement towards:

- (A) North
- (B) South
- (C) West
- (D) East

Q38.

ETEA 2023

When the range of a projectile is equal to one fourth of the height then which one is true:

- (A) $\tan \theta = 10$
- (B) $\tan \theta = 12$
- (C) $\tan \theta = 16$
- (D) $\tan \theta = 1$

Q39.

ETEA 2023

A body is moving with momentum of 100 kg m/s. What is the magnitude of force required to stop this body in 25 sec?

- (A) 4 N
- (B) 25 N
- (C) 100 N
- (D) 2500 N

Q40.

ETEA 2023

Doubling the initial velocity of a projectile while keeping all other parameters the same, the height reached by the projectile increases by:

- (A) Two times
- (B) Three times
- (C) Four times
- (D) Remains the same

Q41.

ETEA 2023

Neglecting the effect of air resistance how long a stone takes to dropped of a 125 m high building lands on the ground, take $g = 10 \text{ m/s}^2$:

- (A) 3 sec
- (B) 4 sec
- (C) 18 sec
- (D) 5 sec

Q42.

DUHS 2023

What will be the value of acceleration, if a body of mass 0.5 Kg is acted upon by a force of 10 N?

- (A) 40 m/s^2
- (B) 5 m/s^2
- (C) 10 m/s^2
- (D) 20 m/s^2

Q43.

DUHS 2023

What is the time rate of change of linear momentum?

- (A) Acceleration
- (B) Force
- (C) Velocity
- (D) Work

Q44.

DUHS 2023

Due to sudden rain, which of the following is true for the car moving on the road?

- (A) Force of engine decreases
- (B) Balance will not be maintained
- (C) Direction of motion will be effected
- (D) Linear momentum increases

Q45.

DUHS 2023

Two bodies of mass 10 kg and 40 kg are dropped from the same height at the same time. Value of which to the following remains the same during the motion of the two bodies?

- (A) Acceleration
- (B) Kinetic energy
- (C) Potential energy
- (D) Power

Q46.

DUHS 2023

A ball is thrown horizontally with 19.6 m/s. After 2 seconds its horizontal velocity component will be:

- (A) 4.9 m/s
- (B) 9.8 m/s
- (C) 19.6 m/s
- (D) 39.2 m/s

Q47.

DUHS 2023

In the projectile motion, the acceleration in the horizontal direction:

- (A) Remain same
- (B) Varies with time
- (C) Is zero
- (D) Is positive

Q48.

DUHS 2023

A force $2F$ acting on a particle of mass 10kg produces an acceleration of 30 m/s^2 . a force $5F$ acting on a particle of mass M , produces an acceleration of 25 m/s^2 . What is the mass?

- (A) 30 kg
- (B) 21 kg
- (C) 4.8 kg
- (D) 3.3 kg

Q49.

NUMS 2023

If the car is slowing down along negative x axis then acceleration will be along:

- (A) positive x axis
- (B) negative x axis
- (C) positive y axis
- (D) negative y axis

Q50.

NUMS 2023

In perfectly elastic collision:

- (A) Only momentum is conserved
- (B) only total energy is conserved
- (C) Only kinetic energy is conserved
- (D) momentum, kinetic energy and total energy, all are conserved

Q51.

NUMS 2023

The slope of a displacement–time graph is equal to:

- (A) Velocity
- (B) Displacement
- (C) Acceleration
- (D) Distance

Q52.

NUMS 2023

Range of a projectile on a horizontal plane is same for the following pair of angles:

- (A) 15° & 30°
- (B) 60° & 25°
- (C) 75° & 15°
- (D) 50° & 25°

Q53.

NUMS 2023

The product of force and time is equal to:

- (A) Angular momentum
- (B) Force
- (C) Change in momentum
- (D) Velocity

Q54.

NUMS 2023

At what point during the motion of projectile its vertical component of velocity is zero?

- (A) Point of projectile
- (B) Landing point
- (C) Highest point
- (D) Just before landing

Q55.

UHS 2022

What is the shape of velocity–time graph for constant acceleration?

- (A) Parabola line
- (B) Incline curve
- (C) Straight line
- (D) Decline curve

Q56.

UHS 2022

Which of the following is the correct definition of variable velocity?

- (A) Unequal distances are covered in equal intervals of time
- (B) Equal displacements are made in unequal intervals of time
- (C) Unequal displacements are made in equal intervals of time
- (D) Equal intervals of time

Q57.

UHS 2022

A stone thrown horizontally from the top of a tall building follows a path that is:

- (A) Circular
- (B) Hyperbolic
- (C) Made of two straight line segments
- (D) Parabolic

Q58.

UHS 2022

Which of the following is incorrect?

- (A) Reaction force on a body is always balanced by the action force
- (B) Reaction and action forces are always equal
- (C) Action and reaction forces never act on the same body
- (D) Newton's third law is always valid in all situations

Q59.

UHS 2022

When a heavy coin falls a short distance towards the ground it does not reach terminal velocity. Why is this so?

- (A) The coin has not hit the ground
- (B) The weight of coin is equal to air resistance
- (C) The weight of coin increases as air resistance increases
- (D) The weight of coin is more than air resistance

Q60.

SZABMU 2022

Two balls collide each–other, it has been observed that the collision is elastic. Which statement advocates the observation?

- (A) K.E before collision = K.E after collision
- (B) Momentum before collision = Momentum after collision
- (C) K.E before collision $\neq$ K.E after collision
- (D) Momentum before collision $\neq$ momentum after collision

Q61.

SZABMU 2022

The gradient of velocity time is equal to:

- (A) Distance
- (B) Force
- (C) Acceleration
- (D) Speed

Q62.

SZABMU 2022

At what pair of angles for a projectile the ranges are equal?

- (A) $20^\circ, 60^\circ$
- (B) $60^\circ, 30^\circ$
- (C) $40^\circ, 60^\circ$
- (D) $25^\circ, 55^\circ$

Q63.

SZABMU 2022

Two cars travelling on straight road in opposite direction with speed 70 kmh^{-1} and 60 kmh^{-1} , their relative velocity will be:

- (A) 10 kmh^{-1}
- (B) 130 kmh^{-1}
- (C) 65 kmh^{-1}
- (D) 5 kmh^{-1}

Q64.

SZABMU 2022

Two bodies having same mass undergo elastic collision then their velocities after collision will be:

- (A) $v'_1 = 0, v'_2 = v_1$
- (B) $v'_1 = v_2, v'_2 = 0$
- (C) $v'_1 = -v_1, v'_2 = -v_2$
- (D) $v'_1 = v_2, v'_2 = v_1$

Q65.

SZABMU 2022

The angle of a projection of a projectile for which its maximum height and horizontal range are equal is:

- (A) 86°
- (B) 46°
- (C) 66°
- (D) 76°

Q66.

SZABMU 2022

Slope of distance time graph can never be:

- (A) Positive
- (B) Negative
- (C) Constant
- (D) Zero

Q67.

SZABMU 2022

At highest point in a projectile motion, the velocity will be:

- (A) $v_x = 0, v_y = 0$
- (B) $v_y = 0, v_x = \text{constant}$
- (C) $v_x = \text{constant}, v_y = \text{constant}$
- (D) $v_y = \text{constant}, v_x = 0$

Q68.

ETEA 2022

A body covers displacement of 10m towards North and returns back to initial point by covering 10m towards south, its total displacement is:

- (A) 20m North
- (B) 10m South
- (C) 0m along North-south
- (D) 0m

Q69.

ETEA 2022

In Newton's first law of motion which quantity remains constant:

- (A) Velocity
- (B) Angular displacement
- (C) Amplitude
- (D) Amount of work

Q70.

ETEA 2022

Law of inertia satisfies:

- (A) Condition of equilibrium
- (B) Condition of variable force
- (C) Condition of force in contact
- (D) Condition of conservation of mass

Q71.

ETEA 2022

A projectile is launched, its velocity is maximum at:

- (A) Point of projection
- (B) Highest point
- (C) Between launching and highest point
- (D) All points

Q72.

ETEA 2022

The net displacement divided by the total time (t) is known as:

- (A) Instantaneous velocity
- (B) Uniform velocity
- (C) Average velocity
- (D) Variable velocity

Q73.

ETEA 2022

The velocity time graph of a motion starting from rest with uniform acceleration is a straight line:

- (A) Not passing through origin
- (B) Parallel to time axis
- (C) Parallel to velocity axis
- (D) Passing through origin

Q74.

ETEA 2022

A projectile is thrown at an angle of 45° with horizontal and its range is R_1 . Another projectile is thrown at an angle of 45° with vertical and its range is R_2 . The relation between R_1 and R_2 is:

- (A) $R_2 = 2R_1$
- (B) $R_1 = 2R_2$
- (C) $R_1 = R_2$
- (D) $3R_1 = R_2$

Q75.

BUMHS 2022

During a projectile path, air friction affects:

- (A) Initial velocity of launch
- (B) Horizontal motion only
- (C) Vertical motion only
- (D) Both horizontal and vertical motions

Q76.

BUMHS 2022

Which of the following pairs has the same direction always?

- (A) Force, displacement
- (B) Force, velocity
- (C) Force, acceleration
- (D) Force, momentum

Q77.

BUMHS 2022

The third law of motion explains:

- (A) The effect of force
- (B) The existence of force
- (C) The existence of two forces
- (D) The existence of a pair of forces in nature

Q78.

BUMHS 2022

A stone is dropped from a building's top 80 m high from the ground. In how much time will it touch the ground?

- (A) 2 s
- (B) 4 s
- (C) 8 s
- (D) 10 s

Q79.

BUMHS 2022

If two equal masses are in motion with same individual speeds, we can conclude that:

- (A) Their momentums are same
- (B) Their momentums can be different from each other
- (C) Their kinetic energies can be different from each other
- (D) Their total energies are same

Q80.

DUHS 2022

A body is dropped from certain height and falls freely. Its velocity after 5 seconds will be:

- (A) 0.49 m/s
- (B) 9.4 m/s
- (C) 4.9 m/s
- (D) 49 m/s

Q81.

DUHS 2022

A bullet is fired horizontally with 20m/s. In the absence of air friction, its horizontal velocity after 2 seconds will be:

- (A) 10 ms^{-1}
- (B) 5 ms^{-1}
- (C) 20 ms^{-1}
- (D) 40 ms^{-1}

Q82.

DUHS 2022

A box of mass $m = 6\text{kg}$ slides with speed $v = 4\text{m/s}$ across a frictionless floor, it suddenly explodes into two pieces. One piece, with mass $m_1 = 2\text{kg}$ moves in the same direction with speed $v_1 = 8\text{ m/s}$. The velocity of the second piece is:

- (A) 2 m/sec
- (B) 3 m/sec
- (C) 4 m/sec
- (D) 6 m/sec

Q83.

DUHS 2022

A helicopter of weight 'W' is ascending with zero acceleration. The upward force 'F' on it is:

- (A) $F > W$
- (B) $F = \sqrt{W}$
- (C) $F = 0$
- (D) $F = W$

Q84.

DUHS 2022

When a body moves with uniform velocity then it's:

- (A) Average velocity is zero
- (B) Instantaneous velocity is greater than average velocity
- (C) Instantaneous velocity is zero
- (D) Instantaneous velocity is equal to average velocity

Q85.

DUHS 2022

The rate of change of linear momentum of a body is equal to:

- (A) Net force
- (B) Net displacement
- (C) Net torque
- (D) Net inertia

Q86.

NUMS 2022

An elastic collision is the one in which:

- (A) Kinetic energy and momentum is conserved
- (B) Kinetic is conserved but total energy is not conserved
- (C) Momentum is conserved but kinetic energy is not conserved
- (D) Both kinetic energy and momentum are not conserved

Q87.

NUMS 2022

The time rate of change of velocity is called:

- (A) Force
- (B) Acceleration
- (C) Power
- (D) Energy

Q88.

NUMS 2022

In projectile motion, the range of projectile will be maximum at an angle of:

- (A) 30 degrees
- (B) 45 degrees
- (C) 60 degrees
- (D) 90 degrees

Q89.

NUMS 2022

Which of the following is NOT TRUE?

- (A) Action and reaction have same nature
- (B) Action and reaction have same line of action
- (C) Action and reaction never act on same body
- (D) Action and reaction can cancel each other

Q90.

NUMS 2022

Two busses moving at 100 km/h and 80 km/h respectively cross each other while moving in opposite direction. Velocity of one bus relative to other bus is:

- (A) 100 km/h
- (B) 20 km/h
- (C) 80 km/h
- (D) 180 km/h

Q91.

NUMS 2022

Which of the following pair of angles have same range for a projectile?

- (A) 10° and 20°
- (B) 75° and 15°
- (C) 45° and 60°
- (D) 0° and 30°

Q92.

NUMS 2022

The angle of projection of a projectile for which its maximum height and horizontal range are equal is:

- (A) 45°
- (B) 90°
- (C) 0°
- (D) 76°

Q93.

NUMS 2022

The explosion of explosive material is application of:

- (A) Law of conservation of energy
- (B) Law of conservation of mass
- (C) Law of conservation of momentum
- (D) Newton's third law of motion

Q94.

PMDC 2021

At what angle of projection of a projectile the range becomes half of its maximum value.

- (A) 15°
- (B) 30°
- (C) 20°
- (D) 40°

Q95.

PMDC 2021

Vertical velocity vs time graph for a projectile motion

- (A) Varies linearly
- (B) Follow a parabolic path
- (C) Is constant
- (D) Is linear

Q96.

PMDC 2021

The magnitude of displacement is _____

- (A) Size of object A
- (B) Straight line distance between initial and final position
- (C) Size of object B
- (D) Any distance between initial and final position

Q97.

PMDC 2021

If the displacement = 15m and time = 10 seconds the average velocity is

- (A) 12.5 m/s
- (B) 1.5 m/s
- (C) 2.5 m/s
- (D) 3 m/s

Q98.

PMDC 2021

Decrease in velocity per unit time is called

- (A) Acceleration
- (B) Deceleration
- (C) Positive acceleration
- (D) Uniform acceleration

Q99.

PMDC 2021

The slope of velocity-time graph represents

- (A) Displacement
- (B) Acceleration
- (C) Force
- (D) Momentum

Q100.

PMDC 2021

An object is accelerating ____

- (A) Only when its speed changes
- (B) Only when its direction changes
- (C) When its speed or direction changes
- (D) If its velocity is large

Q101.

PMDC 2021

What is the slope of a straight-line graph of position vs. time?

- (A) Velocity
- (B) Displacement
- (C) Distance
- (D) Acceleration

Q102.

PMDC 2021

The coefficient of restitution for a perfectly elastic collision is

- (A) 1
- (B) 0
- (C) ∞
- (D) -1

Q103.

PMDC 2021

What is the accelerating force on the Diwali rocket if it ejects 0.05 kg of gases per second at a velocity of 400 m/s?

- (A) 20 N
- (B) 20 dynes
- (C) 1000 N
- (D) 22 dynes

Q104.

PMDC 2021

If mass is 2 kg and velocity is 35 m/s, then momentum is

- (A) 70 kg m/s
- (B) 90 kg m/s
- (C) 17.5 kg m/s
- (D) 105 kg m/s

Q105.

PMDC 2021

If Velocity time graph shape is parallel to Y-axis the acceleration

- (A) Maximum
- (B) 0
- (C) Infinity
- (D) Minimum

Q106.

PMDC 2020

The slope of distance – time graph will always be:

- (A) Negative
- (B) Positive
- (C) Zero
- (D) Maximum

Q107.

PMDC 2020

At what angle of projection of a projectile the range becomes half of its maximum value?

- (A) 15°
- (B) 20°
- (C) 30°
- (D) 40°

Q108.

PMDC 2020

If we drop an object, its initial velocity is zero. How far will it fall in time 't'?

- (A) $9.8t^2$
- (B) $4.9t^2$
- (C) $0.49t^2$
- (D) $98t^2$

Q109.

PMDC 2020

The newton – second is unit of:

- (A) Work
- (B) Power
- (C) Impulse
- (D) Angular momentum

Q110.

NUMS 2020

Which one of the following is the angle of projection of a projectile if its range is equal to its height?

- (A) 48°
- (B) 60°
- (C) 90°
- (D) 76°

Q111.

NUMS 2020

The product of force and time is equal to:

- (A) Angular momentum
- (B) Force
- (C) Change in momentum
- (D) Velocity

Q112.

MDCAT 2019

If two objects of equal masses 'm' are moving towards each other with the same speeds 'v' then what will be the total final momentum after elastic head-on collision?

- (A) $-mv$ kg/s
- (B) $2mv$ kg/s
- (C) mv kg m/s
- (D) 0 kg m/s

Q113.

MDCAT 2019

For projectile motion in the absence of air resistance:

- (A) Vertical speed is constant
- (B) Horizontal acceleration is zero
- (C) Horizontal force is constant
- (D) Vertical acceleration is zero

Q114.

MDCAT 2019

The range of the projectile depends upon the velocity of the projection and the angle of the projection i.e 45° . For a fixed velocity, when the angle of projection is larger than 45° . Which of the following is correct?

- (A) Both the height and the range attained by the projectile will be less
- (B) The height attained by the projectile will be less but the range is more
- (C) Both the height and the range attained by the projectile will be more
- (D) The height attained by the projectile will be more but the range is less

Q115.

MDCAT 2018

If slope of velocity time graph is not constant at different points, then body is moving with ____

- (A) Uniform velocity
- (B) Average acceleration
- (C) Increasing acceleration
- (D) Constant acceleration

Q116.

MDCAT 2018

A cyclist is traveling at 15 ms^{-1} she applies brakes so that she doesn't collide with the wall in front of her distance of 18m. Calculate the magnitude of deceleration.

- (A) 6.3 ms^{-2}
- (B) 13 ms^{-2}
- (C) 5.3 ms^{-2}
- (D) 12.5 ms^{-2}

Q117.

MDCAT 2018

Newton first law of motion is also known is

- (A) Law of inertia
- (B) Law of universal gravity
- (C) Law of electromagnetism
- (D) Law of conservation

Q118.

MDCAT 2017

The ratio of displacement along diameter and total distance along circle:

- (A) $1 : \pi$
- (B) $2 : \pi$
- (C) $\pi : 1$
- (D) $\pi : 2$

Q119.

MDCAT 2017

Arshad is driving down 7th street. He drives 150 meter is 18 seconds. Assume he does not speed up or slow down. What is his speed?

- (A) 0.38 m/s
- (B) 8.33 m/s
- (C) 126 m/s
- (D) 58.33 m/s

Q120.

MDCAT 2017

The distance travelled by a moving car with velocity 15 m/s in 2 seconds, decelerates at 2 m/s^2 is equal to

- (A) 30m
- (B) 16m
- (C) 34m
- (D) 26m

Q121.

MDCAT 2017

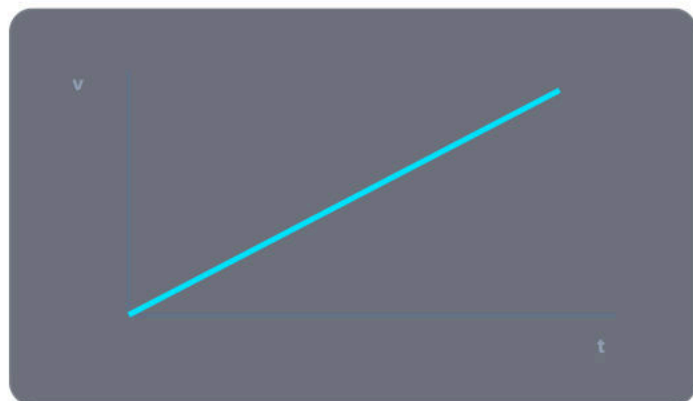
The value of ratio of displacement to distance is:

- (A) Always one
- (B) More than one
- (C) Always less than one
- (D) Equal or less than one

Q122.

MDCAT 2017

Which of the following v-t graph represents the constant acceleration:



- (A) Straight descending line
- (B) Concave upward curve
- (C) Concave downward curve
- (D) All of these

Q123.

ETEA 2017

The numerical ratio of displacement to distance is:

- (A) Always less than one
- (B) Always equal to one
- (C) Always more than one
- (D) Equal to or less than one

Q124.

ETEA 2017

A bullet of mass m moving with a velocity v is fired into large wooden block of mass M if the bullet remains embedded in the wooden block, the velocity of the system will be:

- (A) $\frac{M}{M+m} v$
- (B) $\frac{m}{M+m} v$
- (C) $\frac{M}{M-m} v$
- (D) $\frac{m}{M-m} v$

Q125.

ETEA 2015

Weight rather than mass be used in calculating ____

- (A) Moment of inertia of a body
- (B) The stress in wire due to load hanging from it
- (C) The binding energy of the nucleus
- (D) The gravitational force between the two bodies

Q126.

ETEA 2014

A ball is dropped from the roof of a very tall building. What is its velocity after falling for 5.0s?

- (A) 1.96 ms^{-1}
- (B) 9.80 ms^{-1}
- (C) 49.0 ms^{-1}
- (D) 98.0 ms^{-1}

Q127.

ETEA 2014

A projectile is launched at 45° to the horizontal with initial K, Energy, E. Assuming air resistance to be negligible, what will be the kinetic energy of the projectile when it reaches its highest point?

- (A) $0.71E$
- (B) $0.50E$
- (C) $0.87E$
- (D) E

Q128.

ETEA 2011

One ball is thrown vertically upward with a velocity of 98 m/s. If it takes 10 seconds to reach the highest point, then the acceleration of the ball is

- (A) 9.8 ms^{-2}
- (B) 980 ms^{-2}
- (C) 98 ms^{-2}
- (D) -9.8 ms^{-2}

Q129.

MDCAT 2010

If a force of 12N is applied on a body and its momentum is changed from 60 kgms^{-1} to 36 kgms^{-1} , then find the time during which this force acts:

- (A) 1 second
- (B) 12 seconds
- (C) 2 seconds
- (D) 24 seconds

Q130.

MDCAT 2010

Time of projectile's flight is ____

- (A) $\frac{v_i^2 \sin^2 \theta}{g}$
- (B) $\frac{v_i^2 \sin \theta}{g}$
- (C) $\frac{2v_i \sin \theta}{g}$
- (D) $v_i \sin^2 \theta$

Q131.

MDCAT 2010

If the velocity of the body changes by equal amount in equal intervals of time, the body is said to have:

- (A) Variable acceleration
- (B) Uniform velocity
- (C) Uniform acceleration
- (D) Negative acceleration

Q132.

MDCAT 2010

For finding the height of projectile, the equation used is:

- (A) $2S = a(v_f^2 - v_i^2)$
- (B) $S = 2a(v_f^2 - v_i^2)$
- (C) $2aS = v_f^2 - v_i^2$
- (D) $a = 2S(v_f^2 - v_i^2)$

Q133.

MDCAT 2009

A body is moving with an initial velocity of 2 kms^{-1} . After a time of 50 secs its velocity becomes 1.5 kms^{-1} . Its acceleration will be:

- (A) 30 m s^{-2}
- (B) 20 m s^{-2}
- (C) 40 m s^{-2}
- (D) 10 m s^{-2}

Q134.

MDCAT 2009

In elastic collision, when a massive body collides with light body at conditions $m_1 \gg m_2$ and $v_2 = 0 \text{ ms}^{-1}$, then the change in velocity will be written as:

- (A) $v'_1 \approx -v_1; v'_2 \approx v_1$
- (B) $v'_1 \approx v_1; v'_2 \approx 2v_1$
- (C) $v'_1 \approx v_1; v'_2 \approx 0$
- (D) $v'_1 \approx -v_1; v'_2 \approx 0$

Q135.

MDCAT 2008

The vertical velocity of ball thrown upward ____ with time.

- (A) Decreases linearly
- (B) Doubles
- (C) Remains constant
- (D) Decreases parabolically

Q136.

MDCAT 2008

An ____ missile is called a ballistic missile.

- (A) Un-powered and guided
- (B) Powered and guided
- (C) Un-guided and powered
- (D) Un-powered and un-guided

Q137.

ETEA 2005

A ball is just allowed to fall from the window of a moving train, it will hit the ground following:

- (A) Circular path
- (B) Hyperbolic
- (C) Straight line path
- (D) Parabolic path

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 02. Force & Motion.

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Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	B	SZABMU 2024	29	B	UHS 2023	57	D	UHS 2022	85	A	DUHS 2022	113	B	MDCAT 2019
2	D	SZABMU 2024	30	D	SZABMU 2023	58	A	UHS 2022	86	A	NUMS 2022	114	D	MDCAT 2019
3	D	SZABMU 2024	31	A	SZABMU 2023	59	D	UHS 2022	87	B	NUMS 2022	115	C	MDCAT 2018
4	A	SZABMU 2024	32	B	SZABMU 2023	60	A	SZABMU 2022	88	B	NUMS 2022	116	A	MDCAT 2018
5	A	SZABMU 2024	33	C	SZABMU 2023	61	C	SZABMU 2022	89	D	NUMS 2022	117	A	MDCAT 2018
6	C	KU 2024	34	A	SZABMU 2023	62	B	SZABMU 2022	90	D	NUMS 2022	118	A	MDCAT 2017
7	B	KU 2024	35	A	SZABMU 2023	63	B	SZABMU 2022	91	B	NUMS 2022	119	B	MDCAT 2017
8	A	KU 2024	36	A	ETEA 2023	64	D	SZABMU 2022	92	D	NUMS 2022	120	D	MDCAT 2017
9	C	KU 2024	37	B	ETEA 2023	65	D	SZABMU 2022	93	C	NUMS 2022	121	D	MDCAT 2017
10	B	UHS 2024	38	C	ETEA 2023	66	B	SZABMU 2022	94	A	PMDC 2021	122	A	MDCAT 2017
11	C	UHS 2024	39	A	ETEA 2023	67	B	SZABMU 2022	95	A	PMDC 2021	123	D	ETEA 2017
12	C	UHS 2024	40	C	ETEA 2023	68	D	ETEA 2022	96	B	PMDC 2021	124	B	ETEA 2017
13	C	NUMS 2024	41	D	ETEA 2023	69	A	ETEA 2022	97	B	PMDC 2021	125	D	ETEA 2015
14	B	NUMS 2024	42	D	DUHS 2023	70	A	ETEA 2022	98	B	PMDC 2021	126	C	ETEA 2014
15	C	NUMS 2024	43	B	DUHS 2023	71	A	ETEA 2022	99	B	PMDC 2021	127	B	ETEA 2014
16	B	NUMS 2024	44	B	DUHS 2023	72	C	ETEA 2022	100	C	PMDC 2021	128	D	ETEA 2011
17	D	BUMHS 2024	45	A	DUHS 2023	73	D	ETEA 2022	101	A	PMDC 2021	129	C	MDCAT 2010
18	C	BUMHS 2024	46	C	DUHS 2023	74	C	ETEA 2022	102	A	PMDC 2021	130	C	MDCAT 2010
19	D	BUMHS 2024	47	C	DUHS 2023	75	D	BUMHS 2022	103	A	PMDC 2021	131	C	MDCAT 2010
20	C	BUMHS 2024	48	A	DUHS 2023	76	C	BUMHS 2022	104	A	PMDC 2021	132	C	MDCAT 2010
21	C	BUMHS 2024	49	A	NUMS 2023	77	D	BUMHS 2022	105	C	PMDC 2021	133	D	MDCAT 2009
22	C	BUMHS 2024	50	D	NUMS 2023	78	B	BUMHS 2022	106	B	PMDC 2020	134	B	MDCAT 2009
23	D	BUMHS 2024	51	A	NUMS 2023	79	B	BUMHS 2022	107	A	PMDC 2020	135	A	MDCAT 2008
24	C	UHS 2023	52	C	NUMS 2023	80	D	DUHS 2022	108	B	PMDC 2020	136	D	MDCAT 2008
25	A	UHS 2023	53	C	NUMS 2023	81	C	DUHS 2022	109	C	PMDC 2020	137	D	ETEA 2005
26	C	UHS 2023	54	C	NUMS 2023	82	A	DUHS 2022	110	D	NUMS 2020			
27	B	UHS 2023	55	C	UHS 2022	83	D	DUHS 2022	111	C	NUMS 2020			
28	B	UHS 2023	56	C	UHS 2022	84	D	DUHS 2022	112	D	MDCAT 2019			

TOTAL
MCQS
137

CORRECT

INCORRECT

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ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (B)

SZABMU 2024

The quantity of motion present in a body can be measured by ____.

CORE CONCEPT AND DERIVATION

Historical definitions of physical quantities by Isaac Newton.

Solution:

- Newton originally coined the phrase "quantity of motion" to describe how hard it is to stop a moving object.
- Because stopping power depends heavily on both the object's mass and its velocity, the exact physical measure is momentum ($\vec{P} = m\vec{v}$).

Why other options are incorrect:

Velocity and speed describe how fast it moves, but completely ignore the mass. A speeding bullet and a speeding train have the same speed, but vastly different "quantities of motion" (momentum).

Question #2 Key: (D)

SZABMU 2024

The slope of velocity-time graph gradually decreases, then the body is said to be moving with

CORE CONCEPT AND DERIVATION

The slope of a velocity-time graph is identically the acceleration.

Solution:

- If the slope is "gradually decreasing," it means the value of the slope is changing at every point.
- Because slope = acceleration, a changing slope strictly dictates a changing, non-constant acceleration.
- Therefore, the body is moving with variable acceleration.

Why other options are incorrect:

"Negative acceleration" just tells you the sign of a constant slope. "Uniform velocity" would mean zero acceleration. Only "Variable" directly captures the *changing* nature of the slope.

Question #3 Key: (D)

SZABMU 2024

The acceleration can be determined by the gradient of ____

CORE CONCEPT AND DERIVATION

Definition of acceleration through kinematics.

Solution:

- Acceleration is the rate of change of the velocity vector over time ($\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$).
- The gradient (slope) of a velocity-time graph mathematically plots this exact $\frac{\Delta v}{\Delta t}$ ratio.

Why other options are incorrect:

Displacement-time gives velocity. Speed-time gives magnitude of acceleration but lacks the crucial directional vector data required for true acceleration.

Question #4 Key: (A)

SZABMU 2024

The rate of change of linear momentum is equal to ____

CORE CONCEPT AND DERIVATION

Newton's Second Law verbatim.

Solution:

- According to Newton, the applied net external force strictly equals the time rate of change of linear momentum ($F = \frac{dP}{dt}$).

Why other options are incorrect:

Impulse is the *change* in momentum, not the *rate of change*. Torque is the rotational equivalent of force.

Question #5 Key: (A)

SZABMU 2024

At what angle made by projectile with x-axis, we can get 1/4th value of maximum height achieved by

CORE CONCEPT AND DERIVATION

Relate height at a given angle to absolute maximum height (which occurs at 90 degrees).

Formula:

$$H = H_{\max} \sin^2 \theta$$

Solution:

- Maximum height is achieved when $\theta = 90^\circ$ ($\sin 90^\circ = 1$), so

$$H_{\max} = \frac{v^2}{2g}$$

- We want $H = \frac{1}{4} H_{\max}$.

$$\sin^2 \theta = \frac{1}{4}$$

- Taking the square root: $\sin \theta = \frac{1}{2}$.

- The angle whose sine is 0.5 is exactly 30° .

Why other options are incorrect:

At 45 degrees, $H = 0.5 H_{\max}$. At 60 degrees, $H = 0.75 H_{\max}$.

Question #6 Key: (C)

KU 2024

Which of the following pairs correctly matches a physical quantity with its SI unit?

CORE CONCEPT AND DERIVATION

Standardization of the International System of Units (SI).

Solution:

- Power measures the rate of doing work (Joules per second). The SI derived unit for this is the Watt (W).

Why other options are incorrect:

Energy is Joules. Force is Newtons. Velocity is m/s (m/s² is acceleration).

Question #7 Key: (B)

KU 2024

_____ is the natural tendency of an object to remain at rest or in motion with constant velocity?

CORE CONCEPT AND DERIVATION

Defining fundamental physical behaviors governed by mass.

Solution:

- Inertia is fundamentally defined as the inherent property or "sluggishness" of matter that perfectly resists any attempt to change its current state of motion.
- It aligns perfectly with Newton's First Law.

Why other options are incorrect:

Mass is a *measure* of inertia, but inertia is the conceptual behavioral tendency itself. Friction and weight are external forces.

Question #8 Key: (A)

KU 2024

A car in motion hits and gets crashed into a tree trunk, what is NOT conserved?

CORE CONCEPT AND DERIVATION

Car crashes are violently inelastic collisions.

Solution:

- In all macroscopic collisions (including crashes), total linear momentum is strictly conserved across the entire system.
- However, severe permanent deformation, crunching metal, heat, and loud sounds dissipate massive amounts of kinetic energy.
- Therefore, Kinetic Energy is the quantity that is decidedly NOT conserved.

Why other options are incorrect:

Momentum is always conserved. Because momentum is conserved, options claiming it isn't are false.

Question #9 Key: (C)

KU 2024

The vertical and horizontal component of the projectile motion are

CORE CONCEPT AND DERIVATION

Galilean independence of orthogonal vectors.

Solution:

- A core tenet of projectile physics is that perpendicular motion vectors do not influence one another.
- Gravity only accelerates an object downward. It has strictly zero effect on the horizontal velocity.
- Therefore, the vertical rise and fall is completely mathematically independent of how fast the object moves horizontally.

Why other options are incorrect:

If they were dependent, a faster horizontal speed would alter the time it takes to fall to the ground, which Galileo famously proved false.

Question #10 Key: (B)

UHS 2024

The range of projectile will be maximum if the factor [Formula] becomes

CORE CONCEPT AND DERIVATION

Maximizing the kinematic range equation.

Formula:

$$R = \frac{v_i^2 \sin(2\theta)}{g}$$

Solution:

- For a given initial velocity v_i and gravity g , the range R relies entirely on the value of $\sin(2\theta)$.
- The mathematical sine function fluctuates strictly between -1 and +1.
- Therefore, its absolute maximum possible value is 1, which directly yields the maximum range.

Why other options are incorrect:

Zero means the projectile lands exactly where it started. 2 is mathematically impossible for a raw sine function.

Question #11 Key: (C)

UHS 2024

The two-dimensional motion under constant acceleration due to gravity is called:

CORE CONCEPT AND DERIVATION

Standard definition of classical kinematic trajectories.

Solution:

- When an object is launched into a 2D plane (x and y axes) and the only significant force acting on it is the constant downward pull of gravity, it traces a parabolic path.
- This specific physical scenario is formally titled "Projectile Motion".

Why other options are incorrect:

Circular motion requires a centripetal force constantly changing direction. Vibratory motion is 1D oscillation. Rotational deals with spinning objects.

Question #12 Key: (C)

UHS 2024

In velocity time graph the area under graph is equal to the:

CORE CONCEPT AND DERIVATION

Geometric interpretation of integral calculus on kinematic graphs.

Formula:

$$\text{Area} = \int v \, dt = d$$

Solution:

- The area under any curve is calculated by multiplying the y-axis variable by the x-axis variable.
- Velocity (m/s) multiplied by time (s) yields meters.
- Meters strictly denote a spatial metric: Displacement (or total Distance covered, depending on sign conventions).

Why other options are incorrect:

Acceleration is the slope. Velocity is the actual y-value of the line. Speed is scalar velocity.

Question #13 **Key: (C)**

NUMS 2024

If you stops your car quickly by wearing seat belts, chance of injury is greatly reduced because seat belt app...

CORE CONCEPT AND DERIVATION

Seatbelts utilize the impulse-momentum theorem and Newton's Third Law to protect passengers.

Solution:

- During a sudden stop, your body wants to continue forward due to inertia.
- The seatbelt stretches slightly, applying a restraining force directly backward (opposite) against your chest to safely reduce your momentum over a longer time span.
- This opposite force counters the forward inertia, preventing a high-force impact with the windshield.

Why other options are incorrect:

Extra force is vague. Perpendicular force would push you sideways. Zero force means the seatbelt did absolutely nothing to restrain you.

Question #14 **Key: (B)**

NUMS 2024

A ball with momentum 8 kg m/s hits a wall and bounces straight back without losing K.E. the change in momentum...

CORE CONCEPT AND DERIVATION

Momentum is a highly directional vector. Bouncing reverses the direction entirely.

Formula:

$$\Delta P = P_f - P_i$$

Solution:

- Because it doesn't lose K.E., the collision is perfectly elastic, meaning it bounces back with the exact same speed.
- Initial momentum $P_i = +8 \text{ kg m/s}$.
- Final momentum (reversed direction) $P_f = -8 \text{ kg m/s}$.
- Change in momentum: $\Delta P = -8 - 8 = -16 \text{ Ns (or kg m/s)}$.

Why other options are incorrect:

If one ignores direction, $8 - 8 = 0$. Adding them incorrectly ignores the definition of a "change" (final - initial).

Question #15 Key: (C)

NUMS 2024

In projectile motion for which angle maximum height is half its range?

CORE CONCEPT AND DERIVATION

Solve the geometric relation for Range and Maximum Height.

Formula:

$$\frac{H}{R} = \frac{\tan \theta}{4}$$

Solution:

- The prompt specifies that Height is half of Range: $H = 0.5R$.

- Therefore, $\frac{H}{R} = 0.5$.

- Substitute this in:

$$0.5 = \frac{\tan \theta}{4} \implies \tan \theta = 2$$

- Take inverse tangent: $\theta = \tan^{-1}(2) \approx 63.4^\circ$.
- Rounding gives 63° .

Why other options are incorrect:

Using $R = H/2$ gives $\tan \theta = 8$ (approx 83°). The other angles do not yield a tangent of 2.

Question #16 Key: (B)

NUMS 2024

The horizontal range of projectile will be maximum when?

CORE CONCEPT AND DERIVATION

Mathematical boundaries of the range equation.

Formula:

$$R = \frac{v_i^2 \sin(2\theta)}{g}$$

Solution:

- Range R is directly proportional to the term $\sin(2\theta)$.
- The mathematical sine function hits its absolute peak value at exactly 1.
- Therefore, maximum range occurs exactly when the factor $\sin(2\theta) = 1$.

Why other options are incorrect:

Option A corresponds to max height. Options C and D result in zero trajectory.

Question #17 Key: (D)

BUMHS 2024

Which of the following is a vector quantity?

CORE CONCEPT AND DERIVATION

Identifying physical quantities requiring strictly directional data.

Solution:

- Electric Flux is the dot product of Electric field (vector) and Area (vector), resulting in a pure scalar.
- Work Done is the dot product of Force (vector) and Displacement (vector), also resulting in a scalar.
- All forms of Energy (including Potential) are scalar quantities by definition.
- Since none of the options require a spatial direction to be fully defined, "None of the given options" is correct.

Why other options are incorrect:

Students mistakenly associate "electric" or "work" with vectors because their component formulas contain vectors, but dot products always yield scalars.

Question #18 Key: (C)

BUMHS 2024

Which of the following believed in absolute time? I Newton II Galileo

CORE CONCEPT AND DERIVATION

Historical paradigm of classical mechanics before Einstein's relativity.

Solution:

- Both Galileo Galilei and Isaac Newton constructed their entire frameworks of classical kinematics upon the rigid assumption that time is a universal, absolute constant.
- In their universe, one second ticking on Earth was mathematically identical to one second ticking anywhere else, perfectly independent of an observer's speed or gravity.
- It wasn't until Albert Einstein's Special Relativity that time was proven to be relative.

Why other options are incorrect:

Selecting only one ignores that classical mechanics as a whole was founded on absolute time.

Question #19 Key: (D)

BUMHS 2024

A 40kg body starting from rest falls through a vertical distance of 125cm to ground. The velocity of the body ...

CORE CONCEPT AND DERIVATION

Energy conservation or the third equation of kinematics, heavily relying on strict unit conversion.

Formula:

$$v = \sqrt{2gh}$$

Solution:

- Mass is irrelevant for free fall speed.
- CRITICAL: Convert height from cm to meters. $h = 125 \text{ cm} = 1.25 \text{ meters}$.
- Use gravity $g = 10 \text{ m/s}^2$ (standard estimation).

$$v = \sqrt{2 \times 10 \times 1.25}$$

$$v = \sqrt{25} = 5 \text{ m/s}$$

Why other options are incorrect:

If a student forgets to convert cm to meters, they calculate $\sqrt{2 \times 10 \times 125} = \sqrt{2500} = 50$. If they didn't square root properly, they might land on 25. The 40kg mass is purely a distractor.

Question #20 **Key: (C)**

BUMHS 2024

A person's life was saved in a car accident due to airbags system. During that car accident, airbags expanded ...

CORE CONCEPT AND DERIVATION

Impulse-Momentum Theorem applications to human safety.

Formula:

$$F = \frac{\Delta p}{\Delta t}$$

Solution:

- In a crash, the passenger's momentum must be reduced to strictly zero (Δp is fixed).
- Airbags are soft, meaning they gently compress as the head hits them. This dramatically stretches out the impact time interval (Δt increases).
- Because time is in the denominator, a much larger time mathematically produces a much smaller impact force on the skull.

Why other options are incorrect:

Greater force would shatter the skull. Smaller time (hitting the hard glass) mathematically spikes the force to lethal levels.

Question #21 **Key: (C)**

BUMHS 2024

Which of the following statements is absolutely correct:- I. Forces can stop or make objects move faster II. $F \propto a$...

CORE CONCEPT AND DERIVATION

The foundational capabilities of force as defined by Newton.

Solution:

- A net external force produces an acceleration vector.
- If this acceleration acts against motion, the object slows/stops (Statement I).
- If it acts with motion, it speeds up (Statement I).
- If the force acts perpendicular or diagonally to the current velocity (like gravity on a projectile or a steering wheel turning a car), it alters the path/direction (Statement II).
- Therefore, both statements flawlessly describe classical force mechanics.

Why other options are incorrect:

Excluding either statement artificially ignores half of Newton's Second Law.

Question #22 **Key: (C)**

BUMHS 2024

Gravitational mass of a body is

CORE CONCEPT AND DERIVATION

Distinguishing between inertial mass and gravitational mass formulas.

Solution:

- Gravitational mass measures an object's precise response to a gravitational field, dictating its weight.
- The weight formula is $W = m_g g$.
- Rearranging for gravitational mass gives $m_g = \frac{W}{g}$.

Why other options are incorrect:

F/a calculates strictly *inertial* mass (resistance to general acceleration). While experimentally equivalent to gravitational mass, its formulaic definition arises from Newton's Second Law, not gravitation.

Question #23 Key: (D)

BUMHS 2024

A set of coordinate axes in which measurements are made is called:

CORE CONCEPT AND DERIVATION

The overarching physical terminology for an observation platform.

Solution:

- In physics, you cannot measure position or velocity in a vacuum; you must attach your ruler and clock to a specific, defined viewpoint.
- A coordinate system (like x, y, z axes) combined with a synchronized clock constitutes a "Frame of Reference".
- It is the foundational stage upon which all kinematic measurements are mathematically evaluated.

Why other options are incorrect:

Cartesian, rectangular, and spherical describe specific mathematical geometry types of coordinates, but the physical concept defining the measurement space itself is strictly the Frame of Reference.

Question #24 Key: (C)

UHS 2023

Which of the following is the correct definition of variable velocity?

CORE CONCEPT AND DERIVATION

Velocity defines the strict rate of change of displacement over time.

Solution:

- If a body has uniform velocity, it covers the exact same displacement (same distance, same direction) every single second.
- Variable velocity occurs if the rate changes. Thus, measuring equal time intervals (e.g., 1-second chunks) will yield unequal displacement vectors (either a different distance was covered, or it turned a corner).

Why other options are incorrect:

Option A describes variable speed (because distance is scalar).
Option D describes uniform velocity.

Question #25 Key: (A)

UHS 2023

The velocity-time plot for a moving particle shows a straight line.
This means:

CORE CONCEPT AND DERIVATION

The slope of a velocity-time graph represents acceleration.

Solution:

- A straight line strictly possesses a constant, unchanging geometric slope.
- Because the slope is constant, the physical quantity it represents (acceleration) must also be perfectly constant.
- It might be zero (horizontal line) or a non-zero constant (tilted line), but it strictly classifies as uniform/constant acceleration.

Why other options are incorrect:

If the line crosses the x-axis, the velocity becomes negative, meaning the particle DID turn around. Displacement is the area under the curve, which changes constantly.

Question #26 Key: (C)

UHS 2023

A man is in a car that is moving with the velocity of 36km/hr. His speed with respect to the car is:

CORE CONCEPT AND DERIVATION

Relative velocity depends on the chosen frame of reference.

Solution:

- The man is sitting inside the car. Therefore, both the man and the car share the exact same velocity vector relative to the ground.
- To find his speed *with respect to the car*, we set the car as the stationary frame of reference.
- Since he is not walking around inside the car, his position relative to the steering wheel doesn't change. Thus, his relative speed is zero.

Why other options are incorrect:

10 m/s (which is 36 km/h) would be his speed relative to a stationary observer on the sidewalk outside.

Question #27 Key: (B)

UHS 2023

On which car there is resultant force?

CORE CONCEPT AND DERIVATION

A net resultant force is strictly required to produce an acceleration (Newton's Second Law). Acceleration occurs if either speed OR direction changes.

Solution:

- A car moving around a bend is constantly changing its direction of travel.
- Because velocity is a vector, this continuous change in direction constitutes an acceleration, even if the speedometer (speed) remains constant.
- To create this centripetal acceleration, a resultant force (friction from the tires) must be acting toward the center of the bend.

Why other options are incorrect:

Stationary cars, or cars moving straight ahead at constant velocity (horizontal or uphill), have strictly zero acceleration. Thus, their resultant net force is zero.

Question #28 Key: (B)

UHS 2023

If two equal masses are in motion with same individual speeds, we can conclude that

CORE CONCEPT AND DERIVATION

Repeated question concept testing the vector nature of momentum.

Solution:

- Momentum ($\vec{P} = m\vec{v}$) requires matching direction, not just speed.
- Because their travel directions are unknown, their momentum vectors could be entirely different.

Why other options are incorrect:

Their kinetic energies MUST be the same because K.E. is a scalar strictly dictated by mass and speed.

Question #29 Key: (B)

UHS 2023

In the displacement-time graph, if the slope is constant the velocity is

CORE CONCEPT AND DERIVATION

Graph interpretation requires knowing what the slope physically represents.

Solution:

- The slope of a displacement-time graph mathematically equals velocity ($v = \frac{\Delta d}{\Delta t}$).
- If a line has a strictly constant slope (a straight line), then the value it represents (velocity) must also be completely constant.

Why other options are incorrect:

Variable velocity would require a curved line (changing slope). Infinite velocity is physically impossible.

Question #30 Key: (D)

SZABMU 2023

The car is speeding up along negative y axis then acceleration will be along:

CORE CONCEPT AND DERIVATION

When an object is speeding up, its velocity vector and its acceleration vector must point in the exact same direction.

Solution:

- The car is moving along the negative y-axis. This means its velocity points strictly toward the negative y direction.
- Because it is "speeding up", the force causing it to accelerate must be pushing it in the same direction it is already going.
- Therefore, the acceleration vector is parallel to the velocity vector, pointing along the negative y-axis.

Why other options are incorrect:

If acceleration pointed to the Positive y-axis, the car would be slowing down (braking). X-axis acceleration would cause it to curve.

Question #31 Key: (A)

SZABMU 2023

Momentum is product of mass and velocity, then momentum and velocity are:

CORE CONCEPT AND DERIVATION

Multiplying a vector by a strictly positive scalar preserves its direction entirely.

Formula:

$$\vec{p} = m\vec{v}$$

Solution:

- Mass (m) is an intrinsically positive scalar quantity.
- When the velocity vector ($\vec{v}$) is multiplied by mass, the resulting momentum vector ($\vec{p}$) is scaled up, but its geometric direction is untouched.
- Therefore, momentum ALWAYS points exactly in the same direction as velocity. Vectors in the same direction are parallel.

Why other options are incorrect:

Antiparallel would require a negative mass, which does not exist in classical physics.

Question #32 Key: (B)

SZABMU 2023

Which of the pair of two projectiles projected at different angles have same ranges:

CORE CONCEPT AND DERIVATION

Complementary angles (angles that sum to exactly 90 degrees) always yield identical horizontal ranges, provided initial velocity is the same.

Solution:

- Check the sums:
- A: $30 + 70 = 100^\circ$
- B: $40 + 50 = 90^\circ$ (Complementary!)
- C: $35 + 40 = 75^\circ$
- D: $45 + 40 = 85^\circ$

Why other options are incorrect:

Only Option B fulfills the $\theta_1 + \theta_2 = 90^\circ$ requirement.

Question #33 Key: (C)

SZABMU 2023

The slope of velocity-time graph gives us:

CORE CONCEPT AND DERIVATION

The geometric slope is the change in the y-axis divided by the change in the x-axis.

Formula:

$$\text{Slope} = \frac{\Delta v}{\Delta t}$$

Solution:

- The rate of change of velocity (Δv) over time (Δt) is physically defined as acceleration.

Why other options are incorrect:

Area gives displacement/distance. The y-coordinate itself gives the velocity/speed.

Question #34 Key: (A)

SZABMU 2023

The time rate of change of linear momentum of a body is equal to:

CORE CONCEPT AND DERIVATION

This statement is the actual, fundamental phrasing of Newton's Second Law.

Formula:

$$F_{net} = \frac{\Delta P}{\Delta t}$$

Solution:

- A net force must be applied to change an object's momentum over time. The magnitude of this force equals the rate of momentum change.

Why other options are incorrect:

Acceleration is the rate of change of velocity. Power is the rate of change of energy.

Question #35 Key: (A)

SZABMU 2023

At what angle of projection of a projectile the range becomes half of its maximum value?

CORE CONCEPT AND DERIVATION

Recalling the range formula relative to maximum range.

Formula:

$$R = R_{max} \sin(2\theta)$$

Solution:

- Set $R = 0.5R_{max}$.

$$0.5 = \sin(2\theta)$$

- The angle whose sine is 0.5 is 30° .
- Therefore, $2\theta = 30^\circ \implies \theta = 15^\circ$.

Why other options are incorrect:

A very common error is forgetting the '2' multiplier inside the sine function and choosing 30° .

Question #36 Key: (A)

ETEA 2023

Equal forces F act on isolated bodies A and B. The mass of B is $1/5$ times that of A. The magnitude of the acceleration...

CORE CONCEPT AND DERIVATION

Newton's Second Law establishes an inverse relationship between mass and acceleration for a constant force.

Formula:

$$a = \frac{F}{m}$$

Solution:

- Let body A have mass m_A and acceleration a_A .
- Body B has mass $m_B = \frac{1}{5}m_A$ and acceleration a_B .
- Since the force is the same: $m_A a_A = m_B a_B$.

- Substitute m_B :

$$m_A a_A = \left(\frac{1}{5}m_A\right) a_B$$

- Cancel m_A :

$$a_A = \frac{1}{5}a_B$$

Why other options are incorrect:

Because A is strictly 5 times heavier than B, the same push will cause A to accelerate at only $1/5$ the rate of B.

Question #37 Key: (B)

ETEA 2023

A body is moved through a displacement of 15m towards North, the total displacement will be zero when body cov...

CORE CONCEPT AND DERIVATION

Displacement vectors sum geometrically. To achieve a net zero displacement, the return vector must perfectly cancel the initial vector.

Solution:

- Initial vector: +15 m North.
- To return to the exact starting point (origin), the body must travel precisely backward along the same line.
- The opposite compass direction of North is South. Covering 15m South perfectly zeroes the displacement.

Why other options are incorrect:

More North simply adds distance. East and West create diagonal hypotenuse displacements (Pythagorean theorem).

Question #38 Key: (C)

ETEA 2023

When the range of a projectile is equal to one fourth of the height then which one is true:

CORE CONCEPT AND DERIVATION

Utilize the standard identity linking Range, Height, and Launch Angle.

Formula:

$$\frac{H}{R} = \frac{\tan \theta}{4}$$

Solution:

- The problem states that Range is exactly one fourth of the Height: $R = \frac{H}{4}$.
- Rearranging gives: $\frac{H}{R} = 4$.
- Substitute this into our identity:

$$4 = \frac{\tan \theta}{4}$$

- Multiply both sides by 4:

$$\tan \theta = 16$$

Why other options are incorrect:

Misinterpreting the fraction (e.g., assuming $H = R/4$) would yield $\tan \theta = 1$. Arithmetic errors lead to 10 or 12.

Question #39 **Key: (A)**

ETEA 2023

A body is moving with momentum of 100 kg m/s. What is the magnitude of force required to stop this body in 25 ...

CORE CONCEPT AND DERIVATION

Force evaluates as the rate of change of momentum.

Formula:

$$F = \frac{\Delta p}{\Delta t}$$

Solution:

- Initial momentum $p_i = 100 \text{ kg m/s}$.
- Final momentum $p_f = 0 \text{ kg m/s}$ (because the body is stopped).
- Change in momentum magnitude $\Delta p = 100$.
- Time interval $\Delta t = 25 \text{ s}$.

- $$F = \frac{100}{25} = 4 \text{ Newtons}$$

Why other options are incorrect:

Multiplying instead of dividing yields 2500N. The others are distractors derived from numbers strictly in the prompt.

Question #40 **Key: (C)**

ETEA 2023

Doubling the initial velocity of a projectile while keeping all other parameters the same, the height reached ...

CORE CONCEPT AND DERIVATION

The maximum height of a projectile is proportional to the square of its initial velocity.

Formula:

$$H = \frac{v_i^2 \sin^2 \theta}{2g}$$

Solution:

- Height H varies directly with v_i^2 .
- If v_i is replaced by $(2v_i)$, then:

$$H_{new} \propto (2v_i)^2 = 4v_i^2$$
- Thus, $H_{new} = 4H$. The height strictly increases by a factor of four.

Why other options are incorrect:

Assuming a linear relationship (ignoring the square) would wrongly suggest it increases by two times.

Question #41 Key: (D)

ETEA 2023

Neglecting the effect of air resistance how long a stone takes to dropped of a 125 m high building lands on th...

CORE CONCEPT AND DERIVATION

The time taken for an object dropped from rest to hit the ground strictly depends on the height and gravity.

Formula:

$$S = v_i t + \frac{1}{2} g t^2$$

Solution:

- Because it is dropped, initial velocity $v_i = 0$.
- Height $S = 125$ m.
- Gravity $g = 10 \text{ m/s}^2$.

- Substitute:

$$125 = (0)t + \frac{1}{2}(10)t^2$$

- $125 = 5t^2 \implies t^2 = \frac{125}{5} = 25$
- Take the square root: $t = 5$ seconds.

Why other options are incorrect:

Failing to take the square root results in 25. Ignoring the $1/2$ multiplier gives roughly 3.5s. Simple arithmetic errors lead to the other values.

Question #42 Key: (D)

DUHS 2023

What will be the value of acceleration, if a body of mass 0.5 Kg is acted upon by a force of 10 N?

CORE CONCEPT AND DERIVATION

Newton's Second Law directly relates force, mass, and acceleration.

Formula:

$$F = ma \implies a = \frac{F}{m}$$

Solution:

- Force $F = 10$ N.
- Mass $m = 0.5$ kg.

- Substitute values:

$$a = \frac{10}{0.5}$$

- $a = 20 \text{ m/s}^2$

- Note: The options provided in the source use 'N' as the unit, which is a typographical error in the original paper (it should be m/s^2). We select 20 based on the numerical value.

Why other options are incorrect:

Multiplying 10 by 0.5 yields 5. Mathematical errors in division yield 40 or 10.

Question #43 Key: (B)

DUHS 2023

What is the time rate of change of linear momentum?

CORE CONCEPT AND DERIVATION

This is the fundamental definition of Newton's Second Law in terms of momentum.

Formula:

$$F = \frac{\Delta P}{\Delta t}$$

Solution:

- The rate at which an object's momentum changes is strictly equivalent to the net applied external force.

Why other options are incorrect:

Acceleration is the rate of change of velocity. Work is Force times displacement.

Question #44 Key: (B)

DUHS 2023

Due to sudden rain, which of the following is true for the car moving on the road?

CORE CONCEPT AND DERIVATION

Friction is heavily dependent on the nature of the surfaces in contact. Water acts as a lubricant.

Solution:

- Rain introduces water between the car's tires and the asphalt, significantly reducing the coefficient of friction.
- Without sufficient friction, the tires lose their grip, causing the car to slide (hydroplane) and lose its steady balance and control.

Why other options are incorrect:

Rain does not directly decrease the engine's mechanical power. Direction isn't necessarily affected unless a turn is attempted. Momentum does not suddenly increase just because the road is wet.

Question #45 Key: (A)

DUHS 2023

Two bodies of mass 10 kg and 40 kg are dropped from the same height at the same time. Value of which to the fo...

CORE CONCEPT AND DERIVATION

In the absence of air resistance, all bodies strictly fall at the identical rate of acceleration regardless of their mass.

Solution:

- Galileo famously demonstrated that acceleration due to gravity ($g \approx 9.8 \text{ m/s}^2$) is entirely independent of an object's mass.
- Therefore, both the 10kg and 40kg bodies experience the exact same uniform downward acceleration.

Why other options are incorrect:

Kinetic and potential energies strictly depend on mass ($\frac{1}{2}mv^2$ and mgh). Since their masses are different, their energies are vastly different. Power also depends on mass.

Question #46 Key: (C)

DUHS 2023

A ball is thrown horizontally with 19.6 m/s. After 2 seconds its horizontal velocity component will be:

CORE CONCEPT AND DERIVATION

In projectile motion, there are strictly zero horizontal forces acting on the object (ignoring air resistance).

Solution:

- According to Newton's First Law, horizontal acceleration is absolutely zero.
- Because $a_x = 0$, the horizontal velocity v_x must remain perfectly constant throughout the entire flight.
- If it starts at 19.6 m/s, it remains exactly 19.6 m/s after 2 seconds, or at any other time.

Why other options are incorrect:

The vertical velocity changes by 9.8 m/s every second, but this question specifically asks for the horizontal component, which never changes.

Question #47 Key: (C)

DUHS 2023

In the projectile motion, the acceleration in the horizontal direction:

CORE CONCEPT AND DERIVATION

Projectile motion separates into two independent axes. Gravity only pulls vertically downward.

Solution:

- Since gravity acts strictly along the y-axis, there is absolutely no force acting along the x-axis.
- $F_x = 0 \implies a_x = 0$.
- Therefore, the horizontal acceleration is permanently zero.

Why other options are incorrect:

While technically "Remain same" (remaining at zero) is true, "Is zero" is the strict, exact, and correct physical descriptor.

Question #48 Key: (A)

DUHS 2023

A force $2F$ acting on a particle of mass 10kg produces an acceleration of [Formula]. a force $5F$ acting on a pa...

CORE CONCEPT AND DERIVATION

Use Newton's Second Law sequentially to link the two scenarios.

Formula:

$$F_{\text{net}} = ma$$

Solution:

- Scenario 1:

$$2F = 10 \times 30 = 300$$

- This implies $F = 150\text{ N}$.

- Scenario 2: A force of $5F$ acts on mass M . Force applied = $5 \times 150 = 750\text{ N}$.

- Set up equation 2:

$$750 = M \times 25$$

- Solve for M :

$$M = \frac{750}{25} = 30\text{ kg}$$

Why other options are incorrect:

Algebraic errors solving for F or dividing incorrectly result in the other distractor values.

Question #49 **Key: (A)**

NUMS 2023

If the car is slowing down along negative x axis then acceleration will be along:

CORE CONCEPT AND DERIVATION

When an object slows down, the acceleration vector strictly points in the directly opposite direction of the velocity vector.

Solution:

- The car's velocity points along the negative x-axis (it is moving left).
- Because it is decelerating (slowing down), the force—and thus the acceleration—must be pushing against the motion to stop it.
- The opposite of the negative x-axis is the positive x-axis.

Why other options are incorrect:

If acceleration was along the negative x-axis, the car would be speeding up. Y-axis acceleration would cause turning, not slowing down.

Question #50 **Key: (D)**

NUMS 2023

In perfectly elastic collision:

CORE CONCEPT AND DERIVATION

Classification of collisions rests entirely on conservation laws.

Solution:

- In EVERY closed system, total universal energy and total momentum are strictly conserved regardless of the collision type.
- A "perfectly elastic" collision is specifically uniquely defined by the additional fact that macroscopic Kinetic Energy is also perfectly conserved.
- Therefore, all three quantities (momentum, total energy, kinetic energy) are strictly conserved.

Why other options are incorrect:

Options A, B, and C use the word "only", artificially restricting conservation laws that apply concurrently.

Question #51 **Key: (A)**

NUMS 2023

The slope of a displacement-time graph is equal to:

CORE CONCEPT AND DERIVATION

The mathematical gradient represents the rate of change.

Formula:

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\Delta \vec{d}}{\Delta t}$$

Solution:

- The rate of change of displacement with respect to time is the direct physical definition of velocity.

Why other options are incorrect:

Acceleration is the slope of velocity-time. Distance is the magnitude of a purely scalar path length. Displacement is read directly from the y-axis itself.

Question #52 **Key: (C)**

NUMS 2023

Range of a projectile on a horizontal plane is same for the following pair of angles:

CORE CONCEPT AND DERIVATION

Two launch angles provide the identical horizontal range if they are complementary (sum exactly to 90 degrees).

Solution:

- Check the sums of the angle pairs:
- A: $15 + 30 = 45$.
- B: $60 + 25 = 85$.
- C: $75 + 15 = 90$. This pair is complementary.
- D: $50 + 25 = 75$.

Why other options are incorrect:

Trigonometry dictates $\sin(2\theta_1) = \sin(2\theta_2)$ only if $\theta_1 + \theta_2 = 90^\circ$.

Question #53 Key: (C)

NUMS 2023

The product of force and time is equal to:

CORE CONCEPT AND DERIVATION

This addresses the fundamental impulse-momentum theorem derived from Newton's second law.

Formula:

$$F\Delta t = \Delta p$$

Solution:

- Force multiplied by the time interval over which it acts is defined as Impulse.
- Impulse strictly results in an equivalent change in linear momentum.

Why other options are incorrect:

Velocity change requires division by mass. Angular momentum involves rotation. Force alone is just the rate of momentum change.

Question #54 Key: (C)

NUMS 2023

At what point during the motion of projectile its vertical component of velocity is zero?

CORE CONCEPT AND DERIVATION

Gravity pulls down continuously, slowing an upwardly launched object until it stops, turns around, and falls.

Solution:

- As the projectile rises, gravity decelerates its vertical motion.
- Exactly at the peak (maximum height), the upward velocity is fully exhausted before downward velocity begins.
- Therefore, at the absolute highest point, $v_y = 0$.

Why other options are incorrect:

At launch and landing, the vertical velocity is at its maximum magnitude (ignoring air resistance).

Question #55 Key: (C)

UHS 2022

What is the shape of velocity-time graph for constant acceleration?

CORE CONCEPT AND DERIVATION

Constant slope.

Solution:

- Only a straight line yields a constant slope.

Why other options are incorrect:

Curves imply changing acceleration.

Question #56 Key: (C)

UHS 2022

Which of the following is the correct definition of variable velocity?

CORE CONCEPT AND DERIVATION

Velocity is displacement over time.

Solution:

- Changing the rate of displacement creates variable velocity.

Why other options are incorrect:

Distance applies to speed.

Question #57 Key: (D)

UHS 2022

A stone thrown horizontally from the top of a tall building follows a path that is:

CORE CONCEPT AND DERIVATION

Projectile motion.

Solution:

- Constant horizontal velocity + vertical gravity = Parabola.

Why other options are incorrect:

Standard physics definitions.

Question #58 Key: (A)

UHS 2022

Which of the following is incorrect?

CORE CONCEPT AND DERIVATION

Forces on different bodies do not balance.

Solution:

- They act on different objects, so they cannot cancel (balance) each other.

Why other options are incorrect:

The rest are true statements.

Question #59 Key: (D)

UHS 2022

When a heavy coin falls a short distance towards the ground it does not reach terminal velocity. Why is this s...

CORE CONCEPT AND DERIVATION

Forces during fall.

Solution:

- Weight is strictly greater than the drag force for the duration of the short fall.

Why other options are incorrect:

If equal, it would be at terminal.

Question #60 Key: (A)

SZABMU 2022

Two balls collide each-other, it has been observed that the collision is elastic. Which statement advocates the...

CORE CONCEPT AND DERIVATION

Definition of elastic.

Solution:

- Strict conservation of Kinetic Energy defines elastic collisions.

Why other options are incorrect:

Momentum is conserved in ALL collisions, so it doesn't uniquely identify an elastic one.

Question #61 Key: (C)

SZABMU 2022

The gradient of velocity time is equal to:

CORE CONCEPT AND DERIVATION

The mathematical gradient (or slope) of a line on a Cartesian plane is the ratio of the change in the y-axis variable to the change in the x-axis variable.

Formula:

$$\text{Gradient} = \frac{\Delta y}{\Delta x} = \frac{\Delta v}{\Delta t}$$

Solution:

- In a velocity-time graph, the y-axis represents velocity (v) and the x-axis represents time (t).
- The rate of change of velocity with respect to time ($\frac{\Delta v}{\Delta t}$) is the direct definition of acceleration.

Why other options are incorrect:

The area under the graph gives displacement/distance. Force requires mass (Newton's 2nd Law). Speed is a scalar magnitude of velocity, not its gradient over time.

Question #62 **Key: (B)**

SZABMU 2022

At what pair of angles for a projectile the ranges are equal?

CORE CONCEPT AND DERIVATION

For a given initial velocity, a projectile will land at the exact same horizontal distance (range) for any two complementary launch angles.

Formula:

$$\theta_1 + \theta_2 = 90^\circ \implies R_1 = R_2$$

Solution:

- We must identify which pair of angles sums perfectly to 90° .
- Check Option A: $20^\circ + 60^\circ = 80^\circ$.
- Check Option B: $60^\circ + 30^\circ = 90^\circ$. (These are complementary).
- Check Option C: $40^\circ + 60^\circ = 100^\circ$.
- Check Option D: $25^\circ + 55^\circ = 80^\circ$.

Why other options are incorrect:

Because only angles that satisfy the trigonometric identity $\sin(2(90^\circ - \theta)) = \sin(180^\circ - 2\theta) = \sin(2\theta)$ will yield the same range.

Question #63 **Key: (B)**

SZABMU 2022

Two cars travelling on straight road in opposite direction with speed [Formula] and [Formula], their relative...

CORE CONCEPT AND DERIVATION

Relative velocity measures how fast one object is moving from the perspective of another. When objects move in opposite directions, their approach (or separation) rate is the sum of their individual speeds.

Formula:

$$\vec{v}_{rel} = \vec{v}_1 - \vec{v}_2$$

Solution:

- Let the first car's velocity be $\vec{v}_1 = +70 \text{ km/h}$.
- Since the second car moves in the opposite direction, $\vec{v}_2 = -60 \text{ km/h}$.
- The relative velocity magnitude is $|\vec{v}_{rel}| = |70 - (-60)| = 130 \text{ km/h}$.

Why other options are incorrect:

Subtracting the magnitudes (10 km/h) applies only if they are travelling in the same direction. Averaging them (65 km/h) has no physical meaning here.

Question #64 Key: (D)

SZABMU 2022

Two bodies having same mass undergo elastic collision then their velocities after collision will be:

CORE CONCEPT AND DERIVATION

In a perfectly elastic, one-dimensional collision between two objects of identical mass, the objects completely exchange their velocities.

Formula:

$$v_1' = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1 + \left(\frac{2m_2}{m_1 + m_2}\right)v_2$$

Solution:

- Given $m_1 = m_2 = m$.

- Substitute this into the equation for the first body:

$$v_1' = \left(\frac{m - m}{m + m}\right)v_1 + \left(\frac{2m}{2m}\right)v_2 = (0)v_1 + (1)v_2 = v_2$$

- Similarly, for the second body, $v_2' = v_1$.
- Therefore, they simply swap velocities.

Why other options are incorrect:

Options A and B represent a specific subset where one of the bodies is initially at rest. Option C suggests they bounce back with their own reversed velocities, which only happens if they hit a massive immovable wall.

Question #65 Key: (D)

SZABMU 2022

The angle of a projection of a projectile for which its maximum height and horizontal range are equal is:

CORE CONCEPT AND DERIVATION

There is a fundamental relation between the Height (H) and Range (R) of a projectile based solely on its launch angle.

Formula:

$$\frac{H}{R} = \frac{\tan \theta}{4}$$

Solution:

- The problem states that Range equals Height ($R = H$).

- Substitute this into the equation:

$$\frac{H}{H} = \frac{\tan \theta}{4}$$

- $1 = \frac{\tan \theta}{4} \implies \tan \theta = 4$

- Taking the inverse tangent:

$$\theta = \tan^{-1}(4) \approx 75.96^\circ$$

- Rounding to the nearest whole degree gives 76° .

Why other options are incorrect:

At 45° , Range is 4 times the Height. 66° and 86° do not satisfy the $\tan \theta = 4$ condition.

Question #66 Key: (B)

SZABMU 2022

Slope of distance time graph can never be:

CORE CONCEPT AND DERIVATION

Distance is a scalar quantity that measures the total length of the path covered by a moving object. Because it is a cumulative total, it can only increase or remain the same.

Solution:

- The slope of a distance-time graph represents speed ($\frac{\Delta d}{\Delta t}$).
- Since distance cannot physically decrease over time, Δd must always be greater than or equal to zero.
- Therefore, the slope can be positive (moving) or zero (stationary), but it can mathematically and physically never be negative.

Why other options are incorrect:

Displacement-time graphs CAN have a negative slope (if returning toward the origin), but distance is fundamentally additive.

Question #67 Key: (B)

SZABMU 2022

At highest point in a projectile motion, the velocity will be:

CORE CONCEPT AND DERIVATION

Projectile motion combines uniform horizontal motion and uniformly accelerated vertical motion due to gravity.

Solution:

- Throughout the entire flight, the horizontal velocity v_x remains constant because there is no horizontal force (ignoring air resistance).
- The vertical velocity v_y decreases as the object rises, reaching exactly zero at the absolute highest point of the trajectory, before becoming negative as it falls back down.
- Therefore, at the peak, $v_y = 0$ and $v_x = \text{constant}$.

Why other options are incorrect:

If v_x was also zero (Option A), the projectile would drop straight down like a stone. Gravity ensures v_y is never constant (Option C, D).

Question #68 Key: (D)

ETEA 2022

A body covers displacement of 10m towards North and returns back to initial point by covering 10m towards south...

CORE CONCEPT AND DERIVATION

Displacement is a vector quantity defined strictly as the shortest straight-line distance between the final position and the initial position.

Formula:

$$\vec{d}_{total} = \vec{d}_1 + \vec{d}_2$$

Solution:

- Displacement 1: +10 m (North).
- Displacement 2: -10 m (South).
- Total displacement: $+10 + (-10) = 0$ m.
- Because the final position exactly overlaps the initial position, there is no net change in position. (The zero vector has no specific direction).

Why other options are incorrect:

20m would be the total scalar distance covered. 10m South ignores the initial 10m North journey.

Question #69 Key: (A)

ETEA 2022

In Newton's first law of motion which quantity remains constant:

CORE CONCEPT AND DERIVATION

Newton's First Law (Law of Inertia) states that an object will remain at rest or in uniform motion in a straight line unless acted upon by a net external force.

Solution:

- "Uniform motion in a straight line" is the exact definition of constant velocity.
- If the net force is zero, the acceleration is zero.
- Zero acceleration strictly means the velocity vector (both magnitude and direction) remains absolutely constant.

Why other options are incorrect:

Angular displacement, amplitude, and work are not the fundamental quantities preserved by translational inertia. An object can have constant velocity while its displacement continuously changes.

Question #70 Key: (A)

ETEA 2022

Law of inertia satisfies:

CORE CONCEPT AND DERIVATION

The Law of Inertia (Newton's First Law) applies exclusively when the net external force on a system is strictly zero.

Solution:

- When the sum of all forces acting on an object is zero ($\Sigma F = 0$), the object is in a state of translational equilibrium.
- Because the law of inertia describes motion precisely under this $\Sigma F = 0$ condition, it inherently satisfies the first condition of equilibrium.

Why other options are incorrect:

Variable forces or contact forces induce acceleration, violating the premise of inertia. Mass conservation is a separate principle altogether.

Question #71 Key: (A)

ETEA 2022

A projectile is launched, its velocity is maximum at:

CORE CONCEPT AND DERIVATION

The total velocity of a projectile is the vector sum of its horizontal and vertical components. As it rises against gravity, its kinetic energy decreases and converts to potential energy.

Solution:

- At the point of projection, the projectile possesses its full initial vertical velocity (v_{iy}) and horizontal velocity (v_x).
- As it moves upward, v_x remains constant, but v_y strictly decreases, meaning the overall magnitude $v = \sqrt{v_x^2 + v_y^2}$ decreases.
- The velocity is at its absolute minimum at the highest point (where $v_y = 0$). It returns to its maximum magnitude right as it hits the ground (landing point). Assuming a ground-to-ground launch, projection and landing share the maximum speed.

Why other options are incorrect:

The highest point has the *minimum* velocity. Velocity is not constant across all points.

Question #72 Key: (C)

ETEA 2022

The net displacement divided by the total time (t) is known as:

CORE CONCEPT AND DERIVATION

Kinematic definitions rely on whether a quantity is measured over an interval or at a specific moment.

Formula:

$$\vec{v}_{avg} = \frac{\text{Total } \Delta \vec{x}}{\text{Total } \Delta t}$$

Solution:

- Dividing the total net displacement covered during an entire journey by the total elapsed time yields a single summarizing value.
- This macro-level calculation is the formal definition of average velocity.

Why other options are incorrect:

Instantaneous velocity is measured at a precise moment ($\Delta t \rightarrow 0$). Uniform and variable velocities are states of motion, not defined merely by a bulk division formula.

Question #73 **Key: (D)**

ETEA 2022

The velocity time graph of a motion starting from rest with uniform acceleration is a straight line:

CORE CONCEPT AND DERIVATION

A velocity-time graph maps velocity on the y-axis against time on the x-axis. The slope of this graph is the acceleration.

Formula:

$$v = v_i + at$$

Solution:

- The object starts from rest, meaning initial velocity $v_i = 0$.
- Substituting this gives the equation $v = at$.
- This is a linear equation matching the form $y = mx + c$, where $c = 0$ (the y-intercept).
- Because the y-intercept is exactly 0, the straight line must strictly pass through the origin (0,0).

Why other options are incorrect:

If it did not pass through the origin, v_i would not be zero. Parallel to time axis means zero acceleration. Parallel to velocity axis is physically impossible.

Question #74 **Key: (C)**

ETEA 2022

A projectile is thrown at an angle of [Formula] with horizontal and its range is [Formula]. Another projectile...

CORE CONCEPT AND DERIVATION

Standard kinematics uses the angle relative to the horizontal to calculate range.

Solution:

- Projectile 1: Angle with horizontal is $\theta_1 = 45^\circ$.
- Projectile 2: Angle with the vertical is 45° . Because the axes are orthogonal (90°), the angle with the horizontal is $90^\circ - 45^\circ = 45^\circ$. So, $\theta_2 = 45^\circ$.
- Since both projectiles are effectively launched at the exact same horizontal angle (45°), assuming equal initial velocities, their ranges will be absolutely identical.
- Therefore, $R_1 = R_2$.

Why other options are incorrect:

Any factor scaling implies the angles resulted in different trigonometric outputs, which is false here.

Question #75 **Key: (D)**

BUMHS 2022

During a projectile path, air friction affects:

CORE CONCEPT AND DERIVATION

Air friction (drag) is a vector force that always opposes the instantaneous velocity vector of a moving object.

Solution:

- A projectile travels in a 2D plane, meaning its velocity vector has both horizontal (v_x) and vertical (v_y) components.
- Because drag strictly opposes the direction of motion, it creates both a backward horizontal force (slowing down horizontal speed) and a vertical force (opposing upward rise or slowing downward fall).
- Therefore, air friction continuously affects both dimensions of the motion.

Why other options are incorrect:

Drag does not affect the *initial* launch velocity (which is determined by the launcher). It cannot selectively target only one axis because the projectile moves diagonally through the air.

Question #76 Key: (C)

BUMHS 2022

Which of the following pairs has the same direction always?

CORE CONCEPT AND DERIVATION

According to Newton's Second Law of motion, the relationship between net force and acceleration is rigidly governed by a scalar mass.

Formula:

$$\vec{F}_{net} = m\vec{a}$$

Solution:

- Mass (m) is a strictly positive scalar value.
- When a vector ($\vec{a}$) is multiplied by a positive scalar, the resulting vector ($\vec{F}$) MUST point in the exact same direction.
- Therefore, the net force and the acceleration it produces are permanently and flawlessly aligned in direction.

Why other options are incorrect:

Displacement and velocity vectors tell you where an object is going, not where it is being pushed. For example, a car braking has forward velocity but backward force.

Question #77 Key: (D)

BUMHS 2022

The third law of motion explains:

CORE CONCEPT AND DERIVATION

Newton's Third Law states: To every action, there is always an equal and opposite reaction.

Solution:

- The profound implication of this law is that a solitary, isolated force physically cannot exist in the universe.
- Forces result entirely from interactions between two separate objects.
- Therefore, forces ALWAYS occur in action-reaction pairs. The third law fundamentally declares the existence of this dual-pairing nature of forces.

Why other options are incorrect:

The effect of force is explained by the Second Law ($F = ma$). The existence of a single force conceptually traces back to the First Law. "Two forces" is vague, while "pair of forces" explicitly covers the action-reaction mutual relationship.

Question #78 Key: (B)

BUMHS 2022

A stone is dropped from a building's top 80 m high from the ground. In how much time will it touch the ground?

CORE CONCEPT AND DERIVATION

An object dropped from rest strictly falls under the constant acceleration of gravity. We use the second kinematic equation.

Formula:

$$S = v_i t + \frac{1}{2} g t^2$$

Solution:

- The initial velocity is $v_i = 0$.
- The displacement is $S = 80$ m.
- Taking gravity as $g = 10 \text{ m/s}^2$ (standard simplification for this problem type).
- Substitute values:

$$80 = (0)t + \frac{1}{2}(10)t^2$$

$$80 = 5t^2 \implies t^2 = \frac{80}{5} = 16$$

$$t = \sqrt{16} = 4 \text{ seconds}$$

Why other options are incorrect:

Forgetting the square root gives 16s. Forgetting the 1/2 in the formula gives $\sqrt{8} \approx 2.8$ s. Calculating linearly without squared time gives 8s.

Question #79 Key: (B)

BUMHS 2022

If two equal masses are in motion with same individual speeds, we can conclude that:

CORE CONCEPT AND DERIVATION

Distinguish carefully between scalar quantities (mass, speed, kinetic energy) and vector quantities (velocity, momentum).

Solution:

- Momentum is a vector: $\vec{P} = m\vec{v}$. It depends on both mass and the *direction* of velocity.
- The prompt says they have the same speed (scalar), but does NOT guarantee they are moving in the same *direction*.
- If one moves North and the other South, their momentums are opposite, despite identical speeds and masses.
- Therefore, their momentums CAN be different.

Why other options are incorrect:

Option A falsely assumes same speed = same direction. Option C is wrong because Kinetic Energy ($\frac{1}{2}mv^2$) is a scalar dependent ONLY on speed and mass, so their K.E. must be exactly identical, never different.

Question #80 Key: (D)

DUHS 2022

A body is dropped from certain height and falls freely. Its velocity after 5 seconds will be:

CORE CONCEPT AND DERIVATION

Free fall from rest causes velocity to increase linearly according to gravity.

Formula:

$$v_f = v_i + gt$$

Solution:

- Initial velocity $v_i = 0$.
- Gravity $g = 9.8 \text{ m/s}^2$.
- Time $t = 5 \text{ s}$.

- Substitute:

$$v_f = 0 + (9.8 \times 5) = 49 \text{ m/s}$$

(Option D).

Why other options are incorrect:

4.9 comes from dividing by 2 (confusing with distance formula). 9.4 is a typo for 9.8 (1 second of fall). The decimal point shifts in Options A, B, and C represent calculation errors.

Question #81 Key: (C)

DUHS 2022

A bullet is fired horizontally with 20m/s. In the absence of air friction, its horizontal velocity after 2 sec...

CORE CONCEPT AND DERIVATION

Newton's First Law of motion states an object will maintain constant velocity unless acted on by an external force.

Solution:

- A projectile in flight experiences only one force: gravity, which acts strictly vertically downwards.
- Because there is zero air friction, there are absolutely no horizontal forces acting on the bullet.
- Therefore, horizontal acceleration is zero, and the horizontal velocity remains exactly 20 m/s for the entire duration of the flight (Option C).

Why other options are incorrect:

Options A and B incorrectly assume deceleration. Option D wrongly multiplies velocity by time or assumes horizontal acceleration exists.

Question #82 Key: (A)

DUHS 2022

A box of mass $m = 6\text{ kg}$ slides with speed $v = 4\text{ m/s}$ across a frictionless floor, it suddenly explodes into two pi...

CORE CONCEPT AND DERIVATION

An explosion is governed by internal forces. Therefore, the total momentum of the isolated system is perfectly conserved before and after the explosion.

Formula:

$$P_{\text{initial}} = P_{\text{final}}$$

$$mv = m_1v_1 + m_2v_2$$

Solution:

- Total initial momentum: $6\text{ kg} \times 4\text{ m/s} = 24\text{ kg m/s}$.
- After explosion, Piece 1 mass $m_1 = 2\text{ kg}$ and $v_1 = 8\text{ m/s}$. Its momentum $= 2 \times 8 = 16\text{ kg m/s}$.
- Piece 2 mass $m_2 = \text{Total mass} - m_1 = 6 - 2 = 4\text{ kg}$.
- Set up conservation:

$$24 = 16 + 4v_2$$
- $$8 = 4v_2 \implies v_2 = 2\text{ m/s}$$
 (Option A).

Why other options are incorrect:

Failure to account for the remaining mass correctly, or adding momentums improperly, yields the values in Options B, C, and D.

Question #83 Key: (D)

DUHS 2022

A helicopter of weight ' W ' is ascending with zero acceleration. The upward force ' F ' on it is:

CORE CONCEPT AND DERIVATION

According to Newton's Second Law, acceleration is directly proportional to net force. Zero acceleration implies zero net force.

Formula:

$$\Sigma F = ma$$

$$F_{up} - F_{down} = m(0)$$

Solution:

- The upward force is the lift F .
- The downward force is the weight W .
- Since acceleration is exactly zero (it is moving at a steady, uniform velocity), the forces must perfectly balance.

$$F - W = 0 \implies F = W$$

Why other options are incorrect:

If $F > W$, the helicopter would be accelerating upward (speeding up). If $F < W$, it would be decelerating (slowing down). Zero force implies no lift, meaning it would be in freefall.

Question #84 Key: (D)

DUHS 2022

When a body moves with uniform velocity then it's:

CORE CONCEPT AND DERIVATION

Uniform velocity means the object's speed and direction remain absolutely constant for the entire duration of motion.

Solution:

- If a car drives strictly at 60 km/h East without ever speeding up, slowing down, or turning, its velocity at any given split-second (instantaneous) is 60 km/h East.
- If you calculate the total displacement over total time (average), it will also perfectly yield 60 km/h East.
- Therefore, for uniform motion, the instantaneous velocity is permanently identical to the average velocity.

Why other options are incorrect:

Differences between average and instantaneous only arise if the velocity fluctuates (acceleration/deceleration) over the journey.

Question #85 Key: (A)

DUHS 2022

The rate of change of linear momentum of a body is equal to:

CORE CONCEPT AND DERIVATION

This is the precise, formal mathematical definition of Newton's Second Law of Motion as originally presented by Isaac Newton.

Formula:

$$\vec{F}_{net} = \frac{\Delta \vec{p}}{\Delta t}$$

Solution:

- Momentum ($\vec{p}$) is mass times velocity.
- The rate at which this momentum changes over time defines the net applied force required to cause that change.

Why other options are incorrect:

Torque relates to the rate of change of *angular* momentum. Displacement, inertia, and velocity represent fundamentally different dimensions.

Question #86 Key: (A)

NUMS 2022

An elastic collision is the one in which:

CORE CONCEPT AND DERIVATION

Collisions in isolated systems always conserve linear momentum. How they handle kinetic energy dictates their specific classification.

Solution:

- By universal law, total momentum is conserved in all types of collisions.
- An "elastic" collision is strictly defined as a perfect bounce where absolutely zero macroscopic kinetic energy is converted into heat, sound, or permanent deformation.
- Therefore, both kinetic energy and momentum remain exactly equal before and after the impact.

Why other options are incorrect:

Option C defines an inelastic collision. Option B violates the fundamental First Law of Thermodynamics (total energy is always conserved universally). Option D violates basic momentum conservation.

Question #87 Key: (B)

NUMS 2022

The time rate of change of velocity is called:

CORE CONCEPT AND DERIVATION

Kinematic definitions link position, velocity, and acceleration through time derivatives.

Formula:

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

Solution:

- Velocity describes how fast position changes.
- Acceleration specifically describes how fast velocity itself changes over time (whether speeding up, slowing down, or changing direction).

Why other options are incorrect:

Force is the rate of change of momentum. Power is the rate of doing work. Energy is the capacity to do work.

Question #88 Key: (B)

NUMS 2022

In projectile motion, the range of projectile will be maximum at an angle of:

CORE CONCEPT AND DERIVATION

The horizontal range equation is maximized when its trigonometric component reaches its peak value.

Formula:

$$R = \frac{v_i^2 \sin(2\theta)}{g}$$

Solution:

- The sine function has a maximum possible value of 1, which occurs at an angle of 90° .
- Therefore, for range to be maximum, the term $\sin(2\theta)$ must equal 1.

$$\sin(2\theta) = 1 \implies 2\theta = 90^\circ \implies \theta = 45^\circ$$

Why other options are incorrect:

At 90 degrees, the projectile shoots straight up and lands at the start (Range = 0). 30 and 60 degrees provide equal ranges, but they are smaller than the peak range at 45 degrees.

Question #89 Key: (D)

NUMS 2022

Which of the following is NOT TRUE?

CORE CONCEPT AND DERIVATION

Newton's Third Law governs action and reaction force pairs.

Solution:

- Forces can mathematically cancel each other out ONLY if they are applied to the exact same object.
- Newton's Third Law pairs (Action/Reaction) ALWAYS strictly apply to two different interacting bodies (A pushes B, B pushes A).
- Because they act on different bodies, they dictate the respective motion of those different bodies independently. They can never cancel each other. Therefore, Option D is a false statement.

Why other options are incorrect:

Options A, B, and C are entirely true properties of Newton's Third Law.

Question #90 **Key: (D)**

NUMS 2022

Two busses moving at 100 km/h and 80 km/h respectively cross each other while moving in opposite direction. Ve...

CORE CONCEPT AND DERIVATION

When two objects move in directly opposing directions, the speed at which the gap between them closes is the arithmetic sum of their respective speeds.

Formula:

$$\vec{v}_{rel} = \vec{v}_1 - \vec{v}_2$$

Solution:

- Assign a directional axis. Let Bus 1 move forward: $\vec{v}_1 = +100 \text{ km/h}$.
- Bus 2 moves opposite: $\vec{v}_2 = -80 \text{ km/h}$.
- The velocity of Bus 1 relative to Bus 2:

$$\vec{v}_{12} = 100 - (-80) = 180 \text{ km/h}$$
- To an observer on either bus, the other bus appears to be flying past at 180 km/h.

Why other options are incorrect:

20 km/h would be their relative velocity if they were racing in the SAME direction.

Question #91 **Key: (B)**

NUMS 2022

Which of the following pair of angles have same range for a projectile?

CORE CONCEPT AND DERIVATION

Any two launch angles that add up to 90 degrees (complementary angles) will produce the exact same horizontal range.

Formula:

$$\text{If } \theta_1 + \theta_2 = 90^\circ, \text{ then } R_1 = R_2$$

Solution:

- We simply check the sum of each pair provided in the options.
- A: $10 + 20 = 30^\circ$.
- B: $75 + 15 = 90^\circ$. (This is the correct complementary pair).
- C: $45 + 60 = 105^\circ$.
- D: $0 + 30 = 30^\circ$.

Why other options are incorrect:

Only complementary angles exploit the symmetry of the $\sin(2\theta)$ function in the range equation.

Question #92 Key: (D)

NUMS 2022

The angle of projection of a projectile for which its maximum height and horizontal range are equal is:

CORE CONCEPT AND DERIVATION

Equating the formulas for Range and Maximum Height identifies a specific geometrical trajectory.

Formula:

$$R = H \implies \frac{\tan \theta}{4} = 1$$

Solution:

- This is a frequently repeated concept test. From $R = H$, we derive $\tan \theta = 4$.
- The angle whose tangent is exactly 4 is approximately 75.96° , which rounds cleanly to 76° .

Why other options are incorrect:

At 45° , R is max but $R = 4H$. At 90° , R is zero. At 0° , there is no parabolic flight.

Question #93 Key: (C)

NUMS 2022

The explosion of explosive material is application of:

CORE CONCEPT AND DERIVATION

An explosion is a dramatic event driven entirely by internal forces within a closed system.

Solution:

- Because no external forces act on the bomb at the exact instant of explosion, the total vector momentum of the system must remain constant.
- A stationary bomb (zero momentum) will explode into fragments that fly off in all directions. The vector sum of all fragment momentums mathematically cancels out to exactly zero.
- This makes explosions a classic demonstration of the Law of Conservation of Linear Momentum.

Why other options are incorrect:

Kinetic energy massively *increases* during an explosion (converting chemical potential to kinetic), making "energy conservation" a tricky descriptor for kinematic modeling here. Third law applies to specific pair fragments, but momentum conservation governs the entire system.

Question #94 Key: (A)

PMDC 2021

At what angle of projection of a projectile the range becomes half of its maximum value.

CORE CONCEPT AND DERIVATION

Same as previous year.

Solution:

- $\sin(2\theta) = 0.5 \implies \theta = 15^\circ$.

Why other options are incorrect:

Repetitive.

Question #95 Key: (A)

PMDC 2021

Vertical velocity vs time graph for a projectile motion ____

CORE CONCEPT AND DERIVATION

Velocity changes at a constant rate ($-g$).

Solution:

- This forms a straight line with a constant negative slope.

Why other options are incorrect:

Parabolic applies to displacement.

Question #96 Key: (B)

PMDC 2021

The magnitude of displacement is ____

CORE CONCEPT AND DERIVATION

Geometric definition of displacement vector.

Solution:

- It is the shortest path, hence a straight line.

Why other options are incorrect:

Scalar path is distance.

Question #97 Key: (B)

PMDC 2021

If the displacement = 15m and time = 10 seconds the average velocity is

CORE CONCEPT AND DERIVATION

Basic division.

Solution:

- $v = 15/10 = 1.5 \text{ m/s}$.

Why other options are incorrect:

Math errors.

Question #98 Key: (B)

PMDC 2021

Decrease in velocity per unit time is called

CORE CONCEPT AND DERIVATION

Negative rate of change terminology.

Solution:

- Specific term for decreasing speed is deceleration.

Why other options are incorrect:

Acceleration is general.

Question #99 Key: (B)

PMDC 2021

The slope of velocity-time graph represents

CORE CONCEPT AND DERIVATION

Rise over run: dv/dt .

Solution:

- Derivative of velocity is acceleration.

Why other options are incorrect:

Area is displacement.

Question #100 Key: (C)

PMDC 2021

An object is accelerating ____

CORE CONCEPT AND DERIVATION

Velocity is a vector.

Solution:

- Any change to magnitude or direction is acceleration.

Why other options are incorrect:

"Only" limits the definition.

Question #101 Key: (A)

PMDC 2021

What is the slope of a straight-line graph of position vs. time?

CORE CONCEPT AND DERIVATION

Rise over run: dx/dt .

Solution:

- Derivative of position is velocity.

Why other options are incorrect:

Acceleration is slope of v-t graph.

Question #102 Key: (A)

PMDC 2021

The coefficient of restitution for a perfectly elastic collision is

CORE CONCEPT AND DERIVATION

Ratio of relative speeds.

Solution:

- In perfectly elastic, separation speed = approach speed, so $e = 1$.

Why other options are incorrect:

$e = 0$ is inelastic.

Question #103 Key: (A)

PMDC 2021

What is the accelerating force on the Diwali rocket if it ejects 0.05 kg of gases per second at a velocity of ...

CORE CONCEPT AND DERIVATION

Thrust equation.

Solution:

- $F = v(dm/dt) = 400 \times 0.05 = 20 \text{ N.}$

Why other options are incorrect:

Wrong units.

Question #104 Key: (A)

PMDC 2021

If mass is 2 kg and velocity is 35 m/s, then momentum is

CORE CONCEPT AND DERIVATION

$$P = mv.$$

Solution:

- $2 \times 35 = 70 \text{ kg m/s.}$

Why other options are incorrect:

Math errors.

Question #105 Key: (C)

PMDC 2021

If Velocity time graph shape is parallel to Y-axis the acceleration

CORE CONCEPT AND DERIVATION

Infinite slope.

Solution:

- $\Delta t = 0 \Rightarrow a = \infty.$

Why other options are incorrect:

0 acceleration is parallel to X-axis.

Question #106 Key: (B)

PMDC 2020

The slope of distance – time graph will always be:

CORE CONCEPT AND DERIVATION

Distance strictly increases over time.

Solution:

- Speed is always positive.

Why other options are incorrect:

Negative implies moving backward in distance, which is impossible.

Question #107 Key: (A)

PMDC 2020

At what angle of projection of a projectile the range becomes half of its maximum value?

CORE CONCEPT AND DERIVATION

$$R = R_{\max} \sin(2\theta)$$

Solution:

- $\sin(2\theta) = 0.5 \Rightarrow 2\theta = 30^\circ \Rightarrow \theta = 15^\circ.$

Why other options are incorrect:

Forgetting to divide by 2 gives 30° .

Question #108 Key: (B)

PMDC 2020

If we drop an object, its initial velocity is zero. How far will it fall in time 't'?

CORE CONCEPT AND DERIVATION

Free fall distance equation.

Solution:

- $S = 0.5 \times 9.8 \times t^2 = 4.9t^2$

Why other options are incorrect:

Missing the $1/2$ coefficient gives $9.8t^2$.

Question #109 Key: (C)

PMDC 2020

The newton – second is unit of:

CORE CONCEPT AND DERIVATION

Impulse = Force $\times$ Time.

Solution:

- Newton $\times$ seconds directly maps to Impulse.

Why other options are incorrect:

Work is Newton-meter.

Question #110 Key: (D)

NUMS 2020

Which one of the following is the angle of projection of a projectile if its range is equal to its height?

CORE CONCEPT AND DERIVATION

Relationship: $\tan \theta = 4H/R$.

Solution:

- If $H = R$, $\tan \theta = 4 \implies \theta \approx 76^\circ$.

Why other options are incorrect:

Arithmetic/trig evaluation errors.

Question #111 Key: (C)

NUMS 2020

The product of force and time is equal to:

CORE CONCEPT AND DERIVATION

Impulse-Momentum theorem.

Solution:

- $F\Delta t = \Delta P$.

Why other options are incorrect:

Misunderstanding of Newton's second law.

Question #112 Key: (D)

MDCAT 2019

If two objects of equal masses 'm' are moving towards each other with the same speeds 'v' then what will be th...

CORE CONCEPT AND DERIVATION

Conservation of vector momentum.

Solution:

- Total initial $P = mv - mv = 0$. Thus final is 0.

Why other options are incorrect:

Adding magnitudes ignores vector nature.

Question #113 Key: (B)

MDCAT 2019

For projectile motion in the absence of air resistance:

CORE CONCEPT AND DERIVATION

No horizontal forces means no horizontal acceleration.

Solution:

- $a_x = 0$.

Why other options are incorrect:

Gravity acts vertically.

Question #114 Key: (D)

MDCAT 2019

The range of the projectile depends upon the velocity of the projection and the angle of the projection i.e [F...

CORE CONCEPT AND DERIVATION

Steeper angles increase vertical velocity but decrease efficiency of horizontal range past 45° .

Solution:

- Height increases, Range decreases.

Why other options are incorrect:

Trigonometric fact of $\sin^2 \theta$ vs $\sin(2\theta)$.

Question #115 Key: (C)

MDCAT 2018

If slope of velocity time graph is not constant at different points, then body is moving with _____

CORE CONCEPT AND DERIVATION

Changing slope means changing acceleration.

Solution:

- "Increasing acceleration" is the only option representing variable acceleration.

Why other options are incorrect:

Constant slope means uniform acceleration.

Question #116 Key: (A)

MDCAT 2018

A cyclist is traveling at [Formula] she applies brakes so that she doesn't collide with the wall in front of h...

CORE CONCEPT AND DERIVATION

Kinematics with stopping distance.

Solution:

$$a = \frac{v_f^2 - v_i^2}{2S} = \frac{0 - 225}{36} = -6.25 \approx 6.3 \text{ m/s}^2$$

Why other options are incorrect:

Arithmetic errors.

Question #117 Key: (A)

MDCAT 2018

Newton first law of motion is also known as

CORE CONCEPT AND DERIVATION

Resistance to change in motion.

Solution:

- Inertia is the direct equivalent concept.

Why other options are incorrect:

Basic definitions.

Question #118 Key: (A)

MDCAT 2017

The ratio of displacement along diameter and total distance along circle:

CORE CONCEPT AND DERIVATION

Displacement is the straight line (diameter), distance is the perimeter.

Solution:

- Displacement $|d| = 2r$.
- Distance $S = 2\pi r$.
- Ratio $\frac{2r}{2\pi r} = 1 : \pi$.

Why other options are incorrect:

$2 : \pi$ applies if distance is only a semicircle.

Question #119 Key: (B)

MDCAT 2017

Arshad is driving down 7th street. He drives 150 meter in 18 seconds. Assume he does not speed up or slow down...

CORE CONCEPT AND DERIVATION

Uniform speed equals distance over time.

Solution:

$$v = \frac{150}{18} = 8.33 \text{ m/s}$$

Why other options are incorrect:

Arithmetic errors.

Question #120 Key: (D)

MDCAT 2017

The distance travelled by a moving car with velocity 15 m/s in 2 seconds, decelerates at [Formula] is equal to

CORE CONCEPT AND DERIVATION

Use the second equation of motion.

Solution:

$$S = (15)(2) + 0.5(-2)(2)^2 = 30 - 4 = 26 \text{ m}$$

Why other options are incorrect:

Forgetting negative sign leads to 34m.

Question #121 Key: (D)

MDCAT 2017

The value of ratio of displacement to distance is:

CORE CONCEPT AND DERIVATION

Displacement is the shortest path, always less than or equal to actual path taken.

Solution:

$$|d| \leq S \implies \frac{|d|}{S} \leq 1$$

Why other options are incorrect:

It can never be strictly more than one.

Question #122 Key: (A)

MDCAT 2017

Which of the following v-t graph represents the constant acceleration: v t

CORE CONCEPT AND DERIVATION

Constant slope on v-t graph equals constant acceleration.

Solution:

- Only a straight line provides a constant slope.

Why other options are incorrect:

Curves imply changing acceleration.

Question #123 Key: (D)

ETEA 2017

The numerical ratio of displacement to distance is:

CORE CONCEPT AND DERIVATION

Geometrically, straight line is shortest.

Solution:

- Ratio is strictly ≤ 1 .

Why other options are incorrect:

Repeated concept.

Question #124 Key: (B)

ETEA 2017

A bullet of mass m moving with a velocity v is fired into large wooden block of mass M if the bullet remains e...

CORE CONCEPT AND DERIVATION

Conservation of Momentum for inelastic collision.

Solution:

- $mv = (m + M)V.$
- $V = \frac{m}{M+m}v.$

Why other options are incorrect:

Masses add, not subtract.

Question #125 Key: (D)

ETEA 2015

Weight rather than mass be used in calculating ____

CORE CONCEPT AND DERIVATION

Weight inherently IS the gravitational force.

Solution:

- The gravitational force acting downwards on an object is perfectly synonymous with its weight.

Why other options are incorrect:

Inertia and binding energy strictly require scalar mass.

Question #126 Key: (C)

ETEA 2014

A ball is dropped from the roof of a very tall building. What is its velocity after falling for 5.0s?

CORE CONCEPT AND DERIVATION

Velocity increases by g every second.

Solution:

$$v = gt = 9.8 \times 5 = 49 \text{ m/s}$$

Why other options are incorrect:

9.8 is for 1s, 98 is for 10s.

Question #127 Key: (B)

ETEA 2014

A projectile is launched at [Formula] to the horizontal with initial K , Energy, E . Assuming air resistance to ...

CORE CONCEPT AND DERIVATION

At max height, only horizontal velocity $v_x = v_i \cos \theta$ exists.

Solution:

- $K.E_{\text{top}} = \frac{1}{2} m (v_i \cos 45^\circ)^2 = E \cos^2(45^\circ)$
- $\cos^2(45^\circ) = 0.5$
- So, $K.E = 0.50E$.

Why other options are incorrect:

0.71 E comes from forgetting to square the cosine.

Question #128 Key: (D)

ETEA 2011

One ball is thrown vertically upward with a velocity of 98 m/s. If the takes 10 seconds to reach the highest p...

CORE CONCEPT AND DERIVATION

Acceleration opposes upward velocity.

Solution:

- $a = \frac{0 - 98}{10} = -9.8 \text{ m/s}^2$

Why other options are incorrect:

Missing the negative sign ignores the directional reality of gravity.

Question #129 Key: (C)

MDCAT 2010

If a force of 12N is applied on a body and its momentum is changed form [Formula] to [Formula], then find the...

CORE CONCEPT AND DERIVATION

Force is the rate of change of momentum.

Formula:

$$F = \frac{\Delta P}{\Delta t}$$

Solution:

- $\Delta P = 36 - 60 = -24 \text{ Ns.}$
- The retarding force is $F = -12 \text{ N.}$
- $\Delta t = \frac{-24}{-12} = 2 \text{ s.}$

Why other options are incorrect:

Arithmetic mistakes in subtracting momentum or dividing.

Question #130 Key: (C)

MDCAT 2010

Time of projectile's flight is ____

CORE CONCEPT AND DERIVATION

Total time is double the time to reach maximum height.

Formula:

$$T = \frac{2v_i \sin \theta}{g}$$

Solution:

- Standard derivation from $v_{fy} = v_{iy} - gt$.

Why other options are incorrect:

Option A is for height. Options B and D are dimensionally wrong.

Question #131 Key: (C)

MDCAT 2010

If the velocity of the body changes by equal amount in equal intervals of time, the body is said to have:

CORE CONCEPT AND DERIVATION

Constant rate of change of velocity defines uniform acceleration.

Solution:

- Since $\frac{\Delta v}{\Delta t}$ is constant, it is uniform acceleration.

Why other options are incorrect:

Uniform velocity means no acceleration.

Question #132 Key: (C)

MDCAT 2010

For finding the height of projectile, the equation used is:

CORE CONCEPT AND DERIVATION

The third equation of motion applies independently to the vertical axis.

Solution:

- The mathematically valid expression is $2aS = v_f^2 - v_i^2$.

Why other options are incorrect:

The rest have incorrect algebraic structures.

Question #133 Key: (D)

MDCAT 2009

A body is moving with an initial velocity of [Formula]. After a time of 50 secs its velocity becomes [Formula]...

CORE CONCEPT AND DERIVATION

Calculate the rate of change of velocity using proper SI units.

Formula:

$$a = \frac{v_f - v_i}{t}$$

Solution:

- $v_i = 2000 \text{ m/s}, v_f = 1500 \text{ m/s}, t = 50 \text{ s}.$

- $$a = \frac{1500 - 2000}{50} = -10 \text{ m/s}^2$$

- The magnitude is 10 m/s^2 .

Why other options are incorrect:

Failure to convert km to meters leads to wrong values.

Question #134 Key: (B)

MDCAT 2009

In elastic collision, when a massive body collides with light body at conditions [Formula] and [Formula], the...

CORE CONCEPT AND DERIVATION

In elastic collisions where a massive object hits a stationary tiny object, the massive object is unaffected, and the tiny object flies off at twice the speed.

Solution:

- Because $m_1 \gg m_2, v_1' \approx v_1$ and $v_2' \approx 2v_1$.

Why other options are incorrect:

Option A is if the light body hit a stationary massive wall.

Question #135 Key: (A)

MDCAT 2008

The vertical velocity of ball thrown upward _____ with time.

CORE CONCEPT AND DERIVATION

Acceleration due to gravity is constant, meaning velocity changes at a constant rate.

Formula:

$$v_f = v_i - gt$$

Solution:

- This is a linear equation ($y = mx + c$), so the velocity decreases linearly as time advances.

Why other options are incorrect:

Displacement changes parabolically, not velocity.

Question #136 Key: (D)

MDCAT 2008

An _____ missile is called a ballistic missile.

CORE CONCEPT AND DERIVATION

A ballistic missile primarily relies on projectile motion for the majority of its flight.

Solution:

- After the initial boost, it falls back to Earth under gravity alone, making it un-powered and un-guided during its ballistic arc.

Why other options are incorrect:

Powered and guided systems are cruise missiles.

Question #137 Key: (D)

ETE 2005

A ball is just allowed to fall from the window of a moving train, it will hit the ground following:

CORE CONCEPT AND DERIVATION

When an object is dropped from a moving frame of reference, it retains the horizontal velocity of that frame due to inertia, while falling under gravity.

Solution:

- The combination of constant horizontal velocity and constant vertical acceleration produces a parabolic trajectory.

Why other options are incorrect:

A straight line only occurs if there is no horizontal velocity. Circular and hyperbolic paths do not match projectile kinematics.