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PHY1211 1-70

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1. The momentum of a body is defined to be the product of its mass and its velocity. If the mass of an air-track glider is known to be 225 g and its velocity is measured to be 3.1 cm/s, its momentum should be reported as A) 697.5 g · cm/s B) 698 g · cm/s C) 7.0 □ 102 g · cm/s D) 6.98 □ 102 g · cm/s E) 6.975 □ 102 g · cm/s

To find the momentum of the air-track glider, we can use the formula:

Momentum (p) = mass (m) × velocity (v)

Given: Mass (m) = 225 g Velocity (v) = 3.1 cm/s

Now, let's calculate the momentum:

Momentum (p) = 225 g × 3.1 cm/s

Momentum (p) = 697.5 g · cm/s

So, the correct answer is option A) 697.5 g · cm/s.

2. Vectors A B C D , , , and have the following components: A B C D x component +2.5 units +6.1 units –3.6 units –1.5 units y component +4.3 units –2.1 units +1.0 units –7.3 units The magnitude of the resultant is A) – 4.6 units B) 5.4 units C) 29 units D) 3.5 units E) 7.3 units

To find the magnitude of the resultant vector, we need to sum up the components of vectors A, B, C, and D to get the x and y components of the resultant vector. Then, we can use the Pythagorean theorem to find the magnitude.

Given vectors:

A: (x component = +2.5 units, y component = +4.3 units) B: (x component = +6.1 units, y component = -2.1 units) C: (x component = -3.6 units, y component = +1.0 units) D: (x component = -1.5 units, y component = -7.3 units)

Let's add the x and y components separately:

X component of the resultant = (2.5 units) + (6.1 units) + (-3.6 units) + (-1.5 units) = 3.5 units Y component of the resultant = (4.3 units) + (-2.1 units) + (1.0 units) + (-7.3 units) = -4.1 units

Now, we can calculate the magnitude of the resultant vector (R) using the Pythagorean theorem:

Magnitude (R) = √(X component^2 + Y component^2) Magnitude (R) = √(3.5^2 + (-4.1)^2) Magnitude (R) = √(12.25 + 16.81) Magnitude (R) = √29.06 Magnitude (R) ≈ 5.39 units

Rounding to one decimal place, the magnitude of the resultant vector is approximately 5.4 units.

So, the correct answer is option B) 5.4 units.

3. The density of seawater was measured to be 1.07 g/cm3 . This density in SI units is A) 1.07 □ 10–3 kg/m3 B) (1/1.07) □ 103 kg/m3 C) 1.07 □ 103 kg D) 1.07 □ 10–3 kg E) 1.07 □ 103 kg/m3

To convert the density of seawater from grams per cubic centimeter (g/cm^3) to SI units, which are kilograms per cubic meter (kg/m^3), we need to multiply the density by 1000.

Given density of seawater: 1.07 g/cm^3

Density in SI units (kg/m^3) = 1.07 g/cm^3 × 1000 kg/m^3 Density in SI units (kg/m^3) = 1070 kg/m^3

So, the correct answer is option C) 1.07 × 10^3 kg/m^3.

4. Three vectors A B, and C are added together. Which statement below best describes the additive property of the three vectors? A) ( ) A B C □ □ B) A B C □ □ ( ) C) C B A □ □ D) C A B □ □ E) all the other statements

The correct statement that best describes the additive property of the three vectors A, B, and C is:

B) A + B + C

In vector addition, the order of the vectors being added does not matter. So, A + B + C is the same as B + C + A or C + A + B. Therefore, statement B) A + B + C is the appropriate way to represent the addition of the three vectors.

5. A particle moves from x1 = 30 cm to x2 = – 40 cm. The displacement of this particle is A) 30 cm B) 40 cm C) 70 cm D) –70 cm E) – 40 cm

The displacement of a particle is the change in its position from the initial point to the final point. It is a vector quantity and is given by:

Displacement (Δx) = x2 - x1

where x1 is the initial position and x2 is the final position.

Given: x1 = 30 cm (initial position) x2 = -40 cm (final position)

Displacement (Δx) = (-40 cm) - (30 cm) = -70 cm

So, the correct answer is option D) -70 cm. The negative sign indicates that the particle moved 70 cm in the opposite direction from its initial position.

6. A Ford truck enters a highway and travels at a uniform speed of 50 mph. Half an hour later a Jaguar enters the highway at the same junction and heads in the same direction at 55 mph. How long after the Ford entered the highway does the Jaguar catch up with the truck? A) 5.0 hrs B) 6.0 hrs C) 1.0 hrs D) 1.6 hrs E) 5.5 hrs

Let's find out how long it takes for the Jaguar to catch up with the Ford truck.

Let's assume the time it takes for the Jaguar to catch up with the Ford truck after the Ford entered the highway is "t" hours.

In the time "t," the Ford truck has been traveling for t + 0.5 hours (since it entered half an hour earlier).

Distance traveled by the Ford truck (d1) = Speed × Time d1 = 50 mph × (t + 0.5) hours d1 = 50t + 25 miles

Distance traveled by the Jaguar (d2) = Speed × Time d2 = 55 mph × t hours d2 = 55t miles

When the Jaguar catches up with the Ford truck, they have covered the same distance. So, we can set up the equation:

d1 = d2 50t + 25 = 55t

Now, solve for "t":

55t - 50t = 25 5t = 25 t = 25 / 5 t = 5 hours

So, it takes 5 hours after the Ford truck entered the highway for the Jaguar to catch up with it.

The correct answer is option A) 5.0 hrs.

7. On a graph that shows position on the vertical axis and time on the horizontal axis, a parabolic curve that opens downward represents A) a constant positive acceleration. B) a constant negative acceleration. C) no acceleration. D) a positive followed by a negative acceleration. E) a negative followed by a positive acceleration.

On a graph that shows position on the vertical axis and time on the horizontal axis, a parabolic curve that opens downward represents:

B) a constant negative acceleration.

When a parabolic curve opens downward, it indicates that the position is changing at a decreasing rate with time. In other words, the object is slowing down, which corresponds to a negative acceleration. The acceleration is constant because the shape of the parabola remains consistent, indicating a steady change in velocity.

8. The relationship between the velocity of a body moving along the x axis and time is given by v = 3t 2 – 2t, where the units are SI units. The total distance the body travels between the times t = 2 s and t = 4 s is A) 12 m B) 60 m C) 48 m D) 34 m E) 44 m

To find the total distance the body travels between the times t = 2 s and t = 4 s, we need to find the displacement at each time interval and then add up the magnitudes of these displacements.

The velocity of the body is given by v = 3t^2 - 2t.

To find the displacement between t = 2 s and t = 4 s, we need to integrate the velocity function over this time interval:

$\int[2 \text{ to } 4] (3t^2 - 2t)\, dt$

Now, let's perform the integration:

$\int[2 \text{ to } 4] (3t^2 - 2t)\, dt = [t^3 - t^2]$ evaluated from t = 2 to t = 4 = $(4^3 - 4^2) - (2^3 - 2^2) = (64 - 16) - (8 - 4) = 48 - 4 = 44$ meters

So, the total distance the body travels between t = 2 s and t = 4 s is 44 meters.

The correct answer is option E) 44 m.

9. A projectile was fired at 35º above the horizontal. At the highest point in its trajectory its speed was 200 m/s. If air resistance is ignored, the initial velocity had a horizontal component of A) zero B) 200 cos (35º) m/s C) 200 sin (35º) m/s D) 200/cos (35º) m/s E) 200 m/s

When a projectile is fired at an angle above the horizontal, its initial velocity can be broken down into two components: the horizontal component (Vx) and the vertical component (Vy).

Given: The speed at the highest point in the trajectory is 200 m/s.

At the highest point, the vertical component of the velocity is zero because the projectile momentarily stops moving vertically before it starts descending.

So, Vy = 0 m/s.

The horizontal component of velocity (Vx) remains constant throughout the projectile's motion because there is no horizontal force acting on the projectile (ignoring air resistance).

The initial velocity (V) can be related to its horizontal and vertical components using trigonometry:

$Vx = V * \cos(\theta)$

where: V = initial velocity (magnitude) θ = angle above the horizontal (35º in this case)

We know V = 200 m/s (speed at the highest point) and Vy = 0 m/s.

So,

Vx = 200 m/s * cos(35º)

Now, let's calculate Vx:

Vx = 200 m/s * cos(35º) ≈ 163.3 m/s

So, the correct answer is option B) 200 cos(35º) m/s, approximately 163.3 m/s.

10. A river is 0.76 km wide. The banks are straight and parallel. The current is 5.0 km/h and is parallel to the banks. A boat has a maximum speed of 3 km/h in still water. The pilot of the boat wishes to travel on a straight line from A to B, where AB is perpendicular to the banks. The pilot should A) head directly across the river. B) head 68º upstream from the line AB. C) head 22º upstream from the line AB. D) give up. The trip from A to B is not possible with this boat. E) do none of these.

To determine the best direction for the boat to travel from point A to point B, let's analyze the situation:

1. The river is 0.76 km wide.
2. The current flows at 5.0 km/h parallel to the banks.
3. The boat's maximum speed in still water is 3 km/h.

If the boat heads directly across the river (option A), it will be affected by both the river's current and its maximum speed in still water. As a result, it won't be able to reach the opposite bank directly.

To maximize the boat's speed across the river, it should aim to travel perpendicular to the current. This means it should aim for a direction that is partially upstream and partially perpendicular to the banks.

Let's find the angle at which the boat should head with respect to the line AB (perpendicular to the banks):

tan(θ) = (Speed of the current) / (Boat's maximum speed in still water)

tan(θ) = 5 km/h / 3 km/h tan(θ) = 5/3

θ ≈ 59.04°

So, the boat should head 59.04° upstream from the line AB.

However, none of the provided answer options exactly match this angle. The closest option is:

C) Head 22º upstream from the line AB.

Option C is not the exact angle, but it is the closest approximation among the given choices. So, the pilot should head approximately 22º upstream from the line AB to maximize the boat's speed across the river.

11. The position vector locating the point P(12,–5) relative to the origin is A) 12 5 ˆ ˆ i j □ B) 5 12 ˆ ˆ □ □i j C) 5 12 ˆ ˆ i j □ D) 12 5 ˆ ˆ i j □ E) 13 13 ˆ ˆ i j

The position vector locating the point P(12, -5) relative to the origin (0, 0) is given by:

Position vector = OP = xi + yj

where xi represents the x-component and yj represents the y-component.

Given that the coordinates of point P are (12, -5), the position vector is:

Position vector = 12i - 5j

So, the correct answer is option D) 12i - 5j.

12. The maximum horizontal range of a rock which is thrown at the same speed but different angles with the horizon and which lands at a level, H, below the initial level occurs when the angle is A) less than 0° B) 0° C) greater than 0° and less than 45° (actual value depends on the value of H) D) 45° E) greater than 45°

The maximum horizontal range of a projectile occurs when it is launched at an angle of 45 degrees with the horizontal. This is a well-known result in projectile motion.

When a projectile is launched at an angle of 45 degrees, it achieves the maximum horizontal displacement for a given initial speed. This happens because at 45 degrees, the initial velocity is evenly split into horizontal and vertical components, resulting in the maximum horizontal distance traveled before hitting the ground.

So, the correct answer is option D) 45°.

13. An unknown force F is applied to two unknown masses MA and MB. Their accelerations a A and a B are measured. From these data we can determine A) the magnitude of F only. B) MA and MB only. C) the magnitudes of F, MA, and MB only. D) the ratio of MA to MB only. E) MA, MB, and the weights of MA and MB.

From the given information about the unknown force FF applied to two unknown masses M_AMA and M_BMB, along with their measured accelerations a_AaA and a_BaB, we can determine the ratio of M_AMA to M_BMB (option D) and the magnitude of FF (option A).

To understand why, let's use Newton's second law of motion, which states:

$F = M \times a$F = M × a

where FF is the force applied to an object, MM is the mass of the object, and aa is the acceleration of the object.

Now, we have two objects (masses M_AMA and M_BMB) experiencing different accelerations (a_AaA and a_BaB) due to the same unknown force FF. Let's set up the equations for each object:

For mass M_AMA:

$F = M_A \times a_A$F = MA × aA

For mass M_BMB:

$F = M_B \times a_B$F = MB × aB

Since FF is the same in both cases, we can set the two equations equal to each other:

$M_A \times a_A = M_B \times a_B$MA × aA = MB × aB

Now, we can find the ratio of M_AMA to M_BMB as follows:

$\frac{M_A}{M_B} = \frac{a_B}{a_A}$MBMA = aAaB

So, we can determine the ratio of M_AMA to M_BMB from the given data. Additionally, we can find the magnitude of the force FF from either equation.

However, we cannot determine the individual masses M_AMA and M_BMB separately, and we cannot determine the weights of M_AMA and M_BMB (option E) from the given data.

Therefore, the correct answers are option D) the ratio of M_AMA to M_BMB only and option A) the magnitude of FF only.

14. A horse harnessed to a wagon refuses to pull, citing Newton's third law, which states that for every force there is an equal but opposite reaction force. The horse, incorrect in its reasoning, can pull the wagon because A) after it gives a jerk and the wagon is moving, its pulling force will be greater than the reaction to this force. B) the law applies only to static cases. C) the wagon cannot possibly pull back with a force equal in magnitude to the pulling force. D) the action and reaction forces are acting on different bodies. E) after friction is overcome, the reaction force is less than the pulling force

The correct reason why the horse can pull the wagon, despite citing Newton's third law incorrectly, is:

D) The action and reaction forces are acting on different bodies.

Newton's third law states that for every action force, there is an equal but opposite reaction force. When the horse exerts a force on the wagon (action force), the wagon exerts an equal and opposite force on the horse (reaction force). However, these two forces act on different bodies (the horse and the wagon).

In this situation, the horse is able to pull the wagon because the force exerted by the horse on the wagon is not canceled out by the reaction force acting on the horse. The action-reaction forces always act on different objects, so they do not cancel each other out. As a result, the horse can indeed pull the wagon.

Options A, B, C, and E are incorrect explanations because they do not address the fundamental principle of action and reaction forces acting on different bodies, as stated in Newton's third law.

15. A large (15,000-kg) military helicopter lifts a 6000-kg truck straight up out of a danger zone with an acceleration of 4 m/s2 . Calculate the tension in the lifting cable. A) 3.5 □ 104 N B) 8.3 □ 104 N C) 2.1 □ 102 N D) 5.9 □ 104 N E) 2.4 □ 104 N

To calculate the tension in the lifting cable, we can use Newton's second law of motion, which states that the net force acting on an object is equal to its mass multiplied by its acceleration.

Given: Mass of the helicopter (m_h) = 15,000 kg Mass of the truck (m_t) = 6,000 kg Acceleration (a) = 4 m/s²

The net force (F_net) on the system (helicopter + truck) is the sum of the forces acting on it:

F_net = Tension in the lifting cable - Weight of the helicopter - Weight of the truck

The weight of an object is given by:

Weight = mass × acceleration due to gravity

Acceleration due to gravity (g) is approximately 9.81 m/s².

Weight of the helicopter (W_h) = m_h × g Weight of the truck (W_t) = m_t × g

Now, we can set up the equation:

F_net = T - W_h - W_t

Since the helicopter and truck are moving with the same acceleration, we can rewrite the equation as:

F_net = (m_h + m_t) × a

Now, we can calculate the net force:

F_net = (15,000 kg + 6,000 kg) × 4 m/s² F_net = 21,000 kg × 4 m/s² F_net = 84,000 N

So, the tension in the lifting cable (T) is equal to the net force:

T = 84,000 N

The correct answer is option B) 8.3 × 10^4 N.

16. A cricket batsman hits a ball with a bat. If the force with which the bat hits the ball is considered the action force, what is the reaction force? A) the force the bat exerts on the batsman's hands B) the force on the ball exerted by the hand of the person who catches it C) the force the ball exerts on the bat D) the force the bowler exerts on the ball in throwing it E) friction as the ball rolls to a stop

According to Newton's third law of motion, for every action, there is an equal and opposite reaction. In this case, when the cricket batsman hits the ball with the bat, the force with which the bat hits the ball is the action force. Therefore, the reaction force is:

C) the force the ball exerts on the bat.

The ball exerts an equal and opposite force on the bat as a reaction to the bat hitting it. This reaction force is what causes the ball to change its direction and move away from the bat.

18. An object with a mass of 5.5 kg is allowed to slide from rest down an inclined plane. The plane makes an angle of 30º with the horizontal and is 72 m long. The coefficient of friction between the plane and the object is 0.35. The speed of the object at the bottom of the plane is A) 5.3 m/s B) 15 m/s C) 24 m/s D) 17 m/s E) 11 m/s

To find the speed of the object at the bottom of the inclined plane, we can use the principles of conservation of energy.

The potential energy (PE) of the object at the top of the inclined plane is converted into kinetic energy (KE) at the bottom of the plane.

The potential energy at the top is given by:

PE = mgh

where m is the mass of the object, g is the acceleration due to gravity (approximately 9.81 m/s²), and h is the vertical height of the inclined plane.

h = 72 m × sin(30º) (vertical height of the inclined plane)

Now, let's calculate the height:

h = 72 m × 0.5 = 36 m

PE = 5.5 kg × 9.81 m/s^2 × 36 m ≈ 1962.54 Joules

At the bottom of the inclined plane, all of this potential energy is converted into kinetic energy:

KE = 1/2 mv^2

where v is the speed of the object at the bottom of the inclined plane.

Now, we can set the potential energy equal to the kinetic energy:

PE = KE

5.5 kg × 9.81 m/s^2 × 36 m = 1/2 × 5.5 kg × v^2

1962.54 Joules = 2.75 kg × v^2

v^2 = 1962.54 Joules / 2.75 kg

v^2 ≈ 713.47 m^2/s^2

v ≈ √713.47 m/s ≈ 26.7 m/s

So, the speed of the object at the bottom of the inclined plane is approximately 26.7 m/s.

The correct answer is not provided among the given options. The closest option to the calculated speed is option C) 24 m/s. However, the actual speed is closer to 26.7 m/s.

22. The human heart is essentially a pump for moving blood around the body. If its average power output (over many beats) is about 2.0 W and it pumps blood at an overall average speed of 0.3 m/s into the output aorta channel, calculate the average force with which the heart moves the blood into the aorta. A) 0.60 N B) 6.7 N C) 22 N D) 66 N E) 0.18 N

To calculate the average force with which the heart moves blood into the aorta, we can use the formula for power:

Power (P) = Force (F) × Velocity (v)

Given: Power output of the heart (P) = 2.0 W Average speed of blood (v) = 0.3 m/s

We need to find the force (F).

Rearranging the formula, we get:

Force (F) = Power (P) / Velocity (v)

Now, let's substitute the given values:

Force (F) = 2.0 W / 0.3 m/s ≈ 6.67 N

So, the average force with which the heart moves blood into the aorta is approximately 6.67 N.

The correct answer is option B) 6.7 N.

23. What is the power output needed from a motor to lift, in the absence of friction, a mass of 1.5 □ 104 kg 25 m in 6.0 s at constant speed? A) 2.0 □ 106 W B) 6.1 □ 105 W C) 2.2 □ 104 W D) 8.3 □ 105 W E) 3.1 □ 105 W

To calculate the power output needed from the motor to lift the mass, we can use the formula for power:

Power (P) = Work done (W) / Time (t)

Given: Mass of the object (m) = 1.5 × 10^4 kg Distance lifted (d) = 25 m Time taken (t) = 6.0 s

First, let's calculate the work done to lift the mass:

Work done (W) = Force (F) × Distance (d)

The force required to lift the mass at constant speed is equal to its weight, which is given by:

Force (F) = mass (m) × acceleration due to gravity (g)

acceleration due to gravity (g) ≈ 9.81 m/s^2

Now, calculate the force:

F = 1.5 × 10^4 kg × 9.81 m/s^2 ≈ 1.47 × 10^5 N

Next, calculate the work done:

W = F × d = 1.47 × 10^5 N × 25 m = 3.675 × 10^6 J

Now, we can calculate the power:

Power (P) = Work done (W) / Time (t) = 3.675 × 10^6 J / 6.0 s ≈ 6.125 × 10^5 W

So, the power output needed from the motor to lift the mass at a constant speed is approximately 6.125 × 10^5 W.

The correct answer is option B) 6.1 × 10^5 W.

25. The rest mass of an electron is 9.11 □ 10–31 kg. From this information one can conclude that the rest energy of an electron is A) 8.20 □ 10 14 MeV B) 0.512 MeV C) 2.73 □ 10 22 J D) 0.00171 MeV E) 0.171 MeV

The rest energy of an electron can be calculated using Einstein's famous equation:

$E = mc^2$

where: E is the energy (in joules), m is the mass of the electron (in kilograms), c is the speed of light in a vacuum (approximately 3.00×10^8 m/s).

Given the rest mass of the electron $m = 9.11 \times 10^{-31}$ kg, we can calculate the rest energy E as follows:

$E = (9.11 \times 10^{-31}\text{ kg}) \times (3.00 \times 10^8\text{ m/s})^2$

$E = 8.19 \times 10^{-14}\text{ J}$

Now, let's convert the energy from joules to mega-electron volts (MeV):

1 MeV = 1.60×10^{-13} J

Rest energy (in MeV) = $\frac{8.19 \times 10^{-14}}{1.60 \times 10^{-13}}$

Rest energy (in MeV) = 0.51125 MeV

Rounding to three decimal places, the rest energy of an electron is approximately 0.511 MeV.

So, the correct answer is option B) 0.512 MeV.

26. A woman on a bicycle traveling at 10 m/s on a horizontal road stops pedaling as she starts up a hill inclined at 3.0º to the horizontal. If friction forces are ignored, how far up the hill does she travel before stopping? A) 5.1 m B) 30 m C) 97 m D) 10 m E) The answer depends on the mass of the woman.

To find how far the woman travels up the hill before stopping, we can analyze the conservation of energy. Initially, the woman has kinetic energy due to her motion on the horizontal road, and as she travels up the hill, this kinetic energy is converted into potential energy.

The conservation of energy principle is given by:

Initial kinetic energy = Final potential energy

The initial kinetic energy (KE_initial) is given by:

KE_initial = 0.5 * mass * velocity^2

where mass is the mass of the woman and velocity is her initial velocity on the horizontal road (10 m/s).

The final potential energy (PE_final) is given by:

PE_final = mass * g * height

where g is the acceleration due to gravity (approximately 9.81 m/s²), and height is the height she travels up the hill.

Setting the initial kinetic energy equal to the final potential energy:

0.5 * mass * velocity^2 = mass * g * height

We can cancel out the mass from both sides of the equation:

0.5 * velocity^2 = g * height

Now, solve for height:

height = (0.5 * velocity^2) / g

height = (0.5 * 10^2) / 9.81 ≈ 5.10 meters

So, the woman travels approximately 5.10 meters up the hill before stopping.

The correct answer is option A) 5.1 m.

28. When a hydrogen atom absorbs a photon with E = 4.089 □ 10 19 J, what is the frequency of the photon? A) 6.17 □ 1014 Hz B) 2.45 □ 1018 Hz C) 2.55 □ 108 Hz D) 6.623 □ 1034 Hz E) None of these is correct.

To find the frequency (f) of the photon absorbed by a hydrogen atom, we can use the relationship between energy (E) and frequency (f) of a photon:

$E = hf$ E = hf

where: EE is the energy of the photon (4.089 × 10^19 J in this case), hh is Planck's constant (6.626×10^{-34} 6.626 × 10−34 J·s), ff is the frequency of the photon (what we need to find).

Rearrange the equation to solve for frequency:

$f = \frac{E}{h}$f = hE

Now, let's substitute the given values:

$f = \frac{4.089 \times 10^{19}\ \text{J}}{6.626 \times 10^{-34}\ \text{J\cdotp s}}$f = 6.626×10−34 J\cdotps4.089×1019 J

$f \approx 6.17 \times 10^{14}\ \text{Hz}$f ≈ 6.17 × 1014 Hz

So, the frequency of the photon absorbed by the hydrogen atom is approximately 6.17 × 10^14 Hz.

The correct answer is option A) 6.17 × 10^14 Hz.

29. An 1810-kg truck traveling eastward at 64.4 km/h collides at an intersection with a 905- kg automobile traveling northward at 96.5 km/h. The vehicles lock together and immediately after the collision are headed in which direction? A) 30º N of E B) 37º N of E C) 45º N of E D) 53º N of E E) 67º N of E

To find the direction in which the two vehicles are headed after the collision, we can use the principle of conservation of momentum.

The total momentum of the system before the collision is the sum of the momenta of the truck and the automobile:

$P_{\text{initial}} = m_{\text{truck}} \cdot v_{\text{truck}} + m_{\text{automobile}} \cdot v_{\text{automobile}}$ Pinitial = mtruck ⋅ vtruck + mautomobile ⋅ vautomobile

where: m_{truck} mtruck = mass of the truck = 1810 kg v_{truck} vtruck = velocity of the truck = 64.4 km/h (convert to m/s) $m_{\text{automobile}}$ mautomobile = mass of the automobile = 905 kg $v_{\text{automobile}}$ vautomobile = velocity of the automobile = 96.5 km/h (convert to m/s)

Now, convert the velocities to m/s:

$v_{\text{truck}} = 64.4\ \text{km/h} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{h}}{3600\ \text{s}} \approx 17.89\ \text{m/s}$vtruck = 64.4 km/h × 1 km1000 m × 3600 s1 h ≈ 17.89 m/s

$v_{\text{automobile}} = 96.5\ \text{km/h} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{h}}{3600\ \text{s}} \approx 26.81\ \text{m/s}$vautomobile = 96.5 km/h × 1 km1000 m × 3600 s1 h ≈ 26.81 m/s

Now, calculate the total initial momentum:

$P_{\text{initial}} = 1810\ \text{kg} \times 17.89\ \text{m/s} + 905\ \text{kg} \times 26.81\ \text{m/s}$Pinitial = 1810 kg × 17.89 m/s + 905 kg × 26.81 m/s

$P_{\text{initial}} \approx 32156.6\ \text{kg m/s}$Pinitial ≈ 32156.6 kg m/s

After the collision, the two vehicles lock together and move as one combined mass with a new velocity (v_combined).

The final momentum of the combined mass (P_combined) is equal to the total initial momentum:

$P_{\text{combined}} = P_{\text{initial}}$ Pcombined = Pinitial

$m_{\text{combined}} \cdot v_{\text{combined}} = P_{\text{initial}}$ mcombined ⋅ vcombined = Pinitial

where: m_{combined} mcombined = combined mass of the truck and automobile after the collision (1810 kg + 905 kg) v_{combined} vcombined = velocity of the combined mass after the collision (what we need to find).

Now, calculate the combined mass:

$m_{\text{combined}} = 1810\ \text{kg} + 905\ \text{kg} = 2715\ \text{kg}$mcombined = 1810 kg + 905 kg = 2715 kg

Now, find the velocity of the combined mass:

$v_{\text{combined}} = \frac{P_{\text{initial}}}{m_{\text{combined}}}$vcombined = mcombinedPinitial

$v_{\text{combined}} = \frac{32156.6\ \text{kg m/s}}{2715\ \text{kg}} \approx 11.85\ \text{m/s}$vcombined = 2715 kg32156.6 kg m/s ≈ 11.85 m/s

Now, we have the magnitude of the velocity, and we need to find the direction.

The direction can be found using trigonometry. The combined velocity (v_combined) has components in the eastward and northward directions. The eastward component is the initial velocity of the truck (17.89 m/s), and the northward component is the initial velocity of the automobile (26.81 m/s).

The direction of v_combined can be found using the tangent of the angle (θ) with respect to the eastward direction:

$tan(\theta) = \frac{\text{Northward component}}{\text{Eastward component}} = \frac{v_{\text{automobile}}}{v_{\text{truck}}}$tan(θ) = Eastward componentNorthward component = vtruckvautomobile

$tan(\theta) = \frac{26.81\text{ m/s}}{17.89\text{ m/s}}$tan(θ) = 17.89 m/s26.81 m/s

$\theta \approx 53^{o}$θ ≈ 53º

So, the vehicles are headed in a direction approximately 53º N of E.

The correct answer is option D) 53º N of E.

30. A ball of mass m and velocity u1 collides with and sticks to a ball of mass M and velocity 2 u . If the pair moves on with velocity V, the impulse given the ball of mass m during the collision must have been A) 1 m V u ( ) □ B) 1 m V u ( ) □ C) ( ) m M V □ D) 2 ( )( ) m M V u □ □ E) zero

To solve this problem, we can apply the principle of conservation of momentum during the collision. The total momentum before the collision is equal to the total momentum after the collision.

Before the collision: The momentum of ball m: $m \cdot u_1$ m · u1 The momentum of ball M: $M \cdot 2u$M · 2u (as it moves with 2u velocity)

After the collision: The momentum of the combined mass (m + M): $(m + M) \cdot V$(m + M) · V (moving with velocity V)

According to the principle of conservation of momentum:

$m \cdot u_1 + M \cdot 2u = (m + M) \cdot V$m · u1 + M · 2u = (m + M) · V

Now, let's solve for V:

$V = \frac{m \cdot u_1 + M \cdot 2u}{m + M}$V = m+Mm·u1+M·2u

Next, let's find the impulse (J) given to the ball of mass m during the collision. Impulse is the change in momentum, so it can be calculated as:

$J = \text{Final momentum} - \text{Initial momentum} = (m + M) \cdot V - m \cdot u_1$ J = Final momentum − Initial momentum = (m + M) · V − m · u1

Now, substitute the expression for V:

$J = (m + M) \cdot (\frac{m \cdot u_1 + M \cdot 2u}{m + M}) - m \cdot u_1$ J = (m + M) · (m+Mm·u1+M·2u) − m · u1

$J = \frac{m \cdot u_1 + M \cdot 2u}{m + M} \cdot (m + M - m)$J = m+Mm·u1+M·2u · (m + M − m)

$J = \frac{m \cdot u_1 + M \cdot 2u}{m + M} \cdot M$J = m+Mm·u1+M·2u · M

Now, simplify:

$J = \frac{m \cdot u_1 \cdot M + M \cdot 2u \cdot M}{m + M}$J = m+Mm·u1·M+M·2u·M

$J = \frac{M \cdot (m \cdot u_1 + 2u)}{m + M}$J = m+MM·(m·u1+2u)

So, the impulse given to the ball of mass m during the collision is:

$J = \frac{M \cdot (m \cdot u_1 + 2u)}{m + M}$J = m+MM·(m·u1+2u)

The correct answer is not among the provided options.

31. A particle with speed v1 = 2.64 □ 106 m/s makes a glancing elastic collision with another particle that is at rest. Both particles have the same mass. After the collision, the struck particle moves off at 45º to v1. The speed of the struck particle after the collision is approximately A) 3.4 □ 106 m/s B) 1.3 □ 106 m/s C) 0.53 □ 106 m/s D) 1.9 □ 106 m/s E) 6.4 □ 106 m/s

Let's denote the mass of both particles as mm and the speed of the struck particle after the collision as v_2 v2.

Before the collision, we have the following situation:

Particle 1 (with speed $v_1 = 2.64 \times 10^6$ v1 = 2.64 × 106 m/s) moving towards Particle 2 (at rest).

After the collision, Particle 1 moves off at 45º45º to its initial direction, and Particle 2 moves off at some angle as well, with a speed v_2 v2.

Since the collision is elastic, both momentum and kinetic energy are conserved.

1. Conservation of Momentum: The total momentum before the collision is $m \cdot v_1$ m · v1 (considering Particle 2 is initially at rest). After the collision, the total momentum is the vector sum of the momenta of both particles:

$m \cdot v_1 = m \cdot v_1' + m \cdot v_2'$m · v1 = m · v1′ + m · v2′

Where v_1' is the speed of Particle 1 after the collision (magnitude v_1 but at 45º angle) and v_2' is the speed of Particle 2 after the collision (magnitude v_2).

2. Conservation of Kinetic Energy: The initial kinetic energy of the system is given by $0.5 \cdot m \cdot v_1^2$, and the final kinetic energy is the sum of the kinetic energies of both particles:

$0.5 \cdot m \cdot v_1^2 = 0.5 \cdot m \cdot v_1'^2 + 0.5 \cdot m \cdot v_2'^2$

Now, let's solve these equations to find v_1' and v_2'.

From the conservation of momentum:

$m \cdot v_1' + m \cdot v_2' = m \cdot v_1$

From the conservation of kinetic energy:

$0.5 \cdot m \cdot v_1^2 = 0.5 \cdot m \cdot v_1'^2 + 0.5 \cdot m \cdot v_2'^2$

Since $v_1 = v_1' = 2.64 \times 10^6$ m/s, we can rewrite the equations as:

$2 \cdot v_1' + v_2' = v_1$

$v_1^2 = v_1'^2 + v_2'^2$

Now, substitute the value of $v_1 = 2.64 \times 10^6$ m/s:

$2 \cdot v_1' + v_2' = 2.64 \times 10^6$ m/s

$2.64 \times 10^{12} = (2.64 \times 10^6)^2 + v_2'^2$

$v_2'^2 = 2.64 \times 10^{12} - (2.64 \times 10^6)^2$

$v_2'^2 = 2.64 \times 10^{12} - 6.9696 \times 10^{12}$

$v_2'^2 = -4.3296 \times 10^{12}$

We have a negative value for $v_2'^2$, which is not possible since speed (magnitude of velocity) cannot be negative.

This means that the scenario described in the problem is not physically possible, and there is no valid solution for the speed of the struck particle after the collision.

Therefore, the correct answer is E) None of these is correct.

32. A toy car of mass 2.0 kg moving to the right with a speed of 8.0 m/s collides perfectly inelastically with another toy car of mass 3.0 kg that is moving to the left with a speed of 2.0 m/s. Immediately after the collision the velocity of the system is A) 4.4 m/s to the right. B) 2.0 m/s to the right. C) 0 m/s D) –2.0 m/s to the right. E) 10 m/s to the right.

To solve this problem, we can apply the principle of conservation of momentum for an inelastic collision. In an inelastic collision, the two objects stick together after the collision.

Before the collision, the momentum of the system is the sum of the momenta of both toy cars:

Initial momentum = (mass of the first car × velocity of the first car) + (mass of the second car × velocity of the second car)

$P_{\text{initial}} = (2.0\,\text{kg} \times 8.0\,\text{m/s}) + (3.0\,\text{kg} \times (-2.0\,\text{m/s}))$

$P_{\text{initial}} = 16.0\,\text{kg m/s} - 6.0\,\text{kg m/s} = 10.0\,\text{kg m/s}$

After the collision, the two cars stick together and move as one combined mass. Let v be the final velocity of the combined mass (moving to the right).

The final momentum of the system is the mass of the combined mass (sum of the masses of both cars) multiplied by the final velocity:

$P_{\text{final}} = (2.0\,\text{kg} + 3.0\,\text{kg}) \times v$

$P_{\text{final}} = 5.0\,\text{kg} \times v$

According to the principle of conservation of momentum, the initial momentum is equal to the final momentum:

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

$10.0\,\text{kg m/s} = 5.0\,\text{kg} \times v$

Now, solve for v:

$v = \frac{10.0\,\text{kg m/s}}{5.0\,\text{kg}} = 2.0\,\text{m/s}$

So, the velocity of the system immediately after the collision is 2.0 m/s to the right.

The correct answer is option B) 2.0 m/s to the right.

34. A disc with moment of inertia I1 = 40 kg□m2 and angular velocity □1 = 20 rad/s is dropped on to a stationary second disc along the axis of rotation. The second disc has moment of inertia I2 = 60 kg□m2 . How much rotational kinetic energy is lost? A) 3200 J B) 4800 J C) 8000 J D) 11300 J E) 15000 J

When the first disc is dropped onto the stationary second disc along the axis of rotation, they will eventually start rotating together with a common final angular velocity (ω_f ωf). To find the rotational kinetic energy lost during this process, we can use the conservation of angular momentum.

The total initial angular momentum (L_{initial} Linitial) of the system is the sum of the initial angular momenta of both discs:

$L_{\text{initial}} = I_1 \cdot \omega_1 + I_2 \cdot 0$ Linitial = I1 · ω1 + I2 · 0

Since the second disc is stationary initially, its initial angular velocity (ω_2 ω2) is zero.

The final angular momentum (L_{final} Lfinal) of the system is the sum of the final angular momenta of both discs after they start rotating together:

$L_{\text{final}} = (I_1 + I_2) \cdot \omega_f$ Lfinal = (I1 + I2) · ωf

According to the conservation of angular momentum, the initial angular momentum is equal to the final angular momentum:

$L_{\text{initial}} = L_{\text{final}}$ Linitial = Lfinal

$I_1 \cdot \omega_1 = (I_1 + I_2) \cdot \omega_f$ I1 · ω1 = (I1 + I2) · ωf

Now, solve for ω_f ωf :

$\omega_f = \frac{I_1 \cdot \omega_1}{I_1 + I_2}$ ωf = I1+I2I1 ·ω1

Substitute the given values:

$\omega_f = \frac{40\ \text{kg\cdotpm}^2 \cdot 20\ \text{rad/s}}{40\ \text{kg\cdotpm}^2 + 60\ \text{kg\cdotpm}^2}$ ωf = 40 kg\cdotpm2+60 kg\cdotpm240 kg\cdotpm2·20 rad/s

$\omega_f = \frac{800\ \text{kg\cdotpm}^2/\text{s}}{100\ \text{kg\cdotpm}^2} = 8\ \text{rad/s}$ ωf = 100 kg\cdotpm2800 kg\cdotpm2/s = 8 rad/s

Now, let's find the initial rotational kinetic energy (K_{initial} Kinitial) of the system:

$K_{\text{initial}} = \frac{1}{2} \cdot I_1 \cdot \omega_1^2 + \frac{1}{2} \cdot I_2 \cdot 0^2$ Kinitial = 21 · I1 · ω12 + 21 · I2 · 02

$K_{\text{initial}} = \frac{1}{2} \cdot 40\ \text{kg\cdotpm}^2 \cdot (20\ \text{rad/s})^2 + 0$ Kinitial = 21 · 40 kg\cdotpm2 · (20 rad/s)2 + 0

$K_{\text{initial}} = 8000\ \text{J}$ Kinitial = 8000 J

Now, let's find the final rotational kinetic energy (K_{final} Kfinal) of the system:

$K_{\text{final}} = \frac{1}{2} \cdot (I_1 + I_2) \cdot \omega_f^2$ Kfinal = 21 · (I1 + I2) · ωf2

$K_{\text{final}} = \frac{1}{2} \cdot (40\ \text{kg\cdotpm}^2 + 60\ \text{kg\cdotpm}^2) \cdot (8\ \text{rad/s})^2$ Kfinal = 21 · (40 kg\cdotpm2 + 60 kg\cdotpm2) · (8 rad/s)2

$K_{\text{final}} = \frac{1}{2} \cdot 100\ \text{kg\cdotpm}^2 \cdot 64\ \text{rad}^2/\text{s}^2$ Kfinal = 21 · 100 kg\cdotpm2 · 64 rad2/s2

$K_{\text{final}} = 3200\ \text{J}$ Kfinal = 3200 J

The rotational kinetic energy lost during the process is:

$K_{\text{lost}} = K_{\text{initial}} - K_{\text{final}}$ Klost = Kinitial − Kfinal

$K_{\text{lost}} = 8000\ \text{J} - 3200\ \text{J}$ Klost = 8000 J − 3200 J

$K_{\text{lost}} = 4800\ \text{J}$ Klost = 4800 J

So, the rotational kinetic energy lost is 4800 J.

The correct answer is option B) 4800 J.

35. The angular momentum of a flywheel about its axis is 925 kg · m2 /s. If its moment of inertia about the same axis is 2.50 kg · m2 , its angular velocity is A) 370 rev/min B) 62 rev/min C) 36 rev/min D) 2210 rad/s E) 370 rad/s

We can use the formula for angular momentum (LL) of a rotating object:

$L = I \cdot \omega$L = I · ω

where: LL = angular momentum (925 kg·m²/s in this case), II = moment of inertia about the axis (2.50 kg·m² in this case), ωω = angular velocity (what we need to find).

Rearrange the formula to solve for ωω:

$\omega = \frac{L}{I}$ω = IL

Now, substitute the given values:

$\omega = \frac{925\ \text{kg}\backslash\text{cdotp}\text{m}^2/\text{s}}{2.50\ \text{kg}\backslash\text{cdotp}\text{m}^2}$ω = 2.50 kg\cdotpm2925 kg\cdotpm2/s

$\omega = 370$ rad/sω = 370 rad/s

Now, let's convert ωω to rev/min:

1 rev = 2π rad1 rev = 2π rad

So, ωω in rev/s is:

$\omega_{\text{rev/s}} = \frac{\omega}{2\pi} = \frac{370\ \text{rad/s}}{2\pi} \approx 58.9$ rev/sωrev/s = 2πω = 2π370 rad/s ≈ 58.9 rev/s

Finally, let's convert ωω to rev/min:

1 min = 60 s1 min = 60 s

$\omega_{\text{rev/min}} = \omega_{\text{rev/s}} \times 60 \approx 58.9 \times 60 \approx 3534$ rev/minωrev/min = ωrev/s × 60 ≈ 58.9 × 60 ≈ 3534 rev/min

So, the angular velocity of the flywheel is approximately 3534 rev/min.

The correct answer is option E) 370 rad/s.

36. Two wheels with identical moments of inertia are rotating about the same axle. The first is rotating clockwise at 2.0 rad/s, and the second is rotating counterclockwise at 6.0 rad/s. If the two wheels are brought into contact so that they rotate together, their final angular velocity will be A) 2.0 rad/s, counterclockwise. B) 3.0 rad/s, clockwise. C) 4.0 rad/s, counterclockwise. D) 5.0 rad/s, clockwise. E) 6.0 rad/s, clockwise.

When two rotating objects are brought into contact and allowed to rotate together, their total angular momentum is conserved. This is because there are no external torques acting on the system.

The total initial angular momentum (L_{initial} Linitial) of the system is the sum of the initial angular momenta of both wheels:

$L_{\text{initial}} = I_1 \cdot \omega_1 + I_2 \cdot \omega_2$ Linitial = I1 ⋅ ω1 + I2 ⋅ ω2

where I_1 I1 and I_2 I2 are the moments of inertia of the first and second wheels, respectively, and ω_1 ω1 and ω_2 ω2 are their initial angular velocities.

Since both wheels have identical moments of inertia, $I_1 = I_2 = I$I1 = I2 = I.

Now, substitute the given values:

$L_{\text{initial}} = I \cdot \omega_1 + I \cdot \omega_2$ Linitial = I ⋅ ω1 + I ⋅ ω2

$L_{\text{initial}} = I \cdot (2.0\ \text{rad/s}) + I \cdot (6.0\ \text{rad/s})$Linitial = I ⋅ (2.0 rad/s) + I ⋅ (6.0 rad/s)

$L_{\text{initial}} = I \cdot (2.0\ \text{rad/s} + 6.0\ \text{rad/s})$Linitial = I ⋅ (2.0 rad/s + 6.0 rad/s)

$L_{\text{initial}} = I \cdot 8.0$ rad/sLinitial = I ⋅ 8.0 rad/s

Now, let the final angular velocity of the combined system be ω_f ωf. According to the conservation of angular momentum:

$L_{\text{initial}} = I \cdot \omega_f$ Linitial = I ⋅ ωf

$I \cdot 8.0\ \text{rad/s} = I \cdot \omega_f$ I ⋅ 8.0 rad/s = I ⋅ ωf

$\omega_f = 8.0$ rad/sωf = 8.0 rad/s

Since the initial angular velocities have opposite directions (clockwise and counterclockwise), the final angular velocity will be in the direction of the larger initial angular velocity. In this case, it is 6.0 rad/s6.0 rad/s counterclockwise.

So, the final angular velocity of the combined system will be 8.0 rad/s8.0 rad/s, counterclockwise.

The correct answer is option C) 4.0 rad/s, counterclockwise.

37. If the mass of a planet is doubled with no increase in its size, the escape speed for that planet is A) increased by a factor of 1.4. B) increased by a factor of 2. C) not changed. D) reduced by a factor of 1.4. E) reduced by a factor of 2.

The escape speed of a planet is the minimum speed an object must have to escape the gravitational pull of the planet and move infinitely far away from it.

The escape speed (v_{esc} vesc) is given by the formula:

$v_{\text{esc}} = \sqrt{\frac{2GM}{R}}$vesc = R2GM

√

where: GG is the gravitational constant, MM is the mass of the planet, and RR is the radius of the planet.

If the mass of the planet is doubled ($2M$2M), and there is no increase in its size (radius remains the same RR), the escape speed ($v_{\text{esc-new}}$ vesc-new) for the new planet is given by:

$v_{\text{esc-new}} = \sqrt{\frac{2G(2M)}{R}}$vesc-new = R2G(2M)

√

Now, let's compare the new escape speed ($v_{\text{esc-new}}$ vesc-new) with the original escape speed (v_{esc} vesc):

$\frac{v_{\text{esc-new}}}{v_{\text{esc}}} = \frac{\sqrt{\frac{2G(2M)}{R}}}{\sqrt{\frac{2GM}{R}}}$vescvesc-new = R2GM

√

R2G(2M)

√

Simplify:

$\frac{v_{\text{esc-new}}}{v_{\text{esc}}} = \sqrt{\frac{2G(2M)}{R} \cdot \frac{R}{2GM}}$vescvesc-new = R2G(2M) · 2GMR

√

$\frac{v_{\text{esc-new}}}{v_{\text{esc}}} = \sqrt{\frac{4GMR}{2GMR}}$vescvesc-new = 2GMR4GMR

√

$\frac{v_{\text{esc-new}}}{v_{\text{esc}}} = \sqrt{2}$vescvesc-new = 2

√

So, the escape speed of the planet is increased by a factor of $\sqrt{2}$ 2

√

(approximately 1.414).

The correct answer is option A) increased by a factor of 1.4.

38. What is the escape speed from the sun, beginning (from rest relative to the sun) at the orbit of Earth, R = 1.50 □ 108 km. (Given: G = 6.67 □ 10–11 N · m2 /kg2 ; mass of the sun = 2.0 □ 1030 kg.) A) 3.0 □ 104 m/s B) 2.1 □ 104 m/s C) 1.3 □ 106 m/s D) 9.4 □105 m/s E) 4.2 □ 104 m/s

To find the escape speed from the sun at the orbit of Earth, we can use the escape speed formula:

$v_{\text{esc}} = \sqrt{\frac{2GM}{R}}$vesc = R2GM

√

where: GG is the gravitational constant ($6.67 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2$ 6.67 × 10−11 N · m2/kg2), MM is the mass of the sun (2.0×10^{30} kg2.0 × 1030 kg), and RR is the distance from the sun's center to the orbit of Earth (1.50×10^8 km $= 1.50 \times 10^8 \times 10^3$ m1.50 × 108 km = 1.50 × 108 × 103 m).

Now, let's substitute the given values and calculate the escape speed:

$v_{\text{esc}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 2.0 \times 10^{30}}{1.50 \times 10^8 \times 10^3}}$vesc = 1.50×108×1032×6.67×10−11×2.0×1030

√

$v_{\text{esc}} = \sqrt{\frac{2 \times 6.67 \times 2.0}{1.50} \times 10^{19}}$vesc = 1.502×6.67×2.0 × 1019

√

$v_{\text{esc}} = \sqrt{\frac{26.68}{1.50} \times 10^{19}}$ vesc = 1.5026.68 × 1019

$v_{\text{esc}} = \sqrt{17.78 \times 10^{19}}$ vesc = 17.78 × 1019

$v_{\text{esc}} = \sqrt{1.778 \times 10^{20}}$ vesc = 1.778 × 1020

$v_{\text{esc}} \approx 1.33 \times 10^{5}$ m/svesc ≈ 1.33 × 105 m/s

The escape speed from the sun, beginning from rest relative to the sun at the orbit of Earth, is approximately 1.33×10^{5} m/s1.33 × 105 m/s.

The correct answer is option C) 1.3×10^{6} m/s1.3 × 106 m/s.

39. According to Newton's law of universal gravitation, if the distance between two bodies is tripled, the gravitational force between them is A) unchanged. B) halved. C) doubled. D) reduced to 1/3 its previous value. E) None of these is correct.

According to Newton's law of universal gravitation, the force of gravity (FF) between two bodies is given by the formula:

$F = \frac{G \cdot M_1 \cdot M_2}{r^2}$F = r2G·M1·M2

where: GG is the gravitational constant, M_1M1 and M_2M2 are the masses of the two bodies, and rr is the distance between the centers of the two bodies.

Now, if the distance between the two bodies is tripled ($3r$3r), the new distance is three times the original distance (rr).

Let's find the new gravitational force (F_{new}Fnew) between the two bodies with the new distance:

$F_{\text{new}} = \frac{G \cdot M_1 \cdot M_2}{(3r)^2}$Fnew = (3r)2G·M1·M2

$F_{\text{new}} = \frac{G \cdot M_1 \cdot M_2}{9r^2}$Fnew = 9r2G·M1·M2

Now, let's compare the new force (F_{new}Fnew) with the original force (FF):

$\frac{F_{\text{new}}}{F} = \frac{\frac{G \cdot M_1 \cdot M_2}{9r^2}}{\frac{G \cdot M_1 \cdot M_2}{r^2}}$F Fnew = r2G·M1·M29r2G·M1·M2

Simplify:

$\frac{F_{\text{new}}}{F} = \frac{G \cdot M_1 \cdot M_2}{9r^2} \cdot \frac{r^2}{G \cdot M_1 \cdot M_2}$F Fnew = 9r2G·M1·M2 · G·M1·M2r2

The $G \cdot M_1 \cdot M_2$G · M1 · M2 terms cancel out:

$\frac{F_{\text{new}}}{F} = \frac{1}{9}$F Fnew = 91

So, the new gravitational force is $\frac{1}{9}$91 times the original force.

The correct answer is option D) reduced to 1/3 its previous value.

40. A satellite with a mass m is in a stable circular orbit about a planet with a mass M. The universal gravitational constant is G. The radius of the orbit is R. The ratio of the potential energy of the satellite to its kinetic energy is A) –2R B) +2G C) –2G/R D) –2 E) 2G/R

The potential energy (UU) of the satellite in a stable circular orbit about a planet is given by:

$U = -\frac{G \cdot M \cdot m}{R}$U = −RG·M·m

where: GG is the gravitational constant, MM is the mass of the planet, mm is the mass of the satellite, and RR is the radius of the orbit.

The kinetic energy (KK) of the satellite in a circular orbit is given by:

$K = \frac{1}{2} \cdot m \cdot v^2$ K = 21 · m · v2

where: vv is the speed of the satellite in the circular orbit.

Since the satellite is in a stable circular orbit, its gravitational potential energy is balanced by its kinetic energy. Thus, we have:

$U = K$U = K

$-\frac{G \cdot M \cdot m}{R} = \frac{1}{2} \cdot m \cdot v^2$ −RG·M·m = 21 · m · v2

Now, we can simplify the equation to find the ratio of potential energy to kinetic energy:

$\frac{U}{K} = \frac{-\frac{G \cdot M \cdot m}{R}}{\frac{1}{2} \cdot m \cdot v^2}$KU = 21·m·v2−RG·M·m

$\frac{U}{K} = \frac{-2 \cdot G \cdot M}{R \cdot v^2}$KU = R·v2−2·G·M

Now, recall that for a body in a circular orbit, the centripetal acceleration is given by $a_c = \frac{v^2}{R}$ac = Rv2. Since the satellite is in a stable circular orbit, the centripetal acceleration is equal to the gravitational acceleration:

$a_c = \frac{v^2}{R} = \frac{G \cdot M}{R^2}$ac = Rv2 = R2G·M

Now, solve for v^2 v2:

$v^2 = \frac{G \cdot M}{R}$v2 = RG·M

Substitute this back into the ratio equation:

$\frac{U}{K} = \frac{-2 \cdot G \cdot M}{R \cdot \frac{G \cdot M}{R}}$KU = R·RG·M−2·G·M

$\frac{U}{K} = -2$KU = −2

So, the ratio of the potential energy of the satellite to its kinetic energy is −2−2.

The correct answer is option D) −2−2.

41. The fundamental physical quantities are A) mass, length, time, temperature, amount of a substance, current, and luminous intensity. B) weight, length, time, temperature, amount of a substance, current, and luminous intensity. C) mass, length, time, temperature, force, current, and luminous intensity. D) mass, length, time, force, momentum, amount of a substance, and current. E) weight, length, time, temperature, amount of a substance, potential energy, and luminous intensity.

The fundamental physical quantities are the basic, independent quantities from which other physical quantities are derived. The International System of Units (SI) defines seven fundamental physical quantities, and they are:

A) Mass B) Length C) Time D) Electric current E) Thermodynamic temperature (temperature) F) Amount of substance G) Luminous intensity

So, the correct answer is option A) mass, length, time, temperature, amount of a substance, current, and luminous intensity.

42. The components of a vector A) are not unique. B) depend on the axes chosen. C) can have one of the components equal to zero. D) can be negative. E) All of the above.

The correct answer is E) All of the above.

Explanation:

A) The components of a vector are not unique because they depend on the coordinate system or reference frame chosen to represent the vector.

B) The components of a vector depend on the coordinate axes chosen. The same vector can have different components when represented in different coordinate systems.

C) The components of a vector can have one or more of them equal to zero. This occurs when the vector lies along one of the coordinate axes.

D) The components of a vector can be negative. Negative components indicate that the vector points in the opposite direction of the corresponding coordinate axis.

So, all of the given options (A, B, C, D) are correct.

44. In doing a calculation, you arrive at an expression in which the numerator is in kilometers and the denominator is in meters per second. When the calculation is completed, the result will be in units of A) meters, if you divide by 1000. B) meters, if you multiply by 1000. C) seconds, if you divide by 1000. D) seconds, if you multiply by 1000. E) meters squared per second, if you multiply by 1000.

The correct answer is B) meters if you multiply by 1000.

Explanation:

To convert kilometers to meters, you need to multiply by 1000 because there are 1000 meters in one kilometer. So, if the numerator is in kilometers and the denominator is in meters per second, the correct approach is to convert kilometers to meters by multiplying the numerator by 1000.

For example, if you have an expression like \frac{{\text{numerator in kilometers}}}{{\text{denominator in meters per second}}}, you would convert the numerator to meters by multiplying it by 1000. The result will then be in meters.

So, the final result will be in units of meters.

45. A particle moves from x1 = –50 cm to x2 = 30 cm. The displacement of this particle is A) –50 cm B) 30 cm C) 80 cm D) –30 cm E) –80 cm

The displacement of a particle is the straight-line distance between its initial position (x1) and final position (x2) and it is a vector quantity.

Given x1 = -50 cm and x2 = 30 cm, we can calculate the displacement as follows:

Displacement = x2 - x1 Displacement = 30 cm - (-50 cm) Displacement = 30 cm + 50 cm Displacement = 80 cm

The displacement of the particle is 80 cm.

The correct answer is option C) 80 cm.

47. A Lamborghini sports car can accelerate from zero to 60 mph in 4 seconds. It can decelerate from 60 mph to rest in 120 ft. What is the ratio of average acceleration over average deceleration? (1 mile = 5280 ft) A) 1.74 □ 10–5 B) 1.47 C) 0.682 D) 0.0114 E) 0.688

To calculate the ratio of average acceleration to average deceleration, we need to find the average acceleration and average deceleration first.

1. Average acceleration (a_{avg} aavg) during acceleration phase: The Lamborghini accelerates from rest (0 mph) to 60 mph in 4 seconds. We can convert the final speed to ft/s (since 1 mile = 5280 ft and 1 hour = 3600 seconds):

$60 \text{ mph} = \frac{60 \times 5280 \text{ ft}}{3600 \text{ s}} = 88 \text{ ft/s}$60 mph = 3600 s60×5280 ft = 88 ft/s

The average acceleration is given by:

$a_{\text{avg}} = \frac{\text{change in velocity}}{\text{time taken}} = \frac{88 \text{ ft/s}}{4 \text{ s}} = 22 \text{ ft/s}^2$ aavg = time takenchange in velocity = 4 s88 ft/s = 22 ft/s2

2. Average deceleration (d_{avg} davg) during deceleration phase: The car decelerates from 60 mph to rest (0 mph) in 120 ft. We can convert the final speed to ft/s:

$0 \text{ mph} = \frac{0 \times 5280 \text{ ft}}{3600 \text{ s}} = 0 \text{ ft/s}$0 mph = 3600 s0×5280 ft = 0 ft/s

The average deceleration is given by:

$d_{\text{avg}} = \frac{\text{change in velocity}}{\text{time taken}} = \frac{-88 \text{ ft/s}}{\text{time taken}}$davg = time takenchange in velocity = time taken−88 ft/s

To find the time taken, we can use the formula $d = \frac{1}{2}at^2$ d = 21at2 for deceleration:

$d = 120 \text{ ft}$d = 120 ft, $a = d_{\text{avg}} = -88 \text{ ft/s}$a = davg = −88 ft/s

$120 = \frac{1}{2} \times (-88) \times t^2$ 120 = 21 × (−88) × t2

Solve for t^2 t2:

$t^2 = \frac{120}{-44}$t2 = −44120

$t^2 = -\frac{15}{11}$t2 = −1115

Since time cannot be negative, we take the positive square root:

$t = \sqrt{\frac{15}{11}}$t = 1115

√

The average deceleration is then:

$d_{\text{avg}} = \frac{-88 \text{ ft/s}}{\sqrt{\frac{15}{11}}}$davg = 1115

√

−88 ft/s

Now, let's calculate the ratio of average acceleration to average deceleration:

$\text{Ratio} = \frac{a_{\text{avg}}}{d_{\text{avg}}} = \frac{22 \text{ ft/s}^2}{\frac{-88 \text{ ft/s}}{\sqrt{\frac{15}{11}}}}$Ratio = davgaavg = 1115

√

−88 ft/s22 ft/s2

$\text{Ratio} = 22 \times \sqrt{\frac{15}{11}} \approx 22 \times 1.208$Ratio = 22 × 1115

√

≈ 22 × 1.208

$\text{Ratio} \approx 26.66$Ratio ≈ 26.66

The correct answer is not listed among the options. However, the correct ratio of average acceleration to average deceleration is approximately 26.66.

48. The relationship between the velocity of a body moving along the x axis and time is given by v = 3t 2 – 2t, where the units are SI units. The total distance the body travels between the times t = 2 s and t = 4 s is A) 12 m B) 60 m C) 48 m D) 34 m E) 44 m

To find the total distance traveled by the body between times $t = 2$t = 2 s and $t = 4$t = 4 s, we need to calculate the net displacement over this time interval. The total distance is the sum of the absolute values of all displacements, regardless of direction.

Given that the velocity vv of the body as a function of time tt is $v = 3t^2 - 2t$v = 3t2 − 2t, we can find the displacement by integrating the velocity function with respect to time over the given time interval:

$\text{Displacement} = \int_2^4 (3t^2 - 2t)\,dt$Displacement = ∫24(3t2 − 2t) dt

$\text{Displacement} = [t^3 - t^2]_2^4$Displacement = [t3 − t2]24

$\text{Displacement} = (4^3 - 4^2) - (2^3 - 2^2)$Displacement = (43 − 42) − (23 − 22)

$\text{Displacement} = (64 - 16) - (8 - 4)$Displacement = (64 − 16) − (8 − 4)

$\text{Displacement} = 48 - 4$Displacement = 48 − 4

$\text{Displacement} = 44\ \text{m}$Displacement = 44 m

The total distance traveled by the body between $t = 2$t = 2 s and $t = 4$t = 4 s is 44 m.

The correct answer is option E) 44 m.

49. A ball is whirled in a horizontal circle of radius r and speed v. The radius is increased to 2r keeping the speed of the ball constant. The period of the ball changes by a factor of A) Half B) One C) Two D) Three E) Four

The period of an object in circular motion is the time it takes for the object to complete one full revolution or one cycle of the circular motion.

In this case, the ball is whirled in a horizontal circle of radius rr and speed vv. The period of the ball (denoted by T_1T1) is the time it takes for the ball to complete one full revolution with radius rr.

Now, the radius of the circle is increased to $2r$2r while keeping the speed of the ball constant. The period of the ball with the new radius (denoted by T_2T2) is the time it takes for the ball to complete one full revolution with radius $2r$2r.

The relationship between the period (TT), speed (vv), and radius (rr) for an object in circular motion is given by:

$T = \frac{2\pi r}{v}$T = v2πr

Since the speed of the ball is constant, the periods T_1T1 and T_2T2 are directly proportional to their respective radii rr and $2r$2r:

$\frac{T_1}{T_2} = \frac{r}{2r} = \frac{1}{2}$T2T1 = 2rr = 21

So, the period of the ball changes by a factor of $\frac{1}{2}$21.

The correct answer is option A) Half.

50. A car is at position (x1, y1) = (4 m, 5 m) at time t1 = 1 s. If 10 seconds later the car moving in a straight line is at position (x2, y2) = (204 m, 305 m), find the (size of the) component of the average velocity along the x-axis. A) 30.0 m/s B) 36.1 m/s C) 20.0 m/s D) 18.2 m/s E) 22.2 m/s

To find the component of the average velocity along the x-axis, we need to calculate the change in the x-coordinate (xx) over the given time interval and then divide it by the time interval.

Given that the car is at position $(x_1, y_1) = (4\ \text{m}, 5\ \text{m})$(x1, y1) = (4 m, 5 m) at time $t_1 = 1$ st1 = 1 s and 10 seconds later, it is at position $(x_2, y_2) = (204\ \text{m}, 305\ \text{m})$(x2, y2) = (204 m, 305 m), we can calculate the change in xx (ΔxΔx) over the 10-second time interval:

$\Delta x = x_2 - x_1 = 204\ \text{m} - 4\ \text{m} = 200\ \text{m}$Δx = x2 − x1 = 204 m − 4 m = 200 m

Now, divide the change in xx by the time interval:

$\text{Average velocity along the x-axis} = \frac{\Delta x}{\Delta t} = \frac{200\ \text{m}}{10\ \text{s}} = 20.0\ \text{m/s}$Average velocity along the x-axis = ΔtΔx = 10 s200 m = 20.0 m/s

The component of the average velocity along the x-axis is 20.0 m/s.

The correct answer is option C) 20.0 m/s.

51. The initial path of a rocket is 30º above the horizontal, and the horizontal component of the rocket's velocity is 326 m/s. The initial vertical component of the rocket's velocity is A) 188 m/s B) 330 m/s C) 380 m/s D) 280 m/s E) 250 m/s

To find the initial vertical component of the rocket's velocity, we can use trigonometric relationships. The rocket's initial path is 30º above the horizontal. Let's assume the initial total velocity of the rocket is v_0 v0 and the vertical component of velocity is v_{0y} v0y.

The horizontal component of the velocity (v_{0x} v0x) is given as 326 m/s. We can find v_{0y} v0y using the trigonometric relationship:

$v_{0x} = v_0 \cos\theta$ v0x = v0 cos θ

where $\theta = 30^\circ$ θ = 30∘.

Rearranging the equation to solve for v_0 v0:

$v_0 = \frac{v_{0x}}{\cos\theta} = \frac{326 \text{ m/s}}{\cos 30^\circ}$ v0 = cos θv0x = cos 30∘326 m/s

Now, the vertical component of the velocity (v_{0y} v0y) can be found using another trigonometric relationship:

$v_{0y} = v_0 \sin\theta$ v0y = v0 sin θ

Substitute the value of v_0 v0 we just found:

$v_{0y} = \frac{326 \text{ m/s}}{\cos 30^\circ} \sin 30^\circ$ v0y = cos 30∘326 m/s sin 30∘

& = 326 \times 0.866\\ & \approx 282.2 \, \text{m/s}\end{split}\] The initial vertical component of the rocket's velocity is approximately 282.2 m/s. The correct answer is not listed among the options. However, the closest option to the calculated value is option D) 280 m/s.

53. Three forces, X Y, , and Z, act on a mass of 4.2 kg. The forces are X = 2.0 N acting to the east, Y = 5.0 N acting 45º to the north of east, and Z = 4.0 N acting 30º to the north of west. The magnitude of the net acceleration of the mass is A) 2.9 m/s2 B) 5.3 m/s2 C) 1.4 m/s2 D) 0.0 m/s2 E) 18 m/s2

To find the net acceleration of the mass, we need to calculate the horizontal and vertical components of each force and then sum up the horizontal and vertical components separately.

Given forces:

$X = 2.0 \text{ N}$ X = 2.0 N (east direction)

$Y = 5.0 \text{ N}$ Y = 5.0 N (45º north of east)

$Z = 4.0 \text{ N}$ Z = 4.0 N (30º north of west)

Now, let's resolve the forces into horizontal and vertical components:

1. For XX: The horizontal component of XX is simply $X_x = 2.0 \text{ N}$ Xx = 2.0 N (since it is acting in the east direction and has no vertical component).

2. For YY: The horizontal component of YY is $Y_x = Y\cos 45^\circ$ Yx = Y cos 45∘. The vertical component of YY is $Y_y = Y\sin 45^\circ$ Yy = Y sin 45∘.

$Y_x = 5.0 \text{ N} \times \cos 45^\circ \approx 3.54 \text{ N}$ Yx = 5.0 N × cos 45∘ ≈ 3.54 N

$Y_y = 5.0 \text{ N} \times \sin 45^\circ \approx 3.54 \text{ N}$ Yy = 5.0 N × sin 45∘ ≈ 3.54 N

3. For ZZ: The horizontal component of ZZ is $Z_x = Z\cos 30^\circ$ Zx = Z cos 30∘. The vertical component of ZZ is $Z_y = Z\sin 30^\circ$ Zy = Z sin 30∘.

$Z_x = 4.0 \text{ N} \times \cos 30^\circ \approx 3.46 \text{ N}$ Zx = 4.0 N × cos 30∘ ≈ 3.46 N

$Z_y = 4.0 \text{ N} \times \sin 30^\circ \approx 2.00 \text{ N}$ Zy = 4.0 N × sin 30∘ ≈ 2.00 N

Now, let's add up the horizontal and vertical components separately:

Horizontal component of net force = $X_x + Y_x + Z_x$ Xx + Yx + Zx

$= 2.0 \text{ N} + 3.54 \text{ N} + 3.46 \text{ N} = 9.00 \text{ N}$ = 2.0 N + 3.54 N + 3.46 N = 9.00 N

Vertical component of net force = $Y_y + Z_y$ Yy + Zy

$= 3.54 \text{ N} + 2.00 \text{ N} = 5.54 \text{ N}$ = 3.54 N + 2.00 N = 5.54 N

Now, use Newton's second law $F = ma$ F = ma to find the net acceleration:

Net acceleration $= \frac{\text{Net force}}{\text{mass}} = \frac{9.00 \text{ N}}{4.2 \text{ kg}} \approx 2.14 \text{ m/s}^2$ Net acceleration = massNet force = 4.2 kg9.00 N ≈ 2.14 m/s2

The magnitude of the net acceleration of the mass is approximately 2.14 m/s^2 2.14 m/s2.

The correct answer is not listed among the options. However, the closest option to the calculated value is option C) 1.4 m/s^2.

54. A frictionless pulley of negligible mass is hung from the ceiling using a rope, also of negligible mass. Two masses, m1 and m2 (m1 < m2) are connected to the rope over the pulley. The masses are free to drop. The magnitude of the tension Ttop is ____ the sum of the weights W1 = m1g and W2 = m2g. A) less than B) equal to C) greater than D) unable to tell E) depends on T1 and T2.

The magnitude of the tension T_{top} Ttop in the rope at the top of the pulley is equal to the sum of the weights $W_1 = m_1 g$W1 = m1g and $W_2 = m_2 g$W2 = m2g of the masses.

When the masses are in equilibrium (not accelerating up or down), the tension in the rope must balance the gravitational forces acting on the masses.

Since the pulley is frictionless and the rope is of negligible mass, we can assume that the tension is the same throughout the rope. Therefore, the tension at the top of the pulley must be equal to the sum of the weights of the masses.

Mathematically, we can represent this as:

$T_{\text{top}} = W_1 + W_2 = m_1 g + m_2 g = g(m_1 + m_2)$Ttop = W1 + W2 = m1g + m2g = g(m1 + m2)

So, the magnitude of the tension T_{top} Ttop is equal to the sum of the weights W_1 W1 and W_2 W2.

The correct answer is option B) equal to.

55. Spiral springs A and B are identical. When a weight of 12 N is fastened to the hook on A, the hook is lowered 2 cm. If a weight of 18 N is fastened to the hook on B, that hook is lowered A) 8 cm B) 6 cm C) 3 cm D) 4 cm E) 5 cm

The behavior of a spring is described by Hooke's Law, which states that the extension or compression of the spring is directly proportional to the force applied to it. Mathematically, this can be expressed as:

$F = kx$F = kx

where: FF is the force applied to the spring, kk is the spring constant (a measure of the stiffness of the spring), and xx is the extension or compression of the spring.

Since springs A and B are identical, they have the same spring constant, kk. Let's assume the extension of spring A when a 12 N weight is applied is x_A xA, and the extension of spring B when an 18 N weight is applied is x_B xB.

Given that the extension x_A xA is 2 cm (or 0.02 m) when a 12 N weight is applied to spring A, we can write:

$12\ \text{N} = k \times 0.02\ \text{m}$12 N = k × 0.02 m

Now, find the spring constant kk:

$k = \frac{12\ \text{N}}{0.02\ \text{m}} = 600\ \text{N/m}$k = 0.02 m12 N = 600 N/m

Now, using the same spring constant kk, we can find the extension x_B xB when an 18 N weight is applied to spring B:

$18\ \text{N} = k \times x_B$ 18 N = k × xB

$x_B = \frac{18\ \text{N}}{600\ \text{N/m}} = 0.03\ \text{m} = 3\ \text{cm}$xB = 600 N/m18 N = 0.03 m = 3 cm

So, the hook on spring B is lowered by 3 cm when an 18 N weight is fastened to it.

The correct answer is option C) 3 cm.

58. A particle is moving uniformly in a circle with radius 50 cm. The linear speed of the particle is 60 cm/s. The acceleration of the particle has a magnitude of A) Zero B) 36 m/s2 C) 1.8 □ 105 cm/s2 D) 72 cm/s2 E) 3.6 m/s2

The acceleration of an object moving in a circle at a constant speed is directed towards the center of the circle and is given by:

$a = \frac{v^2}{r}$a = rv2

where: aa is the acceleration, vv is the linear speed of the particle, and rr is the radius of the circle.

Given that the linear speed (vv) of the particle is 60 cm/s and the radius (rr) of the circle is 50 cm, we can calculate the magnitude of the acceleration (aa) as follows:

$a = \frac{(60\ \text{cm/s})^2}{50\ \text{cm}}$a = 50 cm(60 cm/s)2

$a = \frac{3600\ \text{cm}^2/\text{s}^2}{50\ \text{cm}}$a = 50 cm3600 cm2/s2

$a = 72\ \text{cm/s}^2$ a = 72 cm/s2

So, the magnitude of the acceleration of the particle is 72 cm/s^2.

The correct answer is option D) 72 cm/s^2.

59. Which of the following statements is NOT true about friction? A) µk is less than µs B) µk is independent of the relative speed of the surfaces in the range of about 1 cm/s to several meters per second. C) µk depends on the relative speed of the surfaces at speeds over several meters per second. D) The coefficients of friction depend on the nature of the surfaces. E) The force of static friction depends on the area of contact between the two surfaces.

The statement that is NOT true about friction is:

E) The force of static friction depends on the area of contact between the two surfaces.

The force of static friction does not depend on the area of contact between the two surfaces. It depends on the nature of the surfaces in contact and the normal force exerted between them. The force of static friction can vary to prevent relative motion between the surfaces until the maximum static friction force is reached. Once the maximum static friction force is exceeded, the surfaces start moving, and the force of kinetic friction takes over.

So, option E) is the statement that is NOT true about friction.

62. A 5-kg object undergoes a displacement 2 3 . ˆ ˆ □ □ □ s i j During the displacement, a constant force F i j □ □ 4 2 ˆ ˆ acts on the object. All values are given in SI units. The work done by the force F on this object is A) 8 J B) –6 J C) 2 J D) 14 J E) –2 J

The work done (WW) by a force on an object is given by the dot product of the force and the displacement of the object:

$W = F \cdot s$W = F ⋅ s

Given that the displacement of the object is $s = 2i + 3j$s = 2i + 3j and the force on the object is $F = -4i + 2j$F = −4i + 2j, we can calculate the work done as follows:

$W = F \cdot s = (-4i + 2j) \cdot (2i + 3j)$W = F ⋅ s = (−4i + 2j) ⋅ (2i + 3j)

Using the dot product formula $a \cdot b = a_x b_x + a_y b_y$ a ⋅ b = axbx + ayby, where $a = a_x i + a_y j$a = axi + ayj and $b = b_x i + b_y j$b = bxi + byj, we get:

$W = (-4)(2) + (2)(3) = -8 + 6 = -2$ JW = (−4)(2) + (2)(3) = −8 + 6 = −2 J

So, the work done by the force on the object is −2 J−2 J.

The correct answer is option E) −2 J−2 J.

64. The weight of an object on the moon is one-sixth its weight on Earth. A body moving with a given speed on the moon has kinetic energy equal to ______________ it would have if it were moving at the same speed on Earth. A) the kinetic energy B) 1/36 the kinetic energy C) 1/6 the kinetic energy D) 6 times the kinetic energy E) 36 times the kinetic energy

The kinetic energy (KEKE) of an object is given by the formula:

$KE = \frac{1}{2}mv^2$ KE = 21mv2

where mm is the mass of the object and vv is its speed.

Given that the weight of the object on the moon is one-sixth its weight on Earth, we can say that the mass of the object remains the same on both the moon and Earth. This is because weight is directly proportional to mass, and the acceleration due to gravity on the moon is one-sixth of that on Earth.

Since the mass remains the same, the kinetic energy of the object will depend only on its speed. Therefore, the kinetic energy of the object moving with a given speed on the moon is equal to the kinetic energy it would have if it were moving at the same speed on Earth.

The correct answer is option A) the kinetic energy.

65. Susana ascends a mountain via a short, steep trail. Sean ascends the same mountain via a long, gentle trail. Which of the following statements is true? A) Susana gains more gravitational potential energy than Sean. B) Susana gains less gravitational potential energy than Sean. C) Susana gains the same gravitational potential energy as Sean. D) To compare energies, we must know the height of the mountain. E) To compare energies, we must know the lengths of the two trails.

The correct answer is:

E) To compare energies, we must know the lengths of the two trails.

The gravitational potential energy gained by an object when it ascends a mountain depends on both the height of the mountain and the mass of the object. In this case, since both Susana and Sean are ascending the same mountain, the height of the mountain is the same for both of them.

However, the gravitational potential energy also depends on the mass of the object. If Susana and Sean have different masses, they will gain different amounts of gravitational potential energy while ascending the mountain, even if they follow different trails. Therefore, to compare the gravitational potential energy gained by Susana and Sean, we need to know the lengths of the two trails and the masses of Susana and Sean.

Since the masses of Susana and Sean are not provided in the question, we cannot determine who gains more or less gravitational potential energy based solely on the given information.

66. A child is sitting on the seat of a swing with ropes 10 m long. Her father pulls the swing back until the ropes make a 37º angle with the vertical and then releases the swing. If air resistance is neglected, what is the speed of the child at the bottom of the arc of the swing when the ropes are vertical? A) 11 m/s B) 8.8 m/s C) 14 m/s D) 6.3 m/s E) 12 m/s

To find the speed of the child at the bottom of the arc of the swing when the ropes are vertical, we can use the conservation of mechanical energy. At the bottom of the arc, the child's gravitational potential energy is converted entirely into kinetic energy.

The initial gravitational potential energy when the swing is pulled back to an angle of 37º with the vertical is given by:

$PE_{\text{initial}} = mgh$

where m is the mass of the child, g is the acceleration due to gravity, and h is the initial height of the swing.

At the bottom of the arc when the ropes are vertical, the gravitational potential energy is zero, and all of it has been converted into kinetic energy:

$KE_{\text{final}} = \frac{1}{2}mv^2$

where v is the speed of the child at the bottom of the arc.

Since the total mechanical energy is conserved, we can equate the initial potential energy to the final kinetic energy:

$mgh = \frac{1}{2}mv^2$

Canceling out the mass m from both sides, and substituting the given values $h = 10\,\text{m}$ (length of the ropes) and $\theta = 37º$ (angle with the vertical), we get:

$gh = \frac{1}{2}v^2$

Solving for v:

$v = \sqrt{2gh}$

$v = \sqrt{2 \times 9.81\,\text{m/s}^2 \times 10\,\text{m}}$

$v \approx 14\,\text{m/s}$

So, the speed of the child at the bottom of the arc of the swing when the ropes are vertical is approximately $14\,\text{m/s}$.

The correct answer is option C) 14 m/s.

70. You shoot an arrow with a mass of 0.54 kg at 45º above the horizontal. The bow exerts a force of 125 N for 0.65 s. With no air resistance, the maximum height the arrow reaches is A) 1.2 km B) 5.4 m C) 0.57 km D) 0.29 km E) 0.61 km

To find the maximum height the arrow reaches, we can use the kinematic equations. Since there is no air resistance, we can assume the acceleration is due to gravity ($g = 9.81\,\text{m/s}^2$).

The vertical motion of the arrow can be analyzed separately. The initial vertical velocity (v_{0y}) is given by the component of the initial velocity at 45º above the horizontal:

$v_{0y} = v_0 \sin\theta$

where v_0 is the initial speed and θ is the angle above the horizontal (45º in this case).

$v_0 = \frac{\text{force} \times \text{time}}{\text{mass}}$

$v_0 = \frac{125\,\text{N} \times 0.65\,\text{s}}{0.54\,\text{kg}}$

$v_0 \approx 152.78\,\text{m/s}$

$v_{0y} = 152.78\,\text{m/s} \times \sin 45º$

$v_{0y} \approx 108.19\,\text{m/s}$

Next, we can use the kinematic equation for vertical motion:

$v_y^2 = v_{0y}^2 - 2g\Delta y$

where v_y vy is the vertical component of the velocity at the maximum height, and Δy Δy is the maximum height.

At the maximum height, $v_y = 0$ vy = 0, so we can solve for Δy Δy:

$$0 = (108.19\ \mathrm{m/s})^2 - 2 \times 9.81\ \mathrm{m/s}^2 \times \Delta y$$
0 = (108.19 m/s)2 − 2 × 9.81 m/s2 × Δy

$$\Delta y = \frac{(108.19\ \mathrm{m/s})^2}{2 \times 9.81\ \mathrm{m/s}^2}$$
Δy = 2×9.81 m/s2(108.19 m/s)2

$$\Delta y \approx 594.41\ \mathrm{m}$$
Δy ≈ 594.41 m

So, the maximum height the arrow reaches is approximately 594.41 meters.

The correct answer is option C) 0.57 km.