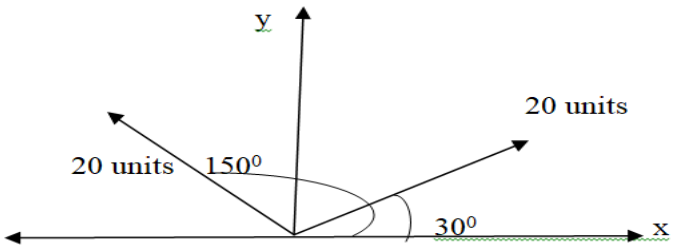
1. Two vectors of equal magnitudes of 20 units are given in x-y plane as shown in the figure below.



What are the magnitudes the direction of the resultant of the two vectors?

A. 20.00 units along positive y – axis
B. 40.00 units along positive y – axis
C. 34.40 units along negative x – axis
D. 34.40 along positive x – axis

SOLUTION

Let the first vector (pointing to the right) be V_1 and the second vector (pointing to the left and up) be V_2. Magnitude of $|V_1| = 20$ units. Magnitude of $|V_2| = 20$ units.

From the figure: V_1 makes an angle of 30° with the positive x-axis and V_2 makes an angle of 150° with the positive x-axis.

Step 1: Resolve each vector into its x and y components.

For V_1 : $V_{1x} = |V_1| \times cos30° = 20 \times \frac{\sqrt{3}}{2} = 17.32\ units$

: $V_{1y} = |V_1| \times sin30° = 20 \times \frac{1}{2} = 10.0\ units$

For V_2 : $V_{2x} = |V_2| \times cos150° = -20 \times \frac{\sqrt{3}}{2} = -17.32\ units$

$V_{2y} = |V_2| \times sin150° = 20 \times \frac{1}{2} = 10.0\ units$

Step 2: Find the components of the resultant vector $R_x = V_{1x} + V_{2x}$ and $R_y = V_{1y} + V_{2y}$

$$R_x = 17.32 - 17.32 = 0\ unit$$

$$R_y = 10.00\ unit\ - 10.00\ unit = 20.00\ units$$

Since R_x =0 and R_y =20, the resultant vector points purely along the positive y-axis.

Therefore, the magnitude of the resultant vector is 20.00 units and its direction is along the positive y-axis.

Answer: A. 20.00 units along positive y - axis

2. A driver of an automobile, moving with 30 m/s, applies a break when he observes a stopping light 180 m ahead. If the automobile decelerates uniformly and comes to stop just at the mark of the stopping light, what is the magnitude of deceleration of the automobile?

   A. 2.5 m/s^2 C.12.0 m/s^2

   B. 2.0 m/s^2 D.1.5 m/s

Solution

Given:

Initial velocity (v_o) = 30 m/s, Final velocity (v_f) = 0 m/s (comes to stop), Displacement (s) = 180 m

We need to find the acceleration (a). We can use the kinematic equation that does not involve time: $v_f{}^2 = v_o{}^2 + 2as$

Substitute the given values: $\boldsymbol{a} = -2.5\ m/s^2$

The negative sign indicates deceleration. The question asks for the magnitude of deceleration.

Therefore, the magnitude of deceleration of the automobile is $2.5\ m/s^2$

Answer: A. $2.5\ m/s^2$

3. Consider the following three phrases.

   I. The acceleration of an object at specific time t

   II. The ratio of change in velocity to significant value of time interval Δt

   III. The ratio of change in velocity to time interval Δt where Δt approaches to zero

   Which one of the following statements is correct about the expressions found in the given phrases?

   A. I and II express average acceleration whereas III expresses instantaneous acceleration.

   B. III expresses average acceleration whereas I and II expresses instantaneous acceleration.

   C. II expresses average acceleration whereas I and III express instantaneous acceleration.

   D. I and III express average acceleration whereas II expresses instantaneous acceleration.

Solution

Let's analyze each phrase in terms of acceleration:

I. The acceleration of an object at specific time t

- This describes the acceleration at a particular instant, which is the definition of **instantaneous acceleration**.

II. The ratio of change in velocity to significant value of time interval Δt

- This describes the acceleration over a measurable (non-infinitesimal) time interval, which is the definition of **average acceleration**.

III. The ratio of change in velocity to time interval Δt where Δt approaches to zero

- This is the mathematical definition of instantaneous acceleration, This represents the acceleration at a specific moment.

Now let's check the options:

A. I and II express average acceleration whereas III expresses instantaneous acceleration. **Incorrect** (I is instantaneous).

B III expresses average acceleration whereas I and II expresses instantaneous acceleration. - **Incorrect** (II is average).

C. II expresses average acceleration whereas I and III express instantaneous acceleration. **Correct.**

D. I and III express average acceleration whereas II expresses instantaneous acceleration. - **Incorrect**.

Therefore, II expresses average acceleration whereas I and III express instantaneous acceleration.

Answer: C. II expresses average acceleration whereas I and III express instantaneous acceleration.

4. When a constant force of magnitude F is applied on an object, it produces a magnitude of acceleration, a. by what factor does the acceleration change if the magnitude of the force is doubled and the mass of the object is halved?

   A. 4 C. 2

   B. $\frac{1}{4}$ D. $\frac{1}{2}$

Solutions

According to Newton's Second Law of Motion: F=ma So, $a = \frac{F}{m}$, Let the initial force be F_1 =F and initial mass be m_1 =m. The initial acceleration is $a_1 = \frac{F}{m}$

Now, the force is doubled (F_2 = 2F) and the mass is halved (m_2 = m/2). The new acceleration (a_2) will be:

$$a_2 = \frac{F_2}{m_2} = \frac{2F}{m/2} = 4\frac{F}{m}$$

Since $a_1 = \frac{F}{m}$, we can write: $a_2 = 4a_1$. Therefore, the acceleration changes by a factor of 4.

Answer: A. 4

5. What is the necessary and sufficient condition for conservation Linear momentum?
   A. The presence of more linear than nonlinear forces in the system.
   B. Net force on the system is zero.
   C. The presence of only non-linear forces.
   D. Internal forces exceed external forces

Solution: The law of conservation of linear momentum states that the total linear momentum of a system remains constant if the net external force acting on the system is zero.

A. The presence of more linear than nonlinear forces in the system.

Incorrect. The linearity or nonlinearity of forces is not the condition for momentum conservation.

B. Net force on the system is zero.

Correct. This is the fundamental condition. If the net external force (ΣF=0) is zero, then $\frac{dP}{dt} = 0$, meaning the total momentum p is conserved.

C. The presence of only non-linear forces. **Incorrect**. This is irrelevant to momentum conservation.

D. Internal forces exceed external forces. **Incorrect**. Momentum conservation depends on the *net external* force. Internal forces, no matter how large, cannot change the total momentum of the system.

Therefore, the necessary and sufficient condition for conservation of linear momentum is that the net force on the system is zero.

Answer: B. Net force on the system is zero.

6. If the weight of an object on the surface of the earth is 2000 N, what is the weight of the same object on the surface of another planet with gravitational acceleration of 5 m/s^2? (Acceleration due to gravity on the Earth is, g = 10 m/s^2)

   A. 2000 N C. 40 N

   B. 1000 N D. 20 N

Solution: Given:

- Weight on Earth (W_E) = 2000 N
- Acceleration due to gravity on Earth (g_E) = 10 m/s^2
- Acceleration due to gravity on another planet (g_p) = 5 m/s^2

Step 1: Calculate the mass of the object. Weight is defined as W=mg. So, m = W_E/g_E
Therefore m=200 kg

Step 2: Calculate the weight of the object on the other planet. $W_p = mg_p$ = 200 kg×5 m/s^2

W_p = 1000 N

Therefore, the weight of the same object on the surface of another planet is 1000 N.

Answer: B. 1000 N

7. Suppose a constant force $\vec{F}$ acts on an object of mass m and displaces the object by displacement$\vec{R}$. then the dot product of F and s defines

   A. The acceleration produced by the force on the mass.

   B. The torque produced by the force on the mass.

   C. The work done by the force on the mass.

   D. The impulse produced by the force on the mass

Solution: Let's look at the definitions:

A. The acceleration produced by the force on the mass.
Acceleration is related by F=ma, not the dot product of F and s.

B. The torque produced by the force on the mass. Torque is a cross product of force and position vector ($\tau = r \times F$), not a dot product of force and displacement.

- **C. The work done by the force on the mass.**

  - The work done by a constant force is defined as the dot product of the force and the displacement: $W=F\cdot s=|F||s|\cos\theta$.
- **D. The impulse produced by the force on the mass.**
  - Impulse is force times time, not a dot product involving displacement.

Therefore, the dot product of F and s defines the work done by the force on the mass.

Answer: C. The work done by the force on the mass.

8. A force $\vec{F}$ = (2i +2j) N acts on an object and changes the position of the object from $\vec{r}_1$ = (2i +0j) m to $\vec{r}_f$ = (2i +4j) m. what is the work done by the force

   A. 16 J C. 12 J

   B. 8 J D. 32 J

Solution: Given:

Force vector (**F**) = (2i+2j) N , Initial position vector ($\mathbf{r}_1$) = (2i+0j^) m Final position vector (r_f) = (2i+4j) m

Step 1: Calculate the displacement vector (Δr).

$$\Delta r = rf - r1 = (2i + 4j) - (2i + 0j) = (2 - 2)i + (4 - 0)j = 0i + 4j = 4j\ m$$

Step 2: Calculate the work done (W) using the dot product. $W=\mathbf{F}\cdot\Delta\mathbf{r}$

$W=(2i+2j)\cdot(0i+4j) = (2)(0)+(2)(4) = 0+8 =8$ J

Therefore, the work done by the force is 8 J.

Answer: B. 8 J

9. Suppose a net force acts on a system of particles and produces a linear acceleration on the system. Which of the following assumption is the right assumption about the point where the net force acts? We can assume that the net force acts at

   A. All points where particles of the system are found.

   B. The point where the heaviest object of the system is found.

   C. The point where the whole mass of the system is. Assumed to be concentrated.

   D. The point where the geometric center of the system is found.

Solution: When analyzing the linear motion of a system of particles under a net external force, we can simplify the system by assuming the net force acts at a specific point. This point is known as the center of mass.

A. All points where particles of the system are found. - This is generally not useful for simplifying the system's overall linear motion.

B. The point where the heaviest object of the system is found. - This is incorrect. The center of mass takes into account the distribution of all masses, not just the heaviest one.

C. The point where the whole mass of the system is. Assumed to be concentrated. - This is the definition of the **center of mass**. For translational motion, we can treat the entire mass of the system as if it were concentrated at its center of mass, and the net external force acts at this point.

D. The point where the geometric center of the system is found. - The geometric center is only the same as the center of mass if the mass is uniformly distributed and the object has a symmetrical shape. For non-uniform or asymmetrical objects, these points differ.

Therefore, we can assume that the net force acts at the point where the whole mass of the system is assumed to be concentrated, which is the center of mass.

Answer: C. The point where the whole mass of the system is. Assumed to be concentrated

10. Critical point in physical states of a given substances differs from its boiling point in that unlike the boiling point, critical point occurs

    A. When the substance exist in a single phase.

    B. At different pressure and temperature.

    C. At one fixed pressure and temperature.

    D. At lower temperature and pressure during phase change

Solution: Let's distinguish between boiling point and critical point:

- **Boiling Point:** The temperature at which a liquid boils and turns into vapor. This occurs at a specific pressure (e.g., standard atmospheric pressure). Above the boiling point, the substance exists as two distinct phases (liquid and gas/vapor) in equilibrium.
- **Critical Point:** A specific point on a phase diagram where the liquid and gas phases of a substance become indistinguishable from each other. Above the critical temperature and critical pressure, the substance exists as a supercritical fluid, where there's no clear distinction between liquid and gas.

Now let's evaluate the options:

A. When the substance exist in a single phase. This is true for the critical point (and beyond, as a supercritical fluid). At the critical point, the liquid and gas phases merge into a single phase. At the boiling point, two phases coexist.

B. At different pressure and temperature. This is too vague - both critical point and Boiling point occurs at different temperatures and pressure depending on the substances

C. At one fixed pressure and temperature.

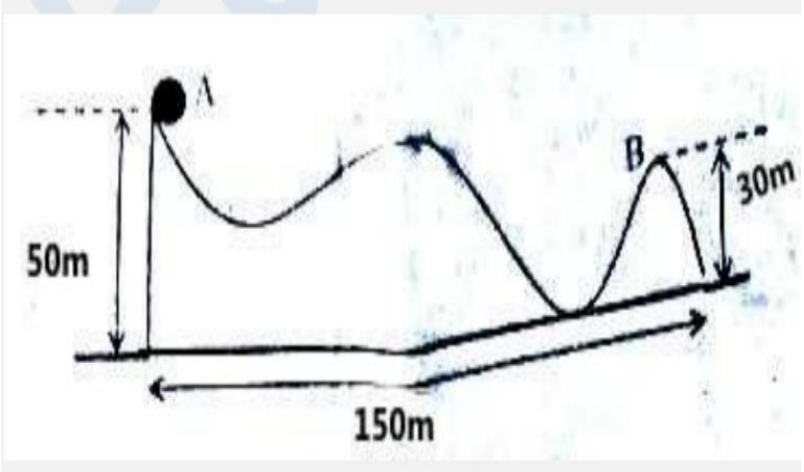
This is true for both boiling and critical points, so it doesn't distinguish them

D. At lower temperature and pressure during phase change. This is incorrect. The critical temperature and pressure are generally much higher than typical boiling points at standard atmospheric pressure.

Therefore, critical point occurs when the substance exists in a single phase**.**

Answer: A

11. A block of mass 50 kg is released from rest at point A on frictionless surface as shown below. What is the speed of block as it arrive point B?



A. 10 m/s

B. $10\sqrt{10}$ m/s

C. $20\ m/s$

D. $20\sqrt{10}$ m/s

solutions

GPE at point A is $GPE_A = 50kg*10\ m/s^2*50m = 25000J$

GPE at point B is $GPE_B = 50kg*10\ m/s^2*30m = 15000J$

AT point B, $Ek = GPE_A - GPE_B = 25000J - 15000J = 10000J$

And also $Ek = ½\ mv^2$, $v = \sqrt{\frac{2Ek}{m}} = \sqrt{\frac{20000}{50}} = 20\ m/s$

Therefore the answer is C.

12. Suppose that you repeatedly observe the electric 'mitad' at your home heats up slower than that of your neighbor when connected to the same source while cooking 'injera'. As compared to your neighbor's, your 'mitad' is

A. made up of higher specific heat material.

B. made up of higher conductivity material.

C. made up of lower mass high rate material.

D. allowed to get lower energy than the source.

The problem states that your "mitad" heats up slower than your neighbor's when connected to the same source. This implies that for the same amount of heat energy supplied, your "mitad" undergoes a smaller temperature change or takes longer to reach a certain temperature. Let's consider the concept of specific heat capacity.

Specific heat capacity is the amount of heat energy required to raise the temperature of 1 kg of a substance by 1 degree Celsius (or Kelvin). The formula for heat transfer is $Q=mc\Delta T$,

If your "mitad" heats up slower, it means that for the same amount of heat (Q) from the source, and assuming similar mass (m) and desired temperature change (ΔT), your "mitad" requires more energy to achieve that temperature change, or takes longer to do so. This point to a higher specific heat capacity. A material with a higher specific heat capacity requires more energy to increase its temperature by a certain amount

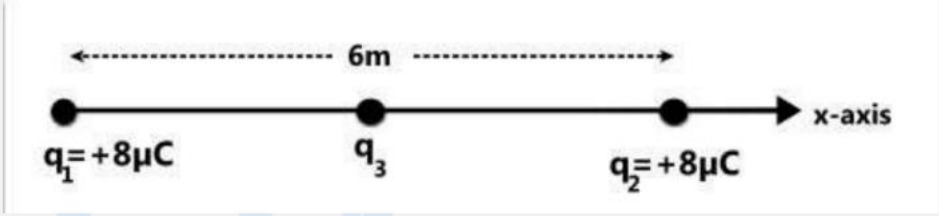
Therefore, the answer is A

13. . In determining the specific-heat capacity of a solid by electrical method, which of the following process or assumptions is possible?
A. Allowing heat flow to the environment.
B. Considering heat flow to the thermometer.
C. Assuming the electrical heater is 100% efficient.
D. Assuming heat flows from the solid object to electrical heater.

When determining the specific heat capacity of a solid using an electrical method (e.g., a calorimeter with an electrical heater), the goal is to precisely measure the heat supplied and the resulting temperature change. For accurate results, certain assumptions or considerations are made to account for heat losses or gains. , "considering heat flow to the thermometer" is a valid aspect of the experimental setup and analysis.

Therefore the answer is B.

14. Two charges $q_1 = 2\ \mu$ C and $q_2 = 8\ \mu$ C are placed along the x-axis as shown in the figure below.



Where a charge q_3 should be placed along the x-axis for the resultant electric force on it to be zero?

A. 2 m from q1
B. 2.5 m from q1
C. 4 m from q1
D. 5 m from q1

Solution: Given: q1=+2 μ C q2=+8 μ C Distance between q1 and q2 = 6 m

For the resultant electric force on a third charge q_3 to be zero, q_3 must be placed between q_1 and q_2 (since both q1 and q2 are positive, they would exert forces in opposite directions on q_3).

Let x be the distance of q_3 from q_1. Then the distance of q_3 from q_2 will be (6−x). Let F_{13} be the force exerted by q_1 on q_3, and F_{23} be the force exerted by q_2 on q_3. For the net force to be zero, $F_{13} = F_{23}$.

Using Coulomb's Law $F_{13} = K\frac{Q_1Q_3}{x^2}$, $F_{23} = K\frac{Q_2Q_3}{(6-x)^2}$

$$K\frac{Q_1Q_3}{x^2} = K\frac{Q_2Q_3}{(6-x)^2}$$

$$\frac{Q_1}{x^2} = \frac{Q_2}{(6-x)^2}$$

$$\frac{2}{x^2} = \frac{8}{(6-x)^2}$$

$$(6-x)^2 = 4x^2$$

Take the square root of both sides (since distances must be positive):

$$\sqrt{(6-x)^2} = \sqrt{4x^2}$$

$$6 - x = 2x, \quad 3x = 6, \quad x = 2m$$

Therefore, the charge q_3 should be placed 2 m from q_1 (and thus 4 m from q_2).

Answer: A. 2 m from q_1

15. A measure of number of electric field lines that crosses a given area is

A. Electric field.
B. Electric flux.
C. Electric force.
D. Electric potential.

Solution: Let's define the terms:

A. Electric field: A region around a charged particle or object within which a force would be exerted on other charged particles or objects. It is represented by electric field lines.

B. Electric flux: A measure of the number of electric field lines passing through a given surface. It quantifies the electric field passing through a particular area.

C. Electric force: The attractive or repulsive force between charged particles.

D. Electric potential: The amount of work needed to move a unit positive charge from a reference point to a specific point in an electric field.

Therefore, a measure of the number of electric field lines that crosses a given area is electric flux.

Answer: B. Electric flux.

16. Which one of the following is correct about elastic and inelastic collisions?
    A. Total kinetic energy of the system is conserved in both elastic and inelastic collisions?
    B. Total kinetic energy of the system is conserved in elastic collisions but not in inelastic collisions.
    C. Total linear momentum of the system is conserved in an elastic collision but not in inelastic collisions.
    D. Momentum and kinetic energy of the system are conserved if colliding objects stick together after collision.

Solution: Let's we evaluate the options for clarity.

A. Total kinetic energy of the system is conserved in both elastic and inelastic collisions?

- Incorrect. Kinetic energy is *not* conserved in inelastic collisions.

B. Total kinetic energy of the system is conserved in elastic collisions but not in inelastic collisions.

- Correct. This is the defining characteristic that differentiates elastic from inelastic collisions in terms of energy.

C. Total linear momentum of the system is conserved in an elastic collision but not in inelastic collisions.

- Incorrect. Total linear momentum is conserved in *both* elastic and inelastic collisions, provided the net external force is zero.

D. Momentum and kinetic energy of the system are conserved if colliding objects stick together after collision.

- Incorrect. When colliding objects stick together, it's a perfectly inelastic collision. In such collisions, momentum is conserved, but kinetic energy is *not* conserved (it's lost to other forms).

Therefore, the correct statement is that total kinetic energy of the system is conserved in elastic collisions but not in inelastic collisions.

Answer: B. Total kinetic energy of the system is conserved in elastic collisions but not in inelastic collisions.

17. Two point charges are fixed on the x-axis in such a way that 8 μC is placed at x = 0 while 10 μC At x = 9.0 cm. taking the electric potential at infinity being zero. At what point on the x-axis between the two charges is the potential equal to zero?

A. X = 9.0 cm
C. X = 4.5 cm
B. X = 5.0 cm
D. X = 4.0 cm

Answer: D. X=4.0 cm (Assuming q2 is negative

18. Which one of the following statements is correct about equipotential surfaces?

A. The electric potentials at different points on a line in a uniform electric field region are the same, if the line is perpendicular to the electric field.
B. The electric potentials at different points on line in a uniform electric field region are different, if the line is perpendicular to the electric field.
C. The magnitudes of electric potentials on each surface of two different concentric circles centered at a point charge are the same.
D. The magnitudes of electric potentials at different points on the same circle centered at a point charge are different.

Solutions.

Equipotential surfaces are surfaces where the electric potential is the same at every point.Let's analyze the options:

A. The electric potentials at different points on a line in a uniform electric field region are the same, if the line is perpendicular to the electric field.

- This is correct. In a uniform electric field, equipotential surfaces are planes perpendicular to the field lines. Any line lying within such a plane (and thus perpendicular to the electric field) would have the same electric potential at all its points.

B. The electric potentials at different points on line in a uniform electric field region are different, if the line is perpendicular to the electric field.

- This is incorrect. If the line is perpendicular to the electric field, it lies on an equipotential surface, so the potential is the same.

C. The magnitudes of electric potentials on each surface of two different concentric circles centered at a point charge are the same.

- This is incorrect. For a point charge, equipotential surfaces are concentric spheres. While all points on a *single* sphere have the same potential, points on *different* concentric spheres (or circles in 2D) will have different potentials because the potential depends on the distance from the point charge ($V=kQ/r$).

D. The magnitudes of electric potentials at different points on the same circle centered at a point charge are different.

- This is incorrect. For a point charge, a circle centered at the charge is an equipotential line (in 2D), meaning all points on that circle are at the same distance r from the charge and thus have the same potential.

Therefore, the correct statement is that electric potentials at different points on a line in a uniform electric field region are the same if the line is perpendicular to the electric field.

Answer: A. The electric potentials at different points on a line in a uniform electric field region are the same, if the line is perpendicular to the electric field

19. One of the following is NOT correct about electric resistance of a conductor

A. The resistance can be due to the collision between free electrons.

B. The resistance can be due to the collision between free electron and positive ions.

C. The resistance of a conductor can increase because of a large free electron.

D. Different substances can have different electric currents resistance.

Solution: Let's evaluate each statement regarding electric resistance:

A. The resistance can be due to the collision between free electrons.

- Collisions between free electrons contribute to resistance, but the primary cause is collisions between free electrons and the vibrating positive ions (lattice atoms). Electron-electron scattering is usually a smaller effect. However, it's not strictly incorrect that such collisions play a role.

B. The resistance can be due to the collision between free electron and positive ions.

- This is correct. The primary cause of electrical resistance in a conductor is the scattering of free electrons by the vibrating positive ions (atoms) in the crystal lattice.

C. The resistance of a conductor can increase because of a large free electron.

- This is NOT correct. A large number of free electrons (higher charge carrier density) generally *decreases* the resistance, as there are more charge carriers available to conduct current. Resistance typically increases with temperature (which increases ion vibrations) and material resistivity, and decreases with increased conductivity.

D. Different substances can have different electric currents resistance.

- This is correct. Different materials have different inherent resistivities, leading to different resistances for the same dimensions. This is why some materials are conductors, insulators, or semiconductors.

Therefore, the statement that is NOT correct is that the resistance of a conductor can increase because of a large free electron.

Answer: C. The resistance of a conductor can increase because of a large free electron

20. When dielectric material is inserted between an isolated charged parallel plate capacitor, which of the following effect happens due to the polarization of the charge?
    A. The potential between the plates remains constant.
    B. The charge stored on the plates is increased.
    C. The electric field between the plates decreased.
    D. The capacitance of the capacitor decreased

Solution: When a dielectric material is inserted into an isolated charged parallel plate capacitor:

- **Isolated charged capacitor:** This means the charge (Q) on the plates remains constant because there's no external circuit to add or remove charge.
- **Polarization of the dielectric:** The electric field created by the plates causes the molecules within the dielectric to polarize. This means their positive and negative charges slightly separate, creating an induced electric field within the dielectric that opposes the original field.

Let's analyze the effects:

A. The potential between the plates remains constant.

- Incorrect. Since the induced electric field within the dielectric opposes the original field, the net electric field between the plates *decreases*.

B. The charge stored on the plates is increased.

- Incorrect. As stated, for an isolated capacitor, the charge Q remains constant.

C. The electric field between the plates decreased.

- Correct. Due to polarization, an induced electric field forms within the dielectric, opposing the external field. This reduces the net electric field between the plates.

D. The capacitance of the capacitor decreased.

- Incorrect. The capacitance of a capacitor with a dielectric is given by C=κC0, where κ (kappa) is the dielectric constant (κ>1) and C0 is the capacitance without the dielectric. Since κ>1, the capacitance *increases* when a dielectric is inserted.

Therefore, the correct effect is that the electric field between the plates decreases.

Answer: C. The electric field between the plates decreased.

21. The pressure produced by the force on the mass. Two forces $\vec{F}_1$ and $\vec{F}_2$ act at a point to give a resultant force of 124 N towards the left. If $\overrightarrow{F1}$ has magnitude of 84 N towards the right. What are the magnitude and the direction of $\vec{F}_2$?

A. 40 N to the left
B. 208 N to the left
C. 208 N to the right
D. 40 N to the right

Solutions

: Let's define the directions: Right as positive (+) and Left as negative (-)

Given: Resultant force $F_R = -124\ N$ (towards the left) and $\vec{F}_1 = 84\ N$ (towards the right)

We know that the resultant force is the vector sum of the individual forces: $F_R = \vec{F}_1 + \vec{F}_2$
Substitute the given values $-124\ N = 84\ N + \vec{F}_2$

Solve for $\vec{F}_2$, $\vec{F}_2 = -124\ N - 84\ N = -208\ N$

The negative sign indicates the direction is to the left.

Therefore, the magnitude of F_2 is 208 N and its direction is to the left.

Answer: B. 208 N to the left

22. A 10 kg block slides down on an inclined plane, making an angle of 30^0 with the horizontal. If the coefficient of kinetic friction between the block and the inclined plane is μ_k = 0.1, the acceleration of the block is

A. 5 m/s².
C. 4.23 m/s².
B. 4.13 m/s².
D. 5.87 m/s².

Solutions

$$mgsin\theta - f_k = ma$$

$$mgsin\theta - \mu mgcos\theta = ma$$

$$a = g(sin\theta - \mu cos\theta) = 10(0.5 - 0.1 \times 0.866) \approx 4.23\ m/s^2$$

Therefore the answer is C

23. An object of mass 4 kg moving with a velocity 4 m/s to the right collides head on with another object of mass 2 kg moving with a velocity 2 m/s to the left. After the collision, the objects stick together and move as a single object. What is their kinetic energy just after collision?

A. 12J
C. 20J
B. 16 J
D. 33J

SOLUTIONS

$$m_1u_{1+}m_2u_2 = (m_1 + m_2)V$$

$$V = \frac{m_1u_{1+}m_2u_2}{m_1 + m_2} = \frac{4kg \times 4\frac{m}{s} - 2kg \times 2\frac{m}{s}}{4kg + 2kg} = 2m/s$$

Then

$$Ek_{final} = \frac{1}{2}(m_1 + m_2)V^2 = \frac{1}{2}(6)2^2 = 3 \times 4 = 12J$$

Therefore A is correct answer

24. The efficiency of a machine can be expressed in terms of the mechanical advantage (MA) and velocity ration (VR) of the machine as

A. $\eta = MA/VR$ C. $\eta = VR \times MA$

B. $\eta = VR/MA$ D. $\eta = VR + MA$

25. In a hydraulic lift, a force $F_1 = 120$ N is applied to a smaller piston of radius r_1 to lift a 12000 N car placed on a larger piston of radius r_2. What is the ratio of r_2 to r_1?

A. 1/100 C. 100

B. 1/10 D. 10

Solutions

Given

$$F_1 = 120N\,, F_2 = 12000N, A_1 = \pi r_1^2 \quad A_2 = \pi r_2^2$$

Since pressure is constant,

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \quad , \quad \frac{120}{\pi r_1^2} = \frac{12000}{\pi r_2^2}, \qquad \frac{r_2^2}{r_1^2} = 100\,, \quad \frac{r_2}{r_1} = 10$$

Therefore the answer is D

26. A square plane sheet of copper is 8.00 cm along each side. What is the change in the area of this sheet when its temperature is increased by 50.0 K? (Coefficient of area expansion of copper is 3.4×10^{-5} /K)

A. 0.1088 cm² C. 0.6410 cm²

B. 0.1944 cm² D. 0.400 cm²

SOLUTIONS

$$\Delta A = A_o \beta \Delta T = {l_o}^2 \alpha \Delta T \quad since\ A_o = {l_o}^2 and$$

$$\Delta A = (8\ cm)^2 \times 3.4 \times 10^{-5}/k \times 50K = 0.1088\ cm^2$$

Therefore the answer is A

27. . Which one of the following statements is correct about longitudinal and transverse waves?

A. In longitudinal waves, particles of the medium through which the wave is travelling perpendicular to the direction of wave propagation.

B. In transverse waves, energy is transferred between two points by actual motion of particles in the medium.

C. Transverse waves cannot propagate in vacuum, whereas longitudinal waves can propagate in vacuum.

D. In transverse waves, the direction of vibration of the particles in the medium or field through which the wave is travelling is perpendicular to the direction of wave propagation.

28. The unit of linear momentum is

A. N/sec.

B. Kg m/sec.

C. Kg m/sec².

D. N/m.

29. . A wedge of 8 cm and thickness 2 cm is pushed into a block of wood. If the effort applied in 40 N, what is the load on the wooden block? (Assume the wedge is 100% efficient)

A. 10 N

B. 160 N

C. 80 N

D. 320 N

Solutions

$$l = 8\ cm\ ,\ \ t = 2\ cm\ \ ,\ \ \ E = 40\ N \qquad L = ?$$

For ideal machine, that has 100% efficiency, $MA = VR$

$$\frac{L}{E} = \frac{L}{t}$$

$$L = \frac{E \times L}{t} = \frac{40\ N\ \times 8\ cm}{2\ cm} = 160\ N$$

Therefore, the answer is B.

30. . The distribution of charges on the surface of an irregularly shaped conductor in electrostatic equilibrium is

A. the greatest at locations where the radius of curvature of the surface is smallest.

B. the same at all locations irrespective of the radius of curvature of the surface.

C. the smallest at locations where the radius of curvature of the surface is smallest.

D. the greatest at locations where the radius of curvature of the surface is largest.

Answer:

The distribution of charges on surface of an irregularly shaped conductor in electrostatic equilibrium is the greatest at locations where the radius of curvature of the surface is largest. That point is the sharpest edge point of the surface.

31. A semiconductor is called

A. n-type, if the majority carriers due to doping are holes.

B. p-type, if it is doped with donor impurities.

C. p-type, if the majority carriers due to doping are holes.

D. n-types, if it is doped with acceptor impurities.

32.Transistors are semiconductor devices that

A. Have two terminals and three junctions.

B. Have three terminals and three junctions.

C. Formed by joining three P - type semiconductors.

D. Have three terminals and two junctions

Solutions

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power.

- It typically consists of three terminals: Emitter (E), Base (B), and Collector (C).
- It is formed by joining three doped semiconductor regions, creating two p-n junctions (e.g., NPN or PNP).

Let's evaluate the options:

A. Have two terminals and three junctions. Incorrect.
Transistors have three terminals, and usually two junctions (e.g., emitter-base junction, collector-base junction).

B. Have three terminals and three junctions. Incorrect.
They have three terminals but typically two junctions.

C. Formed by joining three P - type semiconductors. Incorrect.
They are formed by alternating P-type and N-type semiconductors (e.g., NPN or PNP).

D. Have three terminals and two junctions. Correct.
This is the standard description of a bipolar junction transistor (BJT).

Therefore, transistors are semiconductor devices that have three terminals and two junctions.
Answer: D.

33. Which one of the following statements correctly describes junction diode and its formation?

A. Diode is a single terminal component formed by joining P- type and N- type semiconductors.
B. Diode is a two terminal component formed by joining two semiconductors; silicon and germanium.
C. Diode is a two terminal component formed by joining P- type and N- type semiconductors.
D. Diode is a single terminal component formed by joining two semiconductors; silicon and germanium.

Solution: A p-n junction diode is a semiconductor device.

- **P-type semiconductor:** Doped with acceptor impurities, creating a majority of holes.
- **N-type semiconductor:** Doped with donor impurities, creating a majority of free electrons.

When a p-type semiconductor is joined with an n-type semiconductor, a p-n junction is formed, creating a diode. This device allows current to flow predominantly in one direction (forward bias) and blocks it in the opposite direction (reverse bias).

Let's analyze the options:

- **A. Diode is a single terminal component formed by joining P- type and N- type semiconductors.**
  - Incorrect. A diode is a **two-terminal** component (anode and cathode).
- **B. Diode is a two terminal component formed by joining two semiconductors; silicon and germanium.**
  - Incorrect. While silicon and germanium are common semiconductor materials, a diode is formed by joining a **P-type** and an **N-type** semiconductor, which are created by doping. It's not about joining silicon to germanium as different materials to form the junction itself.
- **C. Diode is a two terminal component formed by joining P- type and N- type semiconductors.**
  - Correct. This accurately describes the structure and number of terminals of a p-n junction diode.
- **D. Diode is a single terminal component formed by joining two semiconductors; silicon and germanium.**
  - Incorrect. (Single terminal and joining silicon and germanium in this context is wrong).

Therefore, the correct statement is that a diode is a two-terminal component formed by joining P-type and N-type semiconductors.

Answer: C. Diode is a two terminal component formed by joining P- type and N- type semiconductors

34. When any objects immersed in a field , it is acted up by the force of buoyancy equal to the weight of the displaced field , this is a well – known statement of
    A. Principle of buoyancy.
    B. Bernoulli's principle
    C. Archimedes.
    D. Pascal's principle

Let's define the principles:

- **A. Principle of buoyancy:** This is a general term for the concept, but not the name of the specific law.
- **C. Archimedes' Principle:** States that the buoyant force on a submerged or floating object is equal to the weight of the fluid displaced by the object. This is precisely the statement given.
- **B. Bernoulli's principle:** Deals with the conservation of energy in fluid flow, relating pressure, velocity, and height.
- **D. Pascal's principle:** States that pressure applied to an enclosed incompressible fluid is transmitted undiminished to every portion of the fluid and to the walls of the containing vessel.

Therefore, the statement "When any objects immersed in a field, it is acted up by the force of buoyancy equal to the weight of the displaced field" is a well-known statement of Archimedes' Principle.

Answer: C. Archimedes.

35. In using sound waves for medical diagnosis, a sound of high frequency (typically 3.5 – 10 MHz) is sent to a body tissue. Then a sound wave collected by the ultrasound machine for analysis is the
    A. Reflected wave from the tissue.
    B. Transmitted wave through the tissue.
    C. Refracted wave through the tissue.
    D. Absorbed wave by the tissue.

Solution: Medical diagnostic imaging using high-frequency sound waves is called **ultrasound**.

Let's consider how ultrasound works:

- A transducer emits high-frequency sound waves into the body.
- These sound waves travel through tissues and fluids.
- When they encounter boundaries between different tissues (e.g., muscle and bone, or different organs), a portion of the sound wave is reflected back to the transducer.
- The transducer detects these reflected (echoed) waves.
- The time it takes for the echo to return, and the intensity of the echo, are used to create an image of the internal structures.

Let's analyze the options:

- **A. Reflected wave from the tissue.**
  - This is correct. Ultrasound imaging relies on the principle of reflection (echoes) of sound waves.
- **B. Transmitted wave through the tissue.**
  - While some waves are transmitted, these are not the primary waves collected for *imaging* in typical ultrasound (though some advanced techniques might use transmission properties).
- **C. Refracted wave through the tissue.**
  - Refraction (bending of waves) occurs, but it's not the primary phenomenon used for image formation.
- **D. Absorbed wave by the tissue.**
  - Some sound energy is absorbed by the tissue, leading to attenuation, but absorbed waves are not collected for analysis.

Therefore, the sound wave collected by the ultrasound machine for analysis is the reflected wave from the tissue.

Answer: A. Reflected wave from the tissue.

36. The racing car starts from rest and acceleration at 2.0 m/s^2 till the finish line which is 90 km away from the starting point. How long was the car in motion?

A. 300 s C. $\sqrt[3]{10}\,s$

B. 90 s D. $\sqrt[3]{20}\,s$

SOLUTIONS

$$s = ut + 1/2\,at^2$$

But u = 0 m/s

$$s = 1/2\,at^2, \qquad t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{180000}{2}} = 300\,s$$

Therefore the answer is A.

37. Two cars. Car A and car B move on the same road along the same direction. If the velocity of car A with respect to the passenger in car B is 30 m/s forward, which of the following statement correctly describes the velocity of the two cars relative to a stationary observer at the roadside?

A. Car A is slower than car B.

B. Car A and car B moves with the same velocities.

C. The velocity of car A can be less than 30 m/s.

D. Car B is slower than car A.

Solution: Let V_A be the velocity of car A relative to the stationary observer. Let V_B be the velocity of car B relative to the stationary observer. Let V_{AB} be the velocity of car A with respect to car B.

Given: V_{AB} =30 m/s forward. The relationship between relative velocities is: $V_{AB} = V_A - V_B$

So, $30 = V_A - V_B$ This implies $V_A = V_B + 30$ m/s

This equation shows that the velocity of car A is 30 m/s greater than the velocity of car B.

- A. Car A is slower than car B. (Incorrect, Car A is faster)
- B. Car A and car B moves with the same velocities. (Incorrect, their velocities differ by 30 m/s)
- C. The velocity of car A can be less than 30 m/s. (Incorrect. If V_B is 0 or negative, V_B can be 30 or less than 30, but the statement says "can be less than 30 m/s" implies that it can be less than 30 while still being greater than B's velocity, which is true. For example if V_B =10 m/s, V_A =40 m/s. If VB =−10 m/s, VA=20 m/s. But the best description is the relation of their velocities.)
- D. Car B is slower than car A. (Correct, since VA=VB+30, car A is faster than car B, meaning car B is slower than car A.)

Answer: D. Car B is slower than car A.

38. Which of the following set of forces contains only non-contact forces?

A. { Fractional force, Drug force, Electric force }

B. { Gravitational force, Magnetic force, Electric force }

C. { Gravitational force, Fractional force, Buoyant force }

D. { Magnetic force, Electric force, Drug force }

Solution: Non-contact forces are forces that act on an object without coming physically in contact with it.

Let's examine the options:

- **A. {Fractional force, Drug force, Electric force }**
  - Fractional force (friction) is a contact force.
  - Drag force (air resistance) is a contact force.
  - Electric force is a non-contact force.
- **B. {Gravitational force, Magnetic force, Electric force }**
  - Gravitational force is a non-contact force.

  - Magnetic force is a non-contact force.
  - Electric force is a non-contact force.
- **C. {Gravitational force, Fractional force, Buoyant force }**
  - Gravitational force is a non-contact force.
  - Fractional force (friction) is a contact force.
  - Buoyant force is a contact force (fluid needs to be in contact with the object).
- **D. { Magnetic force, Electric force, Drug force }**
  - Magnetic force is a non-contact force.
  - Electric force is a non-contact force.
  - Drag force (air resistance) is a contact force.

Therefore, the set that contains only non-contact forces is Gravitational, Magnetic, and Electric force.

Answer: B. {Gravitational force, Magnetic force, Electric force }

39. Which one of the following statements is correct about the classes of levers?

A. Scissors are second class levers in which the fulcrum is between the load and effort.

B. A wheelbarrow is a first class lever with effort between the load and fulcrum.

C. Spade is a third class lever in which the effort is between the load and fulcrum.

D. A paper cutter is a second class lever with the effort between the load and fulcrum.

Solution: Let's define the classes of levers:

- **Class 1 Lever:** The fulcrum is located *between* the effort and the load. (e.g., seesaw, crowbar, scissors)
- **Class 2 Lever:** The load is located *between* the fulcrum and the effort. (e.g., wheelbarrow, nutcracker, bottle opener)
- **Class 3 Lever:** The effort is located *between* the fulcrum and the load. (e.g., fishing rod, tweezers, spade)

Now let's evaluate the options:

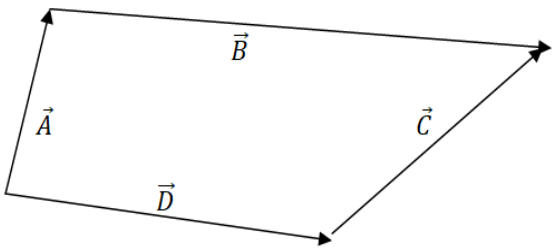
- **A. Scissors are second class levers in which the fulcrum is between the load and effort.**
  - Scissors are **first class levers**. The fulcrum (pivot point) is between the effort (where you apply force) and the load (what you're cutting).
- **B. A wheelbarrow is a first class lever with effort between the load and fulcrum.**
  - A wheelbarrow is a **second class lever**. The load (what's in the wheelbarrow) is between the fulcrum (the wheel) and the effort (where you lift the handles).
- **C. Spade is a third class lever in which the effort is between the load and fulcrum.**

  - A spade (when used for digging, with one hand as fulcrum, other hand as effort, and the soil as load) is generally considered a **third class lever**, where the effort is applied between the fulcrum and the load. This statement correctly describes a Class 3 lever.
- **D. A paper cutter is a second class lever with the effort between the load and fulcrum.**
  - A paper cutter is typically a **first class lever**, where the fulcrum is at the pivot point, the effort is on the handle, and the load is the paper being cut. If it's a guillotine-style cutter, the fulcrum is at one end, the effort is at the handle, and the blade is the load, placing the fulcrum at the end and the load/effort elsewhere.

Therefore, the correct statement is about the spade.

Answer: C. Spade is a third class lever in which the effort is between the load and fulcrum.

40. Four coplanar vectors are drawn with a scale as shown in the figure below.



Which one of the following expressions is correct about the vector?

A. $\vec{A} + \vec{B} + \vec{C} + \vec{D} = 0$

B. $\vec{B} + \vec{C} + \vec{D} = \vec{A}$

C. $\vec{A} + \vec{B} + \vec{C} = \vec{D}$

D. $\vec{A} + \vec{B} = \vec{C} + \vec{D}$

In a closed vector polygon, if vectors are arranged head-to-tail and the sequence ends at the starting point, the resultant vector is zero. Alternatively, if vectors form a closed loop, the sum of vectors going in one direction equals the sum of vectors going in the opposite direction.

Looking at the figure:

- Vectors **A**, **B**, and **C** are arranged head-to-tail, starting from the tail of **A** and ending at the head of **C**.
- Vector **D** starts from the tail of **A** and ends at the head of **C**.

This means that **D** is the resultant of **A**+**B**+**C**. So, A+B+C=D.

Let's check the given options:

- **A. A+B+C+D=0**
  - This would be true if D was pointing in the opposite direction (from head of C to tail of A). Since D closes the loop in the same general direction as the sum of A, B, C, this implies D=A+B+C. Therefore, A+B+C−D=0. So, this option is incorrect.
- **B. B+C+D=A**
  - This is incorrect.
- **C. A+B+C=D**
  - This is correct, as observed from the head-to-tail addition.
- **D. A+B=C+D**
  - This is incorrect.

Therefore, the correct expression is A+B+C=D. Answer: C. A+B+C=D

41. A type of fluid flow where there is disruption to layer fluid in which the velocity of the fluid at any point is continuously changing both in magnitude and direction is rate is changing is

A. laminar flow.
C. turbulent flow.
B. stream line
D. incompressible flow.

42. A rabbit was hopping on a big field toward a carrot pile which was placed at 20m to the positive x-direction and 7m to the negative y-direction from its starting point. Which of the following displacement vector, S, represents her motion?

A. Š = (20i + 7j) m
C. Š = (-20i + 7j) m
B. Š = (7i + 20j) m
D. Š = (20i - 7j) m

43. Which one of the following statements is true about the conductivity of a doped silicon semiconductor?

A. If silicon is doped with boron, the majority carriers are free electrons.
B. If silicon is doped with boron, the majority carriers are holes.
C. If silicon is doped with Arsenic, the majority carriers are holes.
D. If silicon is doped with Arsenic, the number of free electrons and holes are equal.

44. Which one of the following statements is true about a doped semiconductor?

A. In an n-type semiconductor, the majority carries are electrons while the minority carriers are holes

B. An n-type silicon semiconductor can be produced by doping it with group III elements.

C. In n and p-type semiconductors, the concentration of holes and electrons are the same.

D. An arsenic doped silicon semiconductor is a p-type semiconductor.

45. . A converging lens has a focal length of 10 cm. If an object is placed at 6 cm from the lens, the image formed is

A. virtual and located at a distance of 3.75 cm from the lens.

B. real and located at a distance of 3.75 cm from the lens.

C. real and located at a distance of 15 cm from the lens.

D. virtual and located at a distance of 15 cm from the lens.

46. 1. 5 Ω, and 4.0 Ω are connected to a 12 V battery as shown in the figure below. (Figure Description: 1.5 and 2.5 ohm resistors in series, that combination in parallel with a 4 ohm resistor. All connected to 12V.)

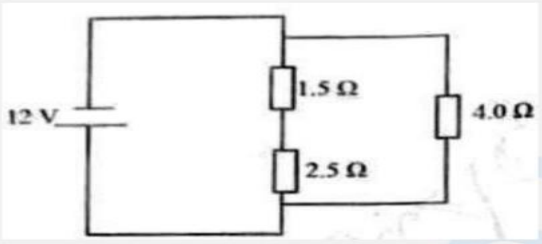
How much current will flow in the 4.0 Ω resistor?

A. 2 A

B. 3 A

C. 1 A

D. 2.5 A



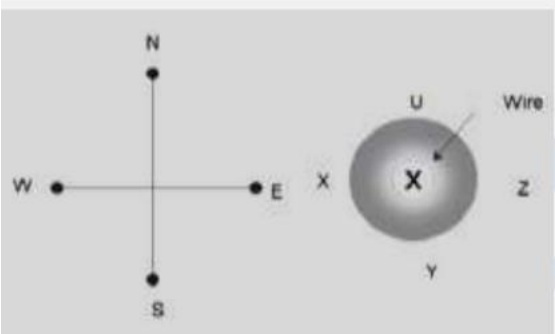
47. 2. Consider a rectangular loop of wire that lies in xy-plane has area of 50 cm² and a current of I=2 A in the clockwise direction as shown in the figure. If a magnetic field B = 0.4 T is applied in the positive x direction, what is the magnitude and direction of the torque acting on the loop?

A. 0.4×10^{-2} Nm, in the negative y direction.

B. 0.4 Nm, in the positive y direction.

C. 0.4 Nm, in the negative y direction.

D. 0.4×10^{-2} Nm, in the positive y direction.



48. Why are diverging mirrors often used for rear-view mirrors in vehicles? What is the main disadvantage of using such a mirror compared with a flat one?
    A. It gives a wide range of view. The image appears to be closer than the actual object.
    B. It gives a narrow range of view. The image appears to be farther than actual object.
    C. It gives a narrow range of view. The image appears to be closer than the actual object.
    D. It gives a wide range of view. The image appears to be farther than the actual object

49. An image of an object produced on a screen which is about 36 cm using a convex lens. The image produced is about 3 times the size of the object. What is the size of the object?
    A. 12 cm B. 33 cm C. 39 cm D. 108 cm

50. _____is small semiconductors chip on which millions of electronic components such as resistors, capacitors and transistors are fabricated.
    A. Integrated circuit
    B. Logic gate
    C. Diode
    D. Transistor