

Question 1:

The plates of a capacitor are charged to a potential difference of 5 V. If the capacitance is 2 mF, what is the charge on the positive plate?, A. '0.005 C', B. '0.01 C', C. '0.02 C', D. '0.5 C'

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Answer Option 1:

The charge on a capacitor is given by the product of the capacitance and the potential difference. Therefore, the charge on the positive plate is $(2 \text{ mF})(5 \text{ V}) = 0.01 \text{ C}$. Final Answer: B

Answer Option 2:

The charge Q on the plates of a capacitor is given by the relation $Q = CV$, where C is the capacitance and V is the voltage. Substituting the given values, we get $Q = 2 \text{ mF} \times 5 \text{ V} = 0.01 \text{ C}$. Final Answer: B

Answer Option 3:

The charge Q on a capacitor is given by the product of the capacitance C and the potential difference V across the capacitor. Mathematically, $Q = CV$. In this case, substituting the given values, $Q = 5 \text{ V} \times 2 \text{ mF} = 0.01 \text{ C}$. So, the charge on the positive plate is 0.01 C. Final Answer: B

Answer Option 4:

The charge Q on a capacitor is given by the formula $Q = CV$, where C is the capacitance and V is the potential difference. Substituting the given values, $Q = 2 \text{ mF} \times 5 \text{ V} = 0.01 \text{ C}$.

Final Answer: B. '0.01 C'

Answer Option 5:

The charge Q on a capacitor is given by the equation $Q = CV$, where C is the capacitance and V is the voltage. In this case, $C = 2 \text{ mF} = 0.002 \text{ F}$ and $V = 5 \text{ V}$. Therefore, the charge $Q = 0.002 \text{ F} \times 5 \text{ V} = 0.01 \text{ C}$.

Final answer: B.

Answer Option 6:

The charge Q on a capacitor is given by the formula $Q = CV$, where C is the capacitance and V is the potential difference. Substituting the given values, we get $Q = 2 \times 10^{-3} \text{ F} \times 5 \text{ V} = 0.01 \text{ C}$. Therefore, the charge on the positive plate is 0.01 C. Final answer: B.

Answer Option 7:

The charge Q on a capacitor is given by the formula $Q = CV$, where C is the capacitance and V is the potential difference. Substituting the given values, we get $Q = (2 \text{ mF})(5 \text{ V}) = 0.01 \text{ C}$. Therefore, the charge on the positive plate is 0.01 C. Final Answer: B. '0.01 C'

Answer Option 8:

The charge on a capacitor can be determined by the formula $Q=CV$, where Q is the charge, C is the capacitance, and V is the voltage. In this case, the voltage V is 5 volts and the capacitance C is 2 millifarads, or 0.002 farads. Therefore, the charge Q is $(0.002 \text{ F})(5 \text{ V}) = 0.01 \text{ coulombs}$. Therefore, the charge on the positive plate is 0.01 coulombs. Final Answer: B. '0.01 C'

Answer Option 9:

The charge (Q) on a capacitor can be calculated using the formula $Q = CV$, where C is the capacitance and V is the voltage. Here, $C = 2 \text{ mF} = 0.002 \text{ F}$ (since $1 \text{ mF} = 0.001 \text{ F}$) and $V = 5 \text{ V}$. Substituting these values into the formula gives $Q = 0.002 \text{ F} \times 5 \text{ V} = 0.01 \text{ C}$. So, the charge on the positive plate is 0.01 C. Final Answer: B. '0.01 C'

Question 2:

'Which of these quantities decreases as the inverse square of distance for distances far from the objects producing the fields?', A. 'the electric field produced by a finite-length charged rod', B. 'the electric field produced by an infinitely long charged cylinder', C. 'the electric field produced by an infinite plane of charge', D. 'the magnetic field produced by an infinitely long, straight current-carrying wire'

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Answer Option 1:

The electric field produced by a finite-length charged rod decreases as the inverse square of distance for distances far from the rod. Final Answer: A

Answer Option 2:

The electric field produced by a finite-length charged rod decreases as the inverse square of the distance for distances far from the rod. Final answer: A.

Answer Option 3:

The electric field produced by a finite-length charged rod decreases as the inverse square of distance for distances far from the rod. So, the answer is A. 'the electric field produced by a finite-length charged rod'.

Answer Option 4:

The electric field produced by a finite-length charged rod decreases as the inverse square of distance for distances far from the rod. So, the correct answer is A. 'the electric field produced by a finite-length charged rod'.

Answer Option 5:

The electric field produced by a finite-length charged rod decreases as the inverse square of the distance for distances far from the rod. So, the correct answer is A. 'the electric field produced by a finite-length charged rod'.

Answer Option 6:

The electric field produced by a finite-length charged rod decreases as the inverse square of distance for distances far from the rod. This is a fundamental principle of electrostatics known as Coulomb's Law. Therefore, the correct answer is A. 'the electric field produced by a finite-length charged rod'.

Answer Option 7:

The correct answer is A. 'the electric field produced by a finite-length charged rod'. This is because the electric field produced by a point charge or a finite-length charged rod decreases as the inverse square of the distance from the charge or rod. The fields described in the other options do not decrease with the inverse square of the distance.

Answer Option 8:

The quantity that decreases as the inverse square of the distance for distances far from the objects producing the fields is A. 'the electric field produced by a finite-length charged rod'. At sufficiently large distances, the rod would appear as a point and the field would decrease as an inverse square law, similar to a point charge. The fields produced by an infinitely long charged cylinder or by an infinite plane of charge, or the magnetic field produced by an infinitely long, straight current-carrying wire, do not decrease with distance. Final Answer: A

Answer Option 9:

The quantity that decreases as the inverse square of distance for distances far from the object producing the field is A. 'the electric field produced by a finite-length charged rod'. This follows the principle that electric field of a point charge decreases with the square of the distance. Since a finite-length rod can be approximated as a point charge when the distance is far enough, its field should decrease as the inverse square of distance. The other options involve infinite distributions of charge or current, which do not follow the inverse square law.

Question 3:

'A solid, metal object is isolated from other charges and has charge distributed on its surface. The charge distribution is not uniform. It may be correctly concluded that the', A. 'electric field outside the object is zero', B. 'the electric field outside the object is equal to the electric field inside the object', C. 'the electric field outside the object is directly proportional to the distance away from the center of mass of the object', D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'

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Answer Option 1:

D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'

Answer Option 2:

D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'

Answer Option 3:

D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'

Answer Option 4:

D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'

Answer Option 5:

D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'

Answer Option 6:

The correct answer is D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'.

Answer Option 7:

D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'

Answer Option 8:

The correct answer is D. 'the electric field outside the object, but very close to the surface, is equal to the surface charge density at any location divided by the permittivity of free space'. This is a direct application of Gauss's law for electricity. It states that the electric field close to a charged surface is proportional to the surface charge density and inversely proportional to the permittivity of free space, a fundamental constant.

Answer Option 9:

For a solid, conductive object, the electric field inside the object is always zero, regardless of the distribution of charge. Meanwhile, the electric field outside the object depends on the charge distribution. However, the electric field just outside the surface of the object is always perpendicular to the surface and its magnitude is given by the surface charge density at that location divided by the permittivity of free space. This is according to Gauss's law for electricity. Final answer: D.

Question 4:

'Standing waves are produced by a 100-Hz generator in a string of fixed length. The tension in the string is increased until a new set of standing waves is produced. Will the wavelength of the new standing waves be greater than or less than the wavelength of the original standing waves?', A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.',

B. 'Greater, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.', C. 'Greater, because the tension in the string varies directly with the wave speed, which varies directly with the wavelength.', D. 'Less, because the tension in the string varies directly with the wave speed, which varies directly with the wavelength.'

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Answer Option 1:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Answer Option 2:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Answer Option 3:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Answer Option 4:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Answer Option 5:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Answer Option 6:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Answer Option 7:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Answer Option 8:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Answer Option 9:

A. 'Less, because the tension in the string varies directly with the wave speed, which varies inversely with the wavelength.'

Question 5:

Two identical capacitors are hooked in parallel to an external circuit. Which of the following quantities must be the same for both capacitors? I. the charge stored on the capacitor II. the voltage across the capacitor III. the capacitance of the capacitor', A. 'I only', B. 'II only', C. 'II and III only', D. '(E) I, II, and III'

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Answer Option 1:

In a parallel circuit, all components share the same voltage. Thus, the voltage across both capacitors must be the same. As for the charge, it can be different on each capacitor depending on its capacitance.

Therefore, only II and III must be the same for both capacitors. Final answer: C.

Answer Option 2:

When capacitors are connected in parallel, they share the same potential difference, or voltage, across their plates, but not necessarily the same charge. Since the capacitors are identical, they will also have the same capacitance. Thus, the correct answer is 'II and III only'. Final answer: C

Answer Option 3:

When capacitors are connected in parallel, the voltage across each capacitor is the same, but the charge stored on each capacitor can be different, depending on their capacitances. Since the capacitors are identical, their capacitances are also the same. So, the correct answer is II and III only. Final answer: C

Answer Option 4:

When capacitors are connected in parallel, they all share the same voltage. So the voltage across the capacitors must be the same, which is statement II. The capacitance of the capacitors is also the same, since they are identical, which is statement III. However, the charge stored on each capacitor can be different, so statement I is incorrect. Therefore, the correct answer is C. 'II and III only'.

Answer Option 5:

When capacitors are connected in parallel, the total voltage across each capacitor is the same. Therefore, II is correct. Since they are identical capacitors, their capacitances are also the same. Therefore, III is correct. However, the charge stored on each capacitor can vary depending on the properties of each capacitor, so I is not necessarily correct. Therefore, the correct answer is C. 'II and III only'.

Answer Option 6:

For identical capacitors hooked in parallel, the voltage across each capacitor is the same, and the capacitance of each capacitor is the same. However, the charge stored on each capacitor may not be the same, as this is related to the accumulated charges by each branch of the parallel circuit which is dependent on the rest of the circuit.

Thus, the answer is $\boxed{\text{C. II and III only}}$.

Answer Option 7:

When capacitors are connected in parallel, each capacitor experiences the same potential difference (voltage). Therefore, statement II is correct. As the problem states that the capacitors are identical, their capacitances are equal. Therefore, statement III is correct. However, the charge stored on each capacitor might not be the same, because even though they have the same capacitance and voltage, the amount of charge they store depends on the time they have been connected to the circuit. Therefore, statement I is not necessarily correct. So, the final answer is C. 'II and III only'.

Answer Option 8:

In parallel circuit, the voltage across all components is the same. Thus, II is correct. The capacitance of a capacitor is a characteristic of the capacitor itself and does not change no matter how the capacitor is connected. Thus, III is also correct. However, the charge stored on each capacitor in a parallel circuit can be different. So, I is not correct. Therefore, the answer is $\boxed{\text{C. II and III only}}$.

Answer Option 9:

When capacitors are connected in parallel, they each experience the same voltage. This is because they are directly connected to the same points in the circuit, and therefore the electric potential difference between these points is the same for each capacitor. So II is correct. The capacitance of each capacitor is a property of the capacitor itself, and not of the circuit it's in. Since the problem states that the capacitors are identical, their capacitances are indeed the same. So III is correct. However, the charge stored on each capacitor may not be the same. Even though they experience the same voltage, different capacitors can store different amounts of charge due to differences in their physical properties (like their surface area and the distance between their plates). So I is not necessarily correct. Therefore, the answer is C. 'II and III only'.

Question 6:

'A 1-kg object is released from rest at the top of a rough-surfaced incline. The object slides without rotating to the bottom of the incline. The object's kinetic energy at the bottom must be', A. 'Equal to the block's gravitational potential energy when it was released, because total mechanical energy must be conserved.', B. 'Equal to the block's gravitational potential energy when it was released, because the gain in kinetic energy compensates for the mechanical energy lost to thermal energy on the rough incline.', C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.', D. 'Less than the block's gravitational potential energy when it was released, because the work done by the friction force must be greater than the block's gain in kinetic energy.'

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Answer Option 1:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Answer Option 2:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Answer Option 3:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Answer Option 4:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Answer Option 5:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Answer Option 6:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Answer Option 7:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Answer Option 8:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Answer Option 9:

C. 'Less than the block's gravitational potential energy when it was released, because the gravitational potential energy was converted both to thermal energy and to kinetic energy.'

Question 7:

'A student is experimenting with a simple spring-block oscillator of spring constant k and amplitude A . The block attached to the spring has a mass of m . If the student places a small block of mass m on top of the original block, which of the following is true?', A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.', B. 'The small block is most likely to slide off when the original block is at the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.', C. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $(M+m)g/(kA)$.', D. 'The small block is most likely to slide off when the original block is at the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $(M+m)g/(kA)$.'

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Answer Option 1:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.'

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Answer Option 2:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.'

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Answer Option 3:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.'

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Answer Option 4:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.'

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Answer Option 5:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.'

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Answer Option 6:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.'

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Answer Option 7:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.'

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Answer Option 8:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.'

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Answer Option 9:

A. 'The small block is most likely to slide off when the original block is at maximum displacement from the equilibrium position, but will not slide off as long as the coefficient of static friction between the blocks is greater than $kA/[(M+m)g]$.

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Question 8:

'How much work is required to charge a 10 μF capacitor to a potential difference of 100 V?', A. '0.005 J', B. '0.01 J', C. '0.05 J', D. '0.1 J'

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Answer Option 1:

The work done in charging a capacitor is given by the formula $W = \frac{1}{2} C V^2$ where C is the capacitance and V is the voltage.

Substituting the given values we get $W = \frac{1}{2} \times 10 \times 10^{-6} \times 100^2 = 0.05 \text{ J}$.

So, the correct answer is C. '0.05 J'.

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Answer Option 2:

The work done to charge a capacitor is given by the expression $W = \frac{1}{2} C V^2$, where C is the capacitance and V is the voltage.

Therefore,

$$W = \frac{1}{2} \times 10 \mu\text{F} \times (100 \text{ V})^2$$

$$= \frac{1}{2} \times 10 \times 10^{-6} \text{ F} \times 10^4 \text{ V}^2$$

$$= \frac{1}{2} \times 10^{-1} \text{ J}$$

$$= 0.05 \text{ J}.$$

So, the correct answer is C. '0.05 J'.

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Answer Option 3:

The energy (or work done) stored in a capacitor is given by the formula $W = \frac{1}{2} C V^2$, where C is the capacitance and V is the voltage.

Substituting the given values, $W = \frac{1}{2} \times 10 \times 10^{-6} \text{ F} \times (100 \text{ V})^2 = 0.05 \text{ J}$.

So, the amount of work required is 0.05 J. Final answer: C.

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Answer Option 4:

The work (W) required to charge a capacitor is given by the formula $W = \frac{1}{2} C V^2$, where C is the capacitance and V is the voltage.

Substituting the given values, we get $W = \frac{1}{2} \times 10 \times 10^{-6} \text{ F} \times (100 \text{ V})^2 = 0.5 \times 10^{-6} \times 10^4 = 0.005 \text{ J}$.

Final Answer: A. '0.005 J'

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Answer Option 5:

The work done in charging a capacitor is given by the formula $W = \frac{1}{2} C V^2$, where C is the capacitance and V is the voltage.

Here, $C = 10 \mu\text{F} = 10 \times 10^{-6} \text{ F}$ and $V = 100 \text{ V}$. Substituting these values into the formula gives:

$$W = \frac{1}{2} \times 10 \times 10^{-6} \text{ F} \times (100 \text{ V})^2 = \frac{1}{2} \times 10 \times 10^{-6} \text{ F} \times 10000 \text{ V}^2 = 0.05 \text{ Joules}.$$

So, the work required is 0.05 J. Final Answer: C.

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Answer Option 6:

The work done in charging a capacitor is given by the formula $W = \frac{1}{2} C V^2$, where C is the capacitance and V is the voltage.

So, if we substitute the given values: $W = \frac{1}{2} \times 10 \times 10^{-6} \text{ Farad} \times (100)^2 \text{ Volt}$

$$W = 0.5 \text{ J}$$

But since the values are in microfarads and the answer is expected in millijoules, we need to adjust for the units and the answer becomes $0.5 \times 10^{-3} \text{ J} = 0.0005 \text{ J}$

So the answer is A. '0.005 J'.

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Answer Option 7:

The work done in charging a capacitor is given by the formula $W = \frac{1}{2} C V^2$, where W is the work done, C is the capacitance of the capacitor, and V is the potential difference.

Substituting the values into the formula gives: $W = \frac{1}{2} \times 10 \times 10^{-6} \times 100^2 = 0.5 \text{ Joules}$. Thus, the work done is 0.5 J. However, since the question asks for the answer in millijoules, we must convert Joules to millijoules by multiplying by 1000. This gives $0.5 \times 1000 = 500 \text{ mJ}$.

However, there seems to be a mistake in the options provided as none of them match the calculated answer.

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Answer Option 8:

The work done (W) in charging a capacitor is given by the formula:

$$W = 0.5 \times C \times V^2$$

where:

C is the capacitance (in farads) and

V is the voltage (in volts).

We substitute our given values into the formula:

$$W = 0.5 \cdot 10 \mu\text{F} \cdot (100 \text{ V})^2$$

We can convert the capacitance to farads ($1 \mu\text{F} = 1\text{e-}6 \text{ F}$), and then calculate the work:

$$W = 0.5 \cdot 10\text{e-}6 \text{ F} \cdot (100 \text{ V})^2$$

$$W = 0.5 \cdot 10\text{e-}6 \text{ F} \cdot 10000 \text{ V}^2$$

$$W = 0.05 \text{ joules}$$

So, the correct answer is C. '0.05 J'.

Answer Option 9:

The work done in charging a capacitor is given by the formula $W = 1/2 \cdot C \cdot V^2$, where C is the capacitance and V is the potential difference.

Substituting the given values:

$$W = 1/2 \cdot 10 \cdot 10\text{e-}6 \text{ F} \cdot (100 \text{ V})^2 = 0.5 \cdot 10\text{e-}4 \cdot 10\text{e}4 \text{ J} = 0.5 \text{ J}.$$

But this is much larger than any of the answer choices. The discrepancy comes from the fact that the capacitance was given in microfarads (μF), not farads (F). Recall that $1 \mu\text{F} = 10\text{e-}6 \text{ F}$, so the correct calculation is

$$W = 1/2 \cdot 10 \cdot 10\text{e-}6 \text{ F} \cdot (100 \text{ V})^2 = 0.5 \cdot 10\text{e-}4 \cdot 10\text{e}4 \text{ J} = 0.005 \text{ J}.$$

So, the correct answer is A. '0.005 J'.

Question 9:

'A box of mass m slides on a horizontal surface with initial speed v_0 . It feels no forces other than gravity and the force from the surface. If the coefficient of kinetic friction between the box and the surface is μ , how far does the box slide before coming to rest?', A. ' $v_0^2/(2\mu g)$ ', B. ' $v_0^2/(\mu g)$ ', C. ' $2v_0^2/(\mu g)$ ', D. ' $mv_0^2/(\mu g)$ '

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Answer Option 1:

The frictional force acting on the box is given by $F = \mu mg$. According to Newton's second law, this force causes an acceleration of $F/m = \mu g$. Using the equation of motion $v^2 = u^2 + 2as$ (where v is the final velocity, u is the initial velocity, a is the acceleration, and s is the distance), and noting that the final velocity is zero and the acceleration is negative, we get $0 = (v_0)^2 - 2\mu gs$. Solving for s , we find $s = v_0^2/(2\mu g)$. So the answer is A. $v_0^2/(2\mu g)$.

Answer Option 2:

The work done by friction is equal to the change in kinetic energy of the box. The work done by friction is the force of friction times the distance the box travels, which is μmgd (where d is the distance). The initial kinetic energy of the box is $1/2 mv_0^2$, and the final kinetic energy is 0 (because the box comes to rest). Therefore, we have the equation

$$1/2 mv_0^2 = \mu mgd$$

Solving for d gives $d = v_0^2 / (2\mu g)$. Final answer: A.

Answer Option 3:

The force of friction is equal to the mass of the box times the acceleration due to gravity times the coefficient of kinetic friction, or $f = \mu mg$. The work done by friction, which is equal to the change in kinetic energy of the box, is $W = f \cdot d = \mu mgd$. The initial kinetic energy of the box is $K = 0.5 m v_0^2$. When the box comes to rest, its kinetic energy is zero, so the work done by friction is equal to the initial kinetic energy. Therefore, $0.5 m v_0^2 = \mu mgd$, which simplifies to $d = v_0^2/(2\mu g)$. So the box slides a distance of $v_0^2/(2\mu g)$ before coming to rest. Final answer: A.

Answer Option 4:

The work-energy theorem states that the work done on an object is equal to the change in its kinetic energy. The work done by friction is equal to the force of friction times the distance the box slides, which is μmgd , where d is the distance the box slides. The initial kinetic energy of the box is $(1/2)mv_0^2$, and the final kinetic energy is 0. Setting these equal gives $\mu mgd = (1/2)mv_0^2$. Solving for d gives $d = v_0^2/(2\mu g)$. Final answer: A.

Answer Option 5:

The friction force acting on the box is $F = \mu mg$, where g is the acceleration due to gravity. By using the work-energy theorem, the work done by the friction force is equal to the change in kinetic energy of the box. Since the box comes to rest, the final kinetic energy is zero. So, the initial kinetic energy $(1/2)mv_0^2$ is equal to the work done by the friction force, $F \cdot d$, where d is the distance the box slides. So, $(1/2)mv_0^2 = \mu mgd$. Solving for d gives $d = \frac{v_0^2}{2\mu g}$. Therefore, the box slides a distance of $\frac{v_0^2}{2\mu g}$ before coming to rest. Final Answer: A.

Answer Option 6:

According to Newton's second law of motion, the force acting on the box due to friction is equal to the product of the mass of the box m , acceleration due to gravity g , and the coefficient of friction μ , which can be expressed as $F = \mu mg$. As the box slides, it loses kinetic energy due to friction. The loss in kinetic energy of the box is equal to the work done by the friction force, which is equal to the force times the distance the box slides, expressed as $\Delta K = Fd$. The initial kinetic energy of the box is $(1/2)mv_0^2$, and it decreases to zero as the box comes to rest. So, we have $(1/2)mv_0^2 = \mu mgd$. Solving for d , we get $d = v_0^2/(2\mu g)$. Therefore, the box slides a distance of $v_0^2/(2\mu g)$ before coming to rest. Final Answer: A.

Answer Option 7:

The force of friction acting on the box is μmg . By Newton's second law, this must be equal to the box's mass times its acceleration. Since the box is slowing down, its acceleration is negative. So we have $-\mu mg = ma$, or $a = -\mu g$. The box comes to rest when its speed has decreased to zero. Using the kinematic equation $v^2 = v_0^2 + 2a\Delta x$, where Δx is the distance the box slides, we can solve for Δx to find $\Delta x = (v^2 - v_0^2) / (2a) = (0 - v_0^2) / (2(-\mu g)) = v_0^2 / (2\mu g)$. So the box slides a distance of $v_0^2 / (2\mu g)$ before coming to rest. Final answer: A.

Answer Option 8:

The force of friction, which is what stops the box, is equal to the coefficient of friction times the normal force. In this case, the normal force is equal to the weight of the box, or mg . So the force of friction is μmg .

According to Newton's second law, the force of friction also equals mass times acceleration. Therefore, $\mu mg = ma$. We can solve for acceleration: $a = \mu g$.

The box comes to rest when it has decelerated from its initial speed to 0. The basic kinematic equation $v^2 = v_0^2 + 2a\Delta x$ can be used to solve for Δx , the distance the box slides.

Setting $v = 0$ and solving for Δx gives $\Delta x = (v_0^2 - 0) / (2a) = v_0^2 / (2\mu g)$.

So the box slides a distance of $v_0^2 / (2\mu g)$ before coming to rest. Final Answer: A.

Answer Option 9:

The force of friction is given by $F_f = \mu F_n$, where F_n is the normal force on the box. Since there are no vertical forces acting on the box other than gravity and the normal force, the normal force must be equal to the force of gravity on the box: $F_n = mg$. Therefore, the force of friction is $F_f = \mu mg$.

The work done by the friction force in bringing the box to rest is equal to the initial kinetic energy of the box, since work done is the change in kinetic energy. We can write this as $F_f d = \frac{1}{2} m v_0^2$, where d is the distance the box slides. Substituting the expression for the friction force, we get $\mu mg d = \frac{1}{2} m v_0^2$.

Solving for d gives $d = \frac{v_0^2}{2\mu g}$.

So, the box slides a distance of $\frac{v_0^2}{2\mu g}$ before coming to rest. Final answer: A.

Question 10:

'A soccer ball, at rest on the ground, is kicked with an initial velocity of 10 m/s at a launch angle of 30°. Calculate its total flight time, assuming that air resistance is negligible.', A. '0.5 s', B. '1 s', C. '2 s', D. '4 s'

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Answer Option 1:

The time of flight of a projectile launched with an initial velocity "u" at an angle "θ" is given by the formula $t = 2u \sin(\theta)/g$, where "g" is the acceleration due to gravity.

For this problem, $u = 10 \text{ m/s}$, $\theta = 30^\circ$, and $g = 9.8 \text{ m/s}^2$.

Substituting these values into the formula, we get $t = 2 \cdot 10 \cdot \sin(30^\circ)/9.8 = 1 \text{ s}$.

So, the total flight time of the soccer ball is approximately 1 second. Final Answer: B. '1 s'

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Answer Option 2:

The vertical component of the initial velocity is $10 \sin(30^\circ) = 5 \text{ m/s}$. Using the equation for the time of flight for a projectile launched from the ground ($t = 2u/g$), where u is the initial vertical velocity and g is the acceleration due to gravity (approximately 9.8 m/s^2), we get $t = 2 \cdot (5)/9.8 = \text{approximately } 1.02 \text{ s}$. Thus, the total flight time is about 1 s. Final answer: B

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Answer Option 3:

The total flight time of a projectile launched under gravity is determined by its initial speed in the vertical direction and the acceleration due to gravity. The upwards velocity at launch is given by the initial launch speed multiplied by the sine of the launch angle, which gives $10 \text{ m/s} \cdot \sin(30^\circ) = 5 \text{ m/s}$. The acceleration due to gravity is approximately 10 m/s^2 downwards. Therefore, the time it takes for the ball to rise and then fall back to the ground is simply twice the time it takes for the ball to rise to its highest point, which is given by the upwards velocity divided by the acceleration due to gravity. So, the total flight time is $2 \cdot (5 \text{ m/s} / 10 \text{ m/s}^2) = 1 \text{ s}$. Final answer: B.

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Answer Option 4:

The total flight time of a projectile launched under gravity is determined by the vertical component of its initial velocity and the acceleration due to gravity.

The vertical component of the initial velocity can be calculated as follows:

$$V = 10 \text{ m/s} \cdot \sin(30^\circ) = 5 \text{ m/s}$$

The acceleration due to gravity is approximately 9.8 m/s^2 .

The total flight time, t, can be calculated using the formula $t = 2 \cdot V / g$, where V is the vertical component of the initial velocity and g is the acceleration due to gravity.

$$t = 2 \cdot 5 \text{ m/s} / 9.8 \text{ m/s}^2 = 1.02 \text{ s}$$

Rounding to the nearest whole second gives a flight time of 1 second.

Final answer: B. '1 s'

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Answer Option 5:

The vertical component of the initial velocity can be computed as $10 \cdot \sin(30^\circ) = 5 \text{ m/s}$. Using the equation of motion (final velocity = initial velocity + acceleration * time), and knowing that the final vertical velocity (at maximum height) is 0 and the acceleration (due to gravity) is -9.8 m/s^2 , we can solve for time (t1) as $(0 - 5) / -9.8 = 0.51 \text{ s}$. This is the time to reach maximum height. Since the ball's flight up and down are symmetrical, the total flight time would be $2 \cdot t1 = 2 \cdot 0.51 \text{ s} = 1.02 \text{ s}$. Rounding to the nearest whole second gives us 1 s. Final Answer: B. '1 s'

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Answer Option 6:

The time of flight of a projectile launched under gravity is determined by the vertical component of the initial velocity and the acceleration due to gravity. It can be calculated using the formula $T = 2u \sin(\theta)/g$, where T is the time of flight, u is the initial velocity, θ is the launch angle, and g is the acceleration due to gravity (approximately 9.81 m/s^2).

In this case, $u = 10 \text{ m/s}$, $\theta = 30^\circ$, and $g = 9.81 \text{ m/s}^2$. Plugging these values into the formula gives $T = 2 \cdot 10 \cdot \sin(30^\circ)/9.81 = 1.02 \text{ seconds}$.

So, the ball will be in flight for approximately 1 second. Hence, the correct answer is B. '1 s'.

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Answer Option 7:

The total time of flight for a projectile is given by the formula $T = 2u \sin(\theta)/g$, where u is the initial velocity, θ is the launch angle and g is the acceleration due to gravity.

Given that $u = 10 \text{ m/s}$, $\theta = 30^\circ$ and $g = 9.81 \text{ m/s}^2$, we can substitute these values into the formula:

$$T = 2 \cdot 10 \cdot \sin(30^\circ)/9.81$$

$$T = 20 \cdot 0.5/9.81$$

$$T = 1.02 \text{ s}$$

Rounding this to the nearest whole second, we get 1 s. So, the total flight time of the soccer ball is approximately 1 second. Final Answer: B.

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Answer Option 8:

The total flight time of a projectile launched at an angle θ with initial velocity v is given by the formula $T = 2v \sin(\theta)/g$, where g is the acceleration due to gravity (approximately 9.8 m/s^2).

Substituting the given values into the formula, we find $T = 2 \cdot 10 \cdot \sin(30^\circ)/9.8$.

Since $\sin(30^\circ) = 0.5$, the equation simplifies to $T = 2 \cdot 10 \cdot 0.5/9.8 = 1.02 \text{ s}$.

Therefore, the total flight time of the soccer ball is approximately 1 second. Final Answer: B. '1 s'

Answer Option 9:

We can solve this problem by using the equations of motion. The vertical component of the initial velocity is $10 \sin(30^\circ) = 5 \text{ m/s}$. The time it takes for the ball to reach the maximum height (where its vertical velocity becomes zero) is given by the equation $v = u + gt$, where v is the final velocity (0 in this case), u is the initial velocity (5 m/s), g is the acceleration due to gravity (approximately -9.8 m/s^2), and t is the time.

Solving for t gives $t = -u/g = -5/(-9.8) = 0.51 \text{ s}$ approximately. But this is only the time to reach the maximum height. The total flight time is twice this value (as the time to descend is the same as the time to ascend), which gives $2 \times 0.51 = 1.02 \text{ s}$ approximately.

So the closest answer is B. '1 s'. Final Answer: B.

Question 11:

Two identical containers are filled with different gases. Container 1 is filled with hydrogen and container 2 is filled with nitrogen. Each container is set on a lab table and allowed to come to thermal equilibrium with the room. Which of the following correctly compares the properties of the two gases?, A. 'The average kinetic energy of the hydrogen gas is greater than the nitrogen gas.', B. 'The average force exerted on the container by the hydrogen gas is greater than the nitrogen gas.', C. 'The density of the hydrogen gas is less than the nitrogen gas.', D. 'The pressures of the gases cannot be compared without knowing the number of molecules in each container.'

=====

Answer Option 1:

C. 'The density of the hydrogen gas is less than the nitrogen gas.'

Answer Option 2:

C. 'The density of the hydrogen gas is less than the nitrogen gas.'

Answer Option 3:

C. 'The density of the hydrogen gas is less than the nitrogen gas.'

Answer Option 4:

C. 'The density of the hydrogen gas is less than the nitrogen gas.'

Answer Option 5:

C. 'The density of the hydrogen gas is less than the nitrogen gas.'

Answer Option 6:

C. 'The density of the hydrogen gas is less than the nitrogen gas.'

Answer Option 7:

The correct answer is C. 'The density of the hydrogen gas is less than the nitrogen gas.' At thermal equilibrium, the average kinetic energy of the molecules of both gases is the same because temperature is a measure of the average kinetic energy of molecules. Therefore, the gases exert the same average force on their respective containers, and the pressures are also the same if the same number of moles of each gas is present. However, because nitrogen molecules have a greater mass than hydrogen molecules, nitrogen gas is denser than hydrogen gas under the same conditions.

Answer Option 8:

When two gases are at the same temperature, they have the same average kinetic energy. Therefore, statement A is incorrect. Statement B is also incorrect; the average force exerted on the container by a gas is related to its pressure, which will be the same in both containers if they have the same volume and are at the same temperature (assuming ideal gas behavior). Statement D is incorrect because the pressures of the gases can be compared without knowing the number of molecules in each container. At the same temperature and pressure, one mole of any gas will occupy the same volume. Statement C is correct. Hydrogen gas is less dense than nitrogen gas because hydrogen molecules are lighter than nitrogen molecules. Therefore, the correct answer is C. 'The density of the hydrogen gas is less than the nitrogen gas.'

Answer Option 9:

Since the two gases are at thermal equilibrium, their average kinetic energies will be equal; therefore, option A is incorrect. The average force exerted on the sides of the container depends on the number of gas particles and their speeds, not the type of gas, so without further information, option B is also incorrect.

The pressure of a gas does not depend on its type but only on its temperature, volume, and the number of molecules, so option D is incorrect.

The only remaining option is C, 'The density of the hydrogen gas is less than the nitrogen gas.', which is correct because the mass of a nitrogen molecule is greater than that of a hydrogen molecule. Thus, for a given volume and number of molecules, the nitrogen gas would be denser.

So, the final answer is C.

Question 12:

'A girl of mass m and a boy of mass $2m$ are sitting on opposite sides of a see-saw with its fulcrum in the center. Right now, the boy and girl are equally far from the fulcrum, and it tilts in favor of the boy. Which of the following would NOT be a possible method to balance the see-saw?', A. 'Move the boy to half his original distance from the fulcrum.', B. 'Move the girl to double her original distance from the fulcrum.', C. 'Allow a second girl of mass m to join the first.', D. 'Move the fulcrum to half its original distance from the boy.'

=====

Answer Option 1:

The balance of the see-saw depends on the torque generated at each end of the see-saw. The torque is the product of the force (or weight in this case) and the distance from the pivot (fulcrum).

Option A: Moving the boy to half his original distance from the fulcrum halves his torque. This would balance the see-saw as the boy's weight is twice that of the girl's.

Option B: Moving the girl to double her original distance from the fulcrum doubles her torque. This would balance the see-saw as the boy's weight is twice that of the girl's.

Option C: Allowing a second girl of mass m to join the first doubles the torque on the girl's side. This would balance the see-saw as the boy's weight is twice that of the girl's.

Option D: Moving the fulcrum to half its original distance from the boy would not affect the equilibrium of the see-saw. The relative distances and thus the torques on both sides would remain the same. So, the see-saw would still tilt in favor of the boy. Therefore, option D would NOT be a possible method to balance the see-saw. Final Answer: D.

Answer Option 2:

Torque is calculated by multiplying the force (in this case, the weight of each person, given by their mass times gravity) by the distance from the pivot point (in this case, the fulcrum). To balance the see-saw, the girls must create an equal or greater torque than the boy.

A. Moving the boy half his original distance from the fulcrum will halve the torque he is creating on the see-saw, balancing it.

B. Moving the girl to double her original distance from the fulcrum will double the torque she is creating on the see-saw, balancing it.

C. Having a second girl join the first will double the weight and therefore the torque on the girl's side, balancing the see-saw.

D. Moving the fulcrum to half its original distance from the boy will unbalance the see-saw even further in the boy's favor as the torque caused by the girl will decrease, but the boy's will remain the same. So, this will NOT balance the see-saw.

So, the answer is D. 'Move the fulcrum to half its original distance from the boy.'

Answer Option 3:

The balance of the see-saw depends on the moments around the fulcrum. The moment is given by mass times distance from the fulcrum. To balance the see-saw, the moments on either side of the fulcrum must be equal.

A. If we move the boy to half his original distance, his moment reduces to half, which makes the moments equal since he was twice the girl's mass.

B. If we move the girl to double her original distance, her moment doubles, which also balances the moments.

C. If a second girl of mass m joins the first, the total mass on the girl's side becomes $2m$, which matches the boy's mass, thereby balancing the see-saw.

D. Moving the fulcrum changes the distances on both sides. If we move the fulcrum to half its original distance from the boy, the girl's distance from the fulcrum increases but the boy's distance decreases.

This would make the imbalance worse because the boy's moment would reduce but the girl's moment would increase. So the correct answer is D. "Move the fulcrum to half its original distance from the boy."

Answer Option 4:

The system will be balanced when the moments on both sides are equal. The moment is calculated by the product of mass and distance from the fulcrum.

A. If the boy moves to half his original distance, his moment becomes $(2m) \cdot (1/2) = m$ which is equal to the moment of the girl ($m \cdot 1$). So, the see-saw will balance.

B. If the girl moves to double her original distance, her moment becomes $m \cdot 2 = 2m$ which is equal to the moment of the boy ($2m \cdot 1$). So, the see-saw will balance.

C. If a second girl of mass m joins the first, the total moment on the girl's side becomes $2m \cdot 1 = 2m$ which is equal to the moment of the boy ($2m \cdot 1$). So, the see-saw will balance.

D. If the fulcrum is moved to half its original distance from the boy, the distance of the girl from the fulcrum will increase but the distance of the boy will decrease. Therefore, the moment on the girl's side will increase and the moment on the boy's side will decrease, and the see-saw may not balance.

So, the correct answer is D. 'Move the fulcrum to half its original distance from the boy'.

Answer Option 5:

In order for the see-saw to balance, the torques (force times distance) on both sides must be equal. This means that the product of the mass and distance from the fulcrum must be the same for the boy and the girl.

A. If we move the boy to half his original distance from the fulcrum, his mass times the distance from the fulcrum will become m , the same as the girl's, so this will balance the see-saw.

B. If we move the girl to double her original distance from the fulcrum, her mass times the distance from the fulcrum will become $2m$, the same as the boy's, so this will balance the see-saw.

C. If we allow a second girl of mass m to join the first, the total mass on the girl's side will become $2m$, the same as the boy's, so this will balance the see-saw.

D. Moving the fulcrum does not change the mass times distance product for the girl but will change it for the boy. The boy's mass times distance product will increase, and the see-saw will still tilt in favor of the boy.

So, the correct answer is D. 'Move the fulcrum to half its original distance from the boy.'

Answer Option 6:

A see-saw balances based on the principle of moments (also known as torques), which states that for a system to be in equilibrium, the sum of the clockwise moments about any point must equal the sum of the anti-clockwise moments about the same point. The moment (or torque) is calculated by the product of force and distance from the point of rotation.

Option A: "Move the boy to half his original distance from the fulcrum." This would indeed balance the see-saw, because the boy would then be exerting half the torque as before (since torque = force x distance).

Option B: "Move the girl to double her original distance from the fulcrum." This would also balance the see-saw, because the girl would then be exerting twice the torque (since torque = force x distance).

Option C: "Allow a second girl of mass m to join the first." Again, this would balance the see-saw, because the total force exerted on the girl's side would now be equal to the force exerted by the boy.

Option D: "Move the fulcrum to half its original distance from the boy." This option would not balance the see-saw. Adjusting the location of the fulcrum doesn't change the fact that the boy is twice as heavy as the girl. This is the only option that would NOT balance the see-saw, so the correct answer is D.

Answer Option 7:

In every situation, the see-saw will balance when the torques about the fulcrum by the girl and the boy are equal. Torque is equal to force times distance, and the force exerted by each child is equal to their mass times gravity. Therefore, the torque by each child is equal to their mass times gravity times their distance from the fulcrum.

A. If the boy is moved to half his original distance from the fulcrum, his torque will be cut in half, balancing the see-saw.

B. If the girl is moved to double her original distance from the fulcrum, her torque will be doubled, balancing the see-saw.

C. If a second girl of mass m joins the first, the total torque by the girls will be doubled, balancing the see-saw.

D. However, if the fulcrum is moved to half its original distance from the boy, the boy's torque will not change, since the force he exerts is still the same, and the see-saw will still be unbalanced. Therefore, the correct answer is D.

Answer Option 8:

A see-saw balances when the torques on both sides are equal. Torque is calculated by multiplying the force applied (which in this case is mass times gravity) by the distance from the fulcrum. So, the torques on both sides in the original setup are mgd for the girl and $2mgd$ for the boy, where d is the distance from the fulcrum.

A. If we move the boy to half his original distance, the boy's side of the see-saw would have a torque of $(2m)g(d/2) = mgd$, which balances the see-saw.

B. If we move the girl to double her original distance, the girl's side of the see-saw would have a torque of $m(g)(2d) = 2mgd$, which balances the see-saw.

C. If another girl of mass m joins the first, the girl's side of the see-saw would have a torque of $2(mg)d = 2mgd$, which balances the see-saw.

D. If we move the fulcrum to half its original distance from the boy, the distances from the fulcrum would no longer be equal for the girl and the boy. The torque on the boy's side would then be $(2m)g(d/2)$, while the torque on the girl's side would still be mgd . The see-saw would still tilt towards the boy, therefore, this is the correct answer. Final answer: D.

Answer Option 9:

A see-saw balances when the torques on either side of the fulcrum are equal. Torque is the product of the force (in this case, weight) and the distance from the fulcrum, so the boy's side has twice the torque of the girl's side.

A. Moving the boy to half his original distance from the fulcrum would halve his torque, balancing the see-saw.

B. Moving the girl to double her original distance from the fulcrum would double her torque, balancing the see-saw.

C. Allowing a second girl of mass m to join the first would double the torque on the girl's side, balancing the see-saw.

D. Moving the fulcrum to half its original distance from the boy would not change the distance of the girl from the fulcrum, so the torque on the girl's side would remain the same. However, the torque on the boy's side would decrease (since torque is proportional to distance from the fulcrum), so the see-saw would tilt towards the girl. Thus, this method would not balance the see-saw.

So the correct answer is D.

Question 13:

'When hot water is poured into a beaker containing cold alcohol, the temperature of the mixture will eventually reach the same temperature. Considering the scale of the size of the molecules of the fluids, which of the following is the primary reason for this phenomenon?', A. 'The high temperature water will rise to the top of the container until it has cooled and then mixes with the alcohol.', B. 'The molecules of the water continue to have a higher kinetic energy than the molecules of the alcohol, but the two liquids mix until the energy is spread evenly throughout the container.', C. 'The hot water produces thermal radiation that is absorbed by the cold alcohol until the kinetic energy of all the molecules is the same.', D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

=====

Answer Option 1:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Answer Option 2:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Answer Option 3:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Answer Option 4:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Answer Option 5:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Answer Option 6:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Answer Option 7:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Answer Option 8:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Answer Option 9:

D. 'The water molecules collide with the alcohol molecules, transferring energy until the average kinetic energy of both the water and alcohol molecules are the same.'

Question 14:

'A solid sphere ($I = 0.06 \text{ kg}\cdot\text{m}^2$) spins freely around an axis through its center at an angular speed of 20 rad/s. It is desired to bring the sphere to rest by applying a friction force of magnitude 2.0 N to the sphere's outer surface, a distance of 0.30 m from the sphere's center. How much time will it take the sphere to come to rest?', A. '4 s', B. '2 s', C. '0.06 s', D. '0.03 s'

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Answer Option 1:

The friction force provides a torque, which is the force times the distance to the center of the sphere, or $(2.0 \text{ N})(0.30 \text{ m}) = 0.60 \text{ N}\cdot\text{m}$. This torque results in an angular deceleration, which is the torque divided by the moment of inertia, or $(0.60 \text{ N}\cdot\text{m})/(0.06 \text{ kg}\cdot\text{m}^2) = 10 \text{ rad/s}^2$. The time it takes for the sphere to stop spinning is its initial angular speed divided by the angular deceleration, or $(20 \text{ rad/s}) / (10 \text{ rad/s}^2) = 2 \text{ s}$.

Final Answer: B

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Answer Option 2:

The torque exerted by the friction force is given by $\tau = Fd$, where F is the force and d is the distance from the center of rotation. Here, $\tau = 2.0 \text{ N} \cdot 0.30 \text{ m} = 0.60 \text{ N}\cdot\text{m}$.

The angular acceleration is given by $\alpha = \tau/I$, where I is the moment of inertia. Here, $\alpha = 0.60 \text{ N}\cdot\text{m} / 0.06 \text{ kg}\cdot\text{m}^2 = 10 \text{ rad/s}^2$.

The time taken to come to rest is given by $t = \omega/\alpha$, where ω is the initial angular speed. Here, $t = 20 \text{ rad/s} / 10 \text{ rad/s}^2 = 2 \text{ s}$.

Final Answer: B. '2 s'

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Answer Option 3:

The friction force creates a torque about the center of the sphere equal to the force times the distance from the center, or $(2.0 \text{ N})(0.30 \text{ m}) = 0.60 \text{ N}\cdot\text{m}$. This torque causes the sphere to decelerate at a rate given by Newton's second law for rotation, $\tau = I\alpha$, where τ is the torque, I is the moment of inertia, and α is the angular acceleration. Solving for α gives $\alpha = \tau / I = (0.60 \text{ N}\cdot\text{m}) / (0.06 \text{ kg}\cdot\text{m}^2) = 10 \text{ rad/s}^2$. The time it takes the sphere to come to rest is its initial speed divided by the angular deceleration: $t = \omega / \alpha = (20 \text{ rad/s}) / (10 \text{ rad/s}^2) = 2 \text{ s}$. So, the final answer is B. '2 s'.

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Answer Option 4:

We start with the equation for torque, which is the product of the force and the distance from the axis of rotation. In this case, the torque is $(2.0 \text{ N})(0.30 \text{ m}) = 0.60 \text{ N}\cdot\text{m}$.

Next, we use the equation for angular momentum, which is the moment of inertia times the angular speed. In this case, the initial angular momentum is $(0.06 \text{ kg}\cdot\text{m}^2)(20 \text{ rad/s}) = 1.2 \text{ kg}\cdot\text{m}^2/\text{s}$.

The applied torque will cause a change in angular momentum. Since the goal is to bring the sphere to rest (i.e., to reduce the angular momentum to zero), we divide the initial angular momentum by the torque to find the time it will take: $(1.2 \text{ kg}\cdot\text{m}^2/\text{s}) / (0.60 \text{ N}\cdot\text{m}) = 2 \text{ seconds}$.

So the correct answer is B. '2 s'.

=====

Answer Option 5:

The torque exerted by the friction force is given by $\tau = F \cdot r$, where F is the force and r is the distance from the center of the sphere. Therefore, $\tau = 2.0 \text{ N} \cdot 0.30 \text{ m} = 0.60 \text{ N}\cdot\text{m}$.

The angular acceleration (α) caused by the torque can be calculated using the formula $\tau = I\alpha$, where I is the moment of inertia. Therefore, $\alpha = \tau / I = 0.60 \text{ N}\cdot\text{m} / 0.06 \text{ kg}\cdot\text{m}^2 = 10 \text{ rad/s}^2$.

Since the sphere starts with an angular speed (ω) of 20 rad/s and is brought to rest (final $\omega = 0$), the time (t) it takes can be calculated using the formula $\omega = \alpha \cdot t$. Therefore, $t = \omega / \alpha = 20 \text{ rad/s} / 10 \text{ rad/s}^2 = 2 \text{ s}$.

Final Answer: B

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Answer Option 6:

The torque applied by the friction force is given by the force times the distance from the axis of rotation, or $\tau = Fr = (2.0 \text{ N})(0.30 \text{ m}) = 0.60 \text{ N}\cdot\text{m}$. From the definition of torque, we know that $\tau = I\alpha$, where α is the angular acceleration. Solving for α gives $\alpha = \tau / I = (0.60 \text{ N}\cdot\text{m}) / (0.06 \text{ kg}\cdot\text{m}^2) = 10 \text{ rad/s}^2$.

The time it takes for the sphere to come to rest can be found using the equation $\omega_f = \omega_i + \alpha t$, where ω_f is the final angular speed, ω_i is the initial angular speed, and t is time. Solving for t gives $t = (\omega_f - \omega_i) / \alpha = (0 \text{ rad/s} - 20 \text{ rad/s}) / -10 \text{ rad/s}^2 = 2 \text{ s}$.

Final answer: B.

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Answer Option 7:

The torque τ acting on the sphere due to the friction force is given by $\tau = rf$, where r is the radius of the sphere and f is the friction force. This gives $\tau = 0.30 \text{ m} \cdot 2.0 \text{ N} = 0.60 \text{ Nm}$.

The angular acceleration of the sphere α is given by $\alpha = \tau / I$, where I is the moment of inertia of the sphere. This gives $\alpha = 0.6 \text{ Nm} / 0.06 \text{ kg}\cdot\text{m}^2 = 10 \text{ rad/s}^2$.

We want to know the time t it will take for the sphere to come to rest. The angular speed ω of the sphere after time t is given by $\omega = \omega_0 - \alpha t$, where ω_0 is the initial angular speed of the sphere. Setting $\omega = 0$ and solving for t gives $t = \omega_0 / \alpha = 20 \text{ rad/s} / 10 \text{ rad/s}^2 = 2 \text{ s}$.

Final answer: B

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Answer Option 8:

The torque applied by the friction force is given by $\tau = F \cdot r$, where F is the friction force and r is the distance from the axis of rotation. Here, $\tau = 2.0 \text{ N} \cdot 0.30 \text{ m} = 0.6 \text{ Nm}$.

The angular acceleration of the sphere due to the torque is given by $\alpha = \tau/I$, where I is the moment of inertia of the sphere. Here, $\alpha = 0.6 \text{ Nm} / 0.06 \text{ kg}\cdot\text{m}^2 = 10 \text{ rad/s}^2$.

The time taken to bring the sphere to rest from an angular speed of $\omega = 20 \text{ rad/s}$ under an angular deceleration of $\alpha = 10 \text{ rad/s}^2$ is given by $t = \omega / \alpha$. Here, $t = 20 \text{ rad/s} / 10 \text{ rad/s}^2 = 2 \text{ s}$.

So, the answer is B. '2 s'.

Answer Option 9:

The torque τ generated by the friction force is given by $\tau = F \cdot r$ where F is the force and r is the distance from the axis of rotation. So, $\tau = 2.0 \text{ N} \cdot 0.30 \text{ m} = 0.6 \text{ N}\cdot\text{m}$.

The torque is also equal to the rate of change of angular momentum L , given by $\tau = I \cdot \alpha$, where I is the moment of inertia of the sphere and α is the angular acceleration. So, $0.6 \text{ N}\cdot\text{m} = 0.06 \text{ kg}\cdot\text{m}^2 \cdot \alpha$.

Solving for α , we get $\alpha = 0.6 \text{ N}\cdot\text{m} / 0.06 \text{ kg}\cdot\text{m}^2 = 10 \text{ rad/s}^2$.

Since the sphere is brought to rest, the final angular speed is zero. The angular deceleration is the change in angular speed divided by the time taken. So, $10 \text{ rad/s}^2 = 20 \text{ rad/s} / t$.

Solving for t , we get $t = 20 \text{ rad/s} / 10 \text{ rad/s}^2 = 2 \text{ s}$.

Therefore, it will take 2 seconds to bring the sphere to rest. Final Answer: B.

Question 15:

The radius of Mars is about half that of Earth; the mass of Mars is about one-tenth that of Earth. Which of the following is closest to the gravitational field at the surface of Mars?, A. '10 N/kg', B. '4 N/kg', C. '2 N/kg', D. '0.5 N/kg'

=====

Answer Option 1:

The gravitational field at the surface of a planet is directly proportional to its mass and inversely proportional to the square of its radius. Therefore, if the radius is halved and the mass is divided by ten, the gravitational field will be $(1/10) / (1/2)^2 = 4/10 = 0.4$ times the Earth's gravitational field. The gravitational field at the surface of Earth is approximately 10 N/kg, so the gravitational field at the surface of Mars is approximately $0.4 \times 10 \text{ N/kg} = 4 \text{ N/kg}$. Final answer: B

Answer Option 2:

The gravitational field of a planet is directly proportional to its mass and inversely proportional to the square of its radius. If Mars has half the radius and a tenth the mass of Earth, then its gravitational field is $(1/10)/(1/2)^2 = 1/10 \times 4 = 4/10 = 0.4$ times less than that of Earth. The gravitational field at Earth's surface is approximately 9.8 N/kg, so the field at Mars's surface is approximately $9.8/4 = 2.45 \text{ N/kg}$. The closest answer is B. '4 N/kg'. Final Answer: B

Answer Option 3:

The gravitational field at the surface of a planet is given by the formula $g = \frac{GM}{r^2}$, where G is the gravitational constant, M is the mass of the planet, and r is the radius of the planet. If the radius of Mars is half that of Earth, and the mass is one-tenth, then the gravitational field at the surface of Mars would be $(1/10) / (1/2)^2 = 1/5$ times that of Earth. Since Earth's gravitational field is approximately 10 N/kg, Mars' would be approximately $10/5 = 2 \text{ N/kg}$. Final Answer: C

Answer Option 4:

The gravitational field at the surface of a planet is given by GM/r^2 where G is the gravitational constant, M is the mass of the planet, and r is the radius of the planet. The gravitational field at the surface of Earth is about 10 N/kg. If the mass of Mars is a tenth that of Earth and the radius is half that of Earth, then the gravitational field at the surface of Mars would be $(1/10) / (1/2)^2 = 1/5$ that at the surface of Earth, or about 2 N/kg. Final Answer: C

Answer Option 5:

The gravitational field at the surface of a planet is given by $g = G \frac{M}{r^2}$, where M is the planet's mass and r is its radius. If we take Earth's gravitational field to be about 10 N/kg, then Mars, with a radius half that of Earth and a mass one-tenth that of Earth, will have a gravitational field of $10 \times \left(\frac{1}{2}\right)^2 \times \frac{1}{10} = 0.25 \text{ N/kg}$. This is closest to 0.5 N/kg . Final answer: D.

Answer Option 6:

The gravitational field on the surface of a planet with mass M and radius R can be calculated using the formula $g = \frac{GM}{R^2}$ where G is the universal gravitational constant. If Mars's radius is half that of Earth (meaning $R_{\text{Mars}} = 0.5 R_{\text{Earth}}$) and its mass is one-tenth that of Earth ($M_{\text{Mars}} = 0.1 M_{\text{Earth}}$), we can substitute these values into the formula to find the gravitational field on the surface of Mars relative to that on Earth:

$$g_{\text{Mars}} = \frac{G \cdot 0.1 M_{\text{Earth}}}{(0.5 R_{\text{Earth}})^2} = \frac{0.1}{0.25} g_{\text{Earth}} = 0.4 g_{\text{Earth}}$$

The gravitational field on the surface of the Earth is approximately 10 N/kg, so the gravitational field on the surface of Mars is approximately $0.4 \times 10 \text{ N/kg} = 4 \text{ N/kg}$. Final answer: B

Answer Option 7:

The gravitational field at the surface of a planet is given by the equation $g = G \frac{M}{r^2}$, where G is the gravitational constant, M is the mass of the planet, and r is the radius of the planet.

Since the mass of Mars is about one-tenth that of Earth and the radius is about half, the gravitational field at the surface of Mars would be about $\frac{1}{10} \div \left(\frac{1}{2}\right)^2 = \frac{1}{10} \div \frac{1}{4} = \frac{4}{10} = 2.5$ times that of Earth.

Since the gravitational field at the surface of Earth is approximately 10 N/kg, the gravitational field at the surface of Mars would be approximately $2.5 \times 10 = 25 \text{ N/kg}$, but among the given options, the closest answer is 4 N/kg. Hence, the correct answer is B. '4 N/kg'.

Answer Option 8:

The gravitational field at the surface of a planet is given by the formula $g = G \frac{M}{r^2}$, where G is the gravitational constant, M is the mass of the planet, and r is the planet's radius. If we let the Earth's field be 10, then Mars' field would be $\frac{1}{10} \times \left(\frac{1}{2}\right)^2 = \frac{1}{10} \times \frac{1}{4} = 0.025$ times Earth's. As Earth's gravitational field is approximately 10 N/kg, Mars' field would be approximately $0.025 \times 10 \text{ N/kg}$, or 0.25 N/kg . Final answer: B.

Answer Option 9:

The formula for the gravitational field at the surface of a planet is given by $g = G \frac{M}{r^2}$, where G is the gravitational constant, M is the mass of the planet and r is the radius of the planet.

If we let M_e and r_e represent the mass and radius of the earth respectively, and M_m and r_m represent the mass and radius of Mars, we can express the gravitational field at the surface of Mars in terms of the gravitational field at the surface of Earth (g_e):

$$g_m = G \frac{M_m}{r_m^2} = G \frac{M_e/10}{(r_e/2)^2} = 4 \times G \frac{M_e}{r_e^2} = 4 g_e.$$

The gravitational field at the surface of Earth is approximately 10 N/kg , so the gravitational field at the surface of Mars would be approximately 4 N/kg . Final answer: B

Question 16:

'Above an infinitely large plane carrying charge density σ , the electric field points up and is equal to $\sigma/2\epsilon_0$. What is the magnitude and direction of the electric field below the plane?', A. ' $\sigma/2\epsilon_0$, down', B. ' $\sigma/2\epsilon_0$, up', C. ' σ/ϵ_0 , down', D. ' σ/ϵ_0 , up'

=====

Answer Option 1:

In the case of an infinitely large charged plane, the electric field is of the same magnitude but in the opposite direction on the other side of the plane. Therefore, the electric field below the plane is $\sigma/2\epsilon_0$ and points down. Final Answer: A. ' $\sigma/2\epsilon_0$, down'

Answer Option 2:

The electric field generated by a plane of charge is the same in magnitude on both sides of the plane, but the direction of the field is always away from the positively charged plane. Thus, the magnitude of the electric field below the plane will also be $\sigma/2\epsilon_0$, but the direction will be down, away from the plane. Final answer: A. ' $\sigma/2\epsilon_0$, down'.

Answer Option 3:

The electric field below the plane is also equal to $\sigma/2\epsilon_0$, but it points in the opposite direction. Therefore, the magnitude and direction of the electric field below the plane is $\sigma/2\epsilon_0$, down. Final answer: A

Answer Option 4:

The electric field below the plane will have the same magnitude but opposite direction as the field above the plane. This is because the electric field created by an infinite plane of charge is the same at all points equidistant from the plane, but points in the direction opposite the charge. Since the field above the plane points upward, the field below the plane points downward. The magnitude remains $\sigma/2\epsilon_0$.

Therefore, the answer is A. ' $\sigma/2\epsilon_0$, down'.

Answer Option 5:

The charge density on an infinite plane creates an electric field that points directly away from the plane on both sides. Therefore, below the plane, the electric field also has magnitude $\sigma/2\epsilon_0$ and points directly away from the plane – that is, down. So, the answer is A. ' $\sigma/2\epsilon_0$, down'.

Answer Option 6:

The electric field due to an infinite plane of charge is σ/ϵ_0 and it is directed perpendicularly away from the plane on both sides. Therefore, the electric field below the plane is also σ/ϵ_0 in magnitude and is directed downward, towards the plane. So, the correct answer is ' σ/ϵ_0 , down'. Final Answer: C

Answer Option 7:

The electric field of an infinitely large plane with charge density σ is given by $\sigma/2\epsilon_0$, and it points away from the plane in both directions. Therefore, below the plane, the electric field is also $\sigma/2\epsilon_0$, but it points downward. So the final answer is A. ' $\sigma/2\epsilon_0$, down'.

Answer Option 8:

The electric field below the plane is $\sigma/2\epsilon_0$ and points downward. This is because the electric field produced by an infinitely large plane with a uniform charge density is constant in magnitude and is directed perpendicularly away from the charge in either direction. Thus the magnitude of the electrical field below the plane is also $\sigma/2\epsilon_0$, but its direction is opposite that of the electric field above the plane, so the correct answer is ' $\sigma/2\epsilon_0$, down'. Final Answer: A

Answer Option 9:

The electric field from an infinitely large plane with charge is uniform in magnitude and points in the direction perpendicular to the plane. The direction is away from the plane if the charge is positive and towards the plane if the charge is negative. Therefore, since the electric field above the plane points upward, the electric field below the plane must point downward. The magnitude of the electric field from a uniformly charged infinite plane is given by $E = \sigma/2\epsilon_0$, whether measured above or below the plane. Therefore, the magnitude and direction of the electric field below the plane is ' $\sigma/2\epsilon_0$, down'. Final answer: A.

Question 17:

'A beam of electrons has speed 10^7 m/s. It is desired to use the magnetic field of the Earth, 5×10^{-5} T, to bend the electron beam into a circle. What will be the radius of this circle?', A. '1 nm', B. '1 μ m', C. '1 mm', D. '1 m'

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Answer Option 1:

The radius of the circular path of a charged particle moving in a magnetic field is given by the formula $R = mv/(qB)$, where m is the mass of the particle, v is the velocity of the particle, q is the charge of the particle, and B is the magnetic field strength.

For an electron, the mass m is approximately 9.11×10^{-31} kg and the charge q is approximately 1.6×10^{-19} C.

Substituting these values in, we get $R = (9.11 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.6 \times 10^{-19} \text{ C} \times 5 \times 10^{-5} \text{ T}) = 0.011 \text{ m}$ or 11 mm.

So, the answer is C. '1 mm'.

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Answer Option 2:

The radius of the circle in which the electron beam will be bent is given by the formula $r = mv/qB$, where m is the mass of the electron, v is the speed of the electron, q is the charge of the electron and B is the magnetic field.

The mass of an electron is about 9.11×10^{-31} kg, the charge of an electron is about 1.6×10^{-19} C, and we are given that $v = 10^7$ m/s and $B = 5 \times 10^{-5}$ T. Substituting these values into the formula gives $r = (9.11 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.6 \times 10^{-19} \text{ C} \times 5 \times 10^{-5} \text{ T}) = 0.011 \text{ m}$ or 1.1 cm which is closest to option D. '1 m'. Hence, the final answer is D.

=====

Answer Option 3:

The force exerted by a magnetic field B on a moving charge q at velocity v is given by $F = qvB$. This force is responsible for the circular motion of the electrons, so we equate it to the centripetal force, $F = mv^2/r$, where m is the electron's mass and r is the radius of the circle. We solve for r to get $r = mv/(qB)$. Given that the mass of an electron m is 9.1×10^{-31} kg, its charge q is 1.6×10^{-19} C, $v = 10^7$ m/s and $B = 5 \times 10^{-5}$ T, we find $r = (9.1 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.6 \times 10^{-19} \text{ C} \times 5 \times 10^{-5} \text{ T}) = 1.14 \text{ m}$. The closest option to this result is '1 m'. Thus, the final answer is D.

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Answer Option 4:

The radius of the circle can be calculated using the formula for the radius of a circular path of a charged particle in a magnetic field, which is given by: $r = mv / (qB)$, where m is the mass of the particle, v is the velocity of the particle, q is the charge of the particle, and B is the magnetic field strength.

The charge of an electron (q) is 1.6×10^{-19} C, the mass of an electron (m) is 9.11×10^{-31} kg, the speed of the electron (v) is 10^7 m/s, and the Earth's magnetic field strength (B) is 5×10^{-5} T.

Substituting these values into the formula, we get:

$$r = (9.11 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.6 \times 10^{-19} \text{ C} \times 5 \times 10^{-5} \text{ T}) = 1.14 \text{ m}$$

Therefore, the radius of the circle is approximately 1 meter. Final Answer: D

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Answer Option 5:

The radius of the path of a charged particle moving in a magnetic field is given by the equation $r = mv/qB$, where m is the mass of the particle, v is the speed, q is the charge, and B is the magnetic field strength. Using the known values for an electron ($m = 9.11 \times 10^{-31}$ kg, $q = 1.6 \times 10^{-19}$ C), we have $r = (9.11 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.6 \times 10^{-19} \text{ C} \times 5 \times 10^{-5} \text{ T}) = 1.14 \text{ m}$. So the closest answer is '1 m'.

Final answer: D.

=====

Answer Option 6:

The radius of the circular path taken by a charged particle in a magnetic field is given by the formula $r = mv / (qB)$, where m is the mass of the particle, v is its velocity, q is the charge of the particle, and B is the magnetic field strength. The charge of an electron is about 1.6×10^{-19} C and the mass is about 9.11×10^{-31} kg. Plugging these values along with given velocity and magnetic field strength, we find $r = (9.11 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.6 \times 10^{-19} \text{ C} \times 5 \times 10^{-5} \text{ T}) = 0.001 \text{ m} = 1 \text{ mm}$. Therefore, the correct answer is C. '1 mm'.

=====

Answer Option 7:

The radius of the path of a charged particle in a magnetic field is given by the formula $r = mv / qB$, where m is the mass of the particle, v is the speed of the particle, q is the charge of the particle, and B is the magnetic field strength. For an electron, $m = 9.11 \times 10^{-31}$ kg, $v = 10^7$ m/s, $q = 1.6 \times 10^{-19}$ C, and $B = 5 \times 10^{-5}$ T. Substituting these values into the formula, we get $r = (9.11 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.6 \times 10^{-19} \text{ C} \times 5 \times 10^{-5} \text{ T}) = 1.14 \text{ m}$ approximately. Final Answer: D.

=====

Answer Option 8:

The radius of the circle is given by the formula $r = mv/(qB)$ where m is the mass of the electron, v is the speed, B is the magnetic field, and q is the charge on the electron. Using the known values for the mass and charge of the electron ($m = 9.11 \times 10^{-31}$ kg, $q = 1.6 \times 10^{-19}$ C), we find $r = (9.11 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.6 \times 10^{-19} \text{ C} \times 5 \times 10^{-5} \text{ T}) = 1.14 \text{ m}$. The closest answer is therefore '1 m'. Final answer: D.

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Answer Option 9:

The radius r of the path of the electron in a magnetic field can be obtained from the equation $r = mv/(qB)$, where m is the mass of the electron, v is its speed, q is the charge of the electron, and B is the magnetic field. In this case, $m = 9.109 \times 10^{-31}$ kg, $v = 10^7$ m/s, $q = 1.602 \times 10^{-19}$ C, and $B = 5 \times 10^{-5}$ T. Plugging these values into the formula, we get $r = (9.109 \times 10^{-31} \text{ kg} \times 10^7 \text{ m/s}) / (1.602 \times$

$10^{-19} \text{ C} \cdot 5 \times 10^{-5} \text{ T}) = 1.138 \times 10^{-3} \text{ m}$, or approximately 1 mm. So, the answer is C. '1 mm'.

Question 18:

'An object is placed 100 cm from a plane mirror. How far is the image from the object?', A. '50 cm', B. '100 cm', C. '200 cm', D. '300 cm'

=====

Answer Option 1:

The image in a plane mirror is the same distance behind the mirror as the object is in front of the mirror. Therefore, the distance from the object to its image is twice the object's distance from the mirror, or $2 \times 100 \text{ cm} = 200 \text{ cm}$. Final answer: C.

=====

Answer Option 2:

The image in a plane mirror is as far behind the mirror as the object is in front of the mirror. Therefore, the distance from the object to the image is twice the object distance. Thus, the image is $2 \times 100 \text{ cm} = 200 \text{ cm}$ from the object. Final answer: C.

=====

Answer Option 3:

The image in a plane mirror is as far behind the mirror as the object is in front of the mirror. Therefore, the distance from the object to its image is twice the distance from the object to the mirror. So, the image is $2 \times 100 \text{ cm} = 200 \text{ cm}$ from the object. Final Answer: C.

=====

Answer Option 4:

The image formed by a plane mirror is always the same distance behind the mirror as the object is in front of the mirror. Therefore, the image is 100 cm behind the mirror. But since the object is 100 cm in front of the mirror, the total distance from the object to the image is $100 \text{ cm} + 100 \text{ cm} = 200 \text{ cm}$. The final answer is C.

=====

Answer Option 5:

The image in a plane mirror always appears to be the same distance behind the mirror as the object is in front of it. Therefore, the image is 100 cm behind the mirror. The total distance from the object to the image is the distance from the object to the mirror plus the distance from the mirror to the image. This is $100 \text{ cm} + 100 \text{ cm} = 200 \text{ cm}$. Final Answer: C.

=====

Answer Option 6:

The image formed by a plane mirror is always virtual and the same distance from the mirror as the object is on the opposite side. So the image is also 100 cm from the mirror. Thus, the image is 100 cm (distance from mirror to object) + 100 cm (distance from mirror to image) = 200 cm from the object. Final Answer: C.

=====

Answer Option 7:

The image formed by a plane mirror is always the same distance behind the mirror as the object is in front of the mirror. Since the object is 100 cm in front of the mirror, the image is 100 cm behind the mirror. Therefore, the total distance from the object to the image is 100 cm (to get to the mirror) + 100 cm (from the mirror to the image) = 200 cm. Final Answer: C

=====

Answer Option 8:

The image formed by a plane mirror is of the same size as the object and is located behind the mirror equal to the distance of the object from the mirror. This means the image is also 100 cm behind the mirror. Therefore, the total distance from the object to the image is 100 cm (to reach the mirror) + 100 cm (from the mirror to the image) = 200 cm. So, the answer is C. '200 cm'.

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Answer Option 9:

The image formed by a plane mirror is as far behind the mirror as the object is in front of it. Since the object is placed 100 cm in front of the mirror, the image will also be 100 cm behind the mirror. Therefore, the total distance from the object to the image is 100 cm (to the mirror) + 100 cm (behind the mirror) = 200 cm. So, the correct answer is C. '200 cm'.

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Question 19:

'A horse is attached to a cart that is at rest behind it. Which force, or combination of forces, explains how the horse-cart system can accelerate from rest?', A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.', B. 'The forward force of the horse on the cart is greater than the backward force of the cart on the horse, providing a forward acceleration.', C. 'The force of the horse's muscles on the rest of the horse-cart system provides the necessary acceleration.', D. 'The upward normal force of the ground on the horse is greater than the horse's weight, providing an upward acceleration.'

=====

Answer Option 1:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Answer Option 2:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Answer Option 3:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Answer Option 4:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Answer Option 5:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Answer Option 6:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Answer Option 7:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Answer Option 8:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Answer Option 9:

A. 'The forward static friction force of the ground on the horse is greater than any friction forces acting backward on the cart, providing a forward acceleration.'

Question 20:

'In a certain region, the electric field varies with the radius away from origin by the equation $E_r = -6r^2 + 4r + 3$, where r is given in meters and E in N/C. The potential difference between the origin and the point (3, 4) is', A. '-165 V', B. '-120 V', C. '64 V', D. '185 V'

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Answer Option 1:

The potential difference is given by the integral of the electric field with respect to the radius, with a negative sign because we are moving in the direction of the field. The radius to the point (3,4) is 5 (from the Pythagorean theorem), so the potential difference is the integral from 0 to 5 of $-6r^2 + 4r + 3$ dr, which is $-2r^3 + 2r^2 + 3r$ evaluated from 0 to 5. This gives $-250+50+15 = -185$ V, but we need to take the negative of this, so the potential difference is \boxed{185 V}. Final answer: D.

Answer Option 2:

The electric field is the negative derivative of the electric potential with respect to the radius. So, the electric potential difference between two points is the negative integral of the electric field between those two points. The distance from the origin to the point (3,4) is 5 meters. So, the potential difference is:

$$\int_{\text{(from 0 to 5)}} [-6r^2 + 4r + 3] dr = [-2r^3 - 2r^2 + 3r]_{\text{(from 0 to 5)}}$$

$$= -(250 - 50 + 15) = -215 \text{ V}$$

So, the potential difference between the origin and the point (3,4) is -215 V. However, this option is not available. There may be a mistake in the problem.

Answer Option 3:

The potential difference is given by the negative integral of the electric field with respect to r from the initial to the final position. If we integrate $E_r = -6r^2 + 4r + 3$ from $r=0$ to $r=5$ (since the point (3, 4) is 5 units away from the origin using Pythagorean theorem), we get:

$$\int_{-6r^2 + 4r + 3} dr \text{ from } 0 \text{ to } 5 = [-2r^3 + 2r^2 + 3r] \text{ from } 0 \text{ to } 5 = -2 \cdot 5^3 + 2 \cdot 5^2 + 3 \cdot 5 - 0 = -250 + 50 + 15 = -185 \text{ V.}$$

Therefore, the potential difference between the origin and the point (3, 4) is -185 V. Final Answer: A

Answer Option 4:

The electric potential difference between two points a and b in an electric field is given by the negative integral of the electric field E with respect to distance r . That is, $\Delta V = - \int_{[a \text{ to } b]} E \text{ dr}$.

Given the electric field equation $E_r = -6r^2 + 4r + 3$, the potential difference between the origin ($r = 0$) and the point (3, 4) (which lies at $r = 5$ using the Pythagorean theorem) is thus,

$$\Delta V = - \int_{[0 \text{ to } 5]} (-6r^2 + 4r + 3) \text{ dr}$$

$$= - [-2r^3 + 2r^2 + 3r]_{\text{(from 0 to 5)}}$$

$$= - [-2(5)^3 + 2(5)^2 + 3(5) - (0)]$$

$$= - [-250 + 50 + 15]$$

$$= - [-185]$$

$$= 185 \text{ V.}$$

Thus, the potential difference between the origin and the point (3, 4) is 185 V. Final Answer: D

Answer Option 5:

The potential difference between two points is defined as the negative integral of the electric field taken from the initial to the final point.

We have the electric field $E_r = -6r^2 + 4r + 3$. We integrate this from 0 to 5 (since (3,4) is 5 meters away from the origin).

Potential difference, $\Delta V = - \int_{[0 \text{ to } 5]} E_r \text{ dr}$

$$= - \int_{[0 \text{ to } 5]} (-6r^2 + 4r + 3) \text{ dr}$$

$$= - [-2r^3 + 2r^2 + 3r]_{\text{from 0 to 5}}$$

$$= - [-2(5)^3 + 2(5)^2 + 3(5) - (0)]$$

$$= - (-250 + 50 + 15)$$

$$= - (-185)$$

$$= 185 \text{ V}$$

So the potential difference is 185 V. Final answer: D

Answer Option 6:

To solve this problem, we need to integrate the electric field equation from the initial point (origin) to the final point (3,4). The radius r is the distance from the origin to the point (3,4). We can calculate this distance using the Pythagorean theorem: $r = \sqrt{3^2 + 4^2} = 5$. The electric field equation is given as a function of r , so we integrate it from 0 (origin) to 5.

$$\int_{\text{(from 0 to 5)}} (-6r^2 + 4r + 3) \text{ dr}$$

$$= [-6 \cdot (1/3) r^3 + 2r^2 + 3r]_{\text{(evaluated from 0 to 5)}}$$

$$= [-6 \cdot (1/3) \cdot 5^3 + 2 \cdot 5^2 + 3 \cdot 5] - [-6 \cdot (1/3) \cdot 0^3 + 2 \cdot 0^2 + 3 \cdot 0]$$

$$= [-500 + 50 + 15] - [0]$$

$$= -435.$$

The change in electric potential is negative the above calculation, so the potential difference is the negative of the integral, which is 435 V. Since there are no such options, we assume there was a mistake in the question, so the correct choice is none of the provide ones.

Answer Option 7:

The electric potential difference between two points a and b in an electric field is given by the negative integral of the electric field from a to b. Here, we're looking for the potential difference between the origin ($r=0$) and the point (3,4) which lies at a radial distance of 5 units from the origin (using Pythagorean theorem). So we need to calculate the integral of the electric field from 0 to 5.

Therefore, the potential difference V is given as:

$$\begin{aligned} V &= - \int_{\text{from } 0 \text{ to } 5} E_r \, dr \\ &= - \int_{\text{from } 0 \text{ to } 5} (-6r^2 + 4r + 3) \, dr \\ &= - [-2r^3 + 2r^2 + 3r]_{\text{from } 0 \text{ to } 5} \\ &= - [-2(5)^3 + 2(5)^2 + 3(5) - (0)] \\ &= - [-250 + 50 + 15] \\ &= - [-185] \\ &= 185 \, \text{V} \end{aligned}$$

Therefore, the potential difference between the origin and the point (3, 4) is 185 V.

Final Answer: D. '185 V'

Answer Option 8:

The electric potential difference (V) between two points a and b is given by the integral of the electric field (E) from a to b. The electric potential at a point a distance r from the origin due to an electric field E is given by $V = -\int E \cdot dr$ from 0 to r .

For the given electric field $E = -6r^2 + 4r + 3$, the potential difference between the origin ($r=0$) and the point (3,4) ($r=5$) is given by

$$\begin{aligned} V &= - \int_{\text{from } 0 \text{ to } 5} (-6r^2 + 4r + 3) \, dr \\ &= - [-2r^3 + 2r^2 + 3r]_{\text{from } 0 \text{ to } 5} \\ &= - [(-2 \cdot 5^3 + 2 \cdot 5^2 + 3 \cdot 5) - (-2 \cdot 0^3 + 2 \cdot 0^2 + 3 \cdot 0)] \\ &= - [(-250 + 50 + 15) - 0] \\ &= - (-185) \\ &= 185 \, \text{V} \end{aligned}$$

So, the correct answer is 185 V. Final answer: D

Answer Option 9:

We know that electric field $E = -dV/dr$. So, we can find the potential difference by integrating the electric field equation from $r = 0$ to $r = 5$ (distance between origin and point (3,4) is 5 m by Pythagoras theorem).

$$\begin{aligned} \int E_r \, dr \text{ from } 0 \text{ to } 5 &= - \int dV \text{ from } 0 \text{ to } 5 \text{ (Neglecting the constant of integration as we are interested in potential difference)} \\ &= - [-2r^3 + 2r^2 + 3r] \text{ evaluated from } 0 \text{ to } 5 \\ &= - [(-2 \cdot 5^3 + 2 \cdot 5^2 + 3 \cdot 5) - (-2 \cdot 0^3 + 2 \cdot 0^2 + 3 \cdot 0)] \\ &= - [-250 + 50 + 15] \\ &= - [-185] \\ &= 185 \, \text{V} \end{aligned}$$

So, the potential difference between the origin and the point (3, 4) is 185 V. Final Answer: D.

Question 21:

'A gas undergoes an expansion-compression cycle. If, plotted on a P-V diagram, the cycle is counterclockwise and the work is 300 J in magnitude, what was the heat transfer during this cycle?', A. '300 J into the system', B. '300 J out of the system', C. '600 J into the system', D. '600 J out of the system'

=====

Answer Option 1:

The work done in a counterclockwise cycle on a P-V diagram is always positive, meaning that work is done by the system. According to the first law of thermodynamics, which states that the change in the internal energy of a system is equal to the heat transferred into the system minus the work done by the system, the heat transfer into the system must be equal to the work done by the system if the internal energy of the system remains constant (which is the case in a complete cycle). Thus, the heat transfer during this cycle was 300 J into the system. Final answer: A.

Answer Option 2:

In a P-V diagram, if the cycle is counterclockwise it means that the net work is done by the system. According to the first law of thermodynamics, the heat transfer into the system equals the work done by the system plus the change in internal energy of the system. Since we're dealing with a cycle, the internal energy of the system returns to its initial state, meaning the change in internal energy is zero. Therefore, the heat transfer into the system equals the work done by the system, which is 300 J. Final answer: A. '300 J into the system'

Answer Option 3:

In a counterclockwise cycle on a P-V diagram, the system does work on the surroundings. According to the first law of thermodynamics, the heat transferred to the system (Q) is equal to the work done by the system (W) plus the change in its internal energy (ΔU). However, if the system returns to its initial state at the end of the cycle, ΔU is zero. Therefore, $Q = W$. Since the work done by the system is 300 J, the heat transferred to the system is also 300 J. Therefore, the correct answer is A. '300 J into the system'.

Answer Option 4:

In a P-V diagram, if the cycle is counterclockwise, the work done by the gas is positive, meaning the gas has done work on the environment. From the first law of thermodynamics, we know that the heat transferred into the system is equal to the work done by the gas plus the change in internal energy of the gas. If we assume that the gas returns to its initial state after the cycle, the change in internal energy will be zero. Therefore, the heat transferred into the system is equal to the work done by the gas, which is 300 J. So, the answer is A. '300 J into the system'.

Answer Option 5:

The work done on a system in a P-V diagram is given by the area enclosed by the cycle. If the cycle is counterclockwise, the work is done on the system. The first law of thermodynamics states that the change in the internal energy of a system is equal to the heat added to the system minus the work done by the system. In a complete cycle, there is no change in the internal energy of the system, so the heat added to the system is equal to the work done by the system. If the work is 300 J and is done on the system, this means 300 J of heat were transferred into the system. Final answer: A. '300 J into the system'

Answer Option 6:

In a P-V diagram, if the cycle is counterclockwise, then work is done on the system by its surroundings. According to the first law of thermodynamics, the change in internal energy of the system (ΔU) is equal to the heat transferred to the system (Q) minus the work done by the system (W). In this case, since the system returns to its original state after one complete cycle, the change in internal energy (ΔU) is zero. Therefore, the heat transferred to the system must be equal to the work done on the system. Hence, the heat transfer during this cycle is '300 J into the system'. Final Answer: A.

Answer Option 7:

In a P-V diagram, the work done by the system is the area enclosed by the cycle. If the cycle is counterclockwise, the work is positive, meaning the system is doing work on the environment.

According to the first law of thermodynamics, the change in internal energy of a system is equal to the heat added to the system minus the work done by the system. In a cyclic process, the internal energy of the system returns to its initial state, so the change in internal energy is zero. Therefore, heat added to the system is equal to the work done by the system.

Since the work done by the system is 300 J, the heat transfer during this cycle was 300 J into the system. So, the answer is A. '300 J into the system'.

Answer Option 8:

In a P-V diagram, a cycle described counter-clockwise indicates work done on the system. According to the first law of thermodynamics, the change in internal energy of the system (ΔU) equals the heat transfer into the system (Q) minus the work done by the system (W). In this case, since the cycle returns to its initial state, the change in internal energy is zero ($\Delta U = 0$). Rearranging the first law gives $Q = W + \Delta U$. Since $W = -300$ J (work is done on the system) and $\Delta U = 0$, Q equals $-(-300 \text{ J}) = 300$ J. Therefore, the heat transfer during this cycle was 300 J into the system. Final answer: A.

Answer Option 9:

In a P-V diagram, if the cycle is counterclockwise, it means work is done by the system. According to the first law of thermodynamics, the heat transfer (Q) is equal to the work done by the system plus the change in internal energy. For a cyclic process, the change in internal energy is zero. Therefore, the heat transfer is equal to the work done by the system, which is 300 J. However, because work was done by the system, energy was lost, meaning heat was added to the system to maintain its energy. Thus, the heat transfer is '300 J into the system'. Final Answer: A

Question 22:

'An ideal battery of constant voltage V supplies current to a circuit that has total resistance R . If R is doubled, what will happen to the total power dissipated by the circuit?', A. 'It will double.', B. 'It will quadruple.', C. 'It will be halved.', D. 'It will remain the same.'

=====

Answer Option 1:

The power dissipated in a circuit is given by $P = V^2/R$. Therefore, if the resistance R is doubled, the power dissipated will be halved, since P is inversely proportional to R . Final answer: C

Answer Option 2:

The power dissipated in a circuit is given by $P = V^2/R$. If R is doubled, then the new power $P' = V^2/(2R)$, which is half of the original power. So, the total power dissipated by the circuit will be halved. Final answer: C

Answer Option 3:

The power dissipated in a circuit is given by the formula $P = V^2/R$. If the resistance R is doubled, then the new power P' is given by $P' = V^2/(2R)$. Therefore, the power will be halved. So the answer is C. 'It will be halved.'

Answer Option 4:

The total power dissipated by the circuit is given by the formula $P = V^2/R$. Therefore, if R is doubled, the power will be halved. Final answer: C

Answer Option 5:

The power dissipated in a resistor is given by the formula $P = V^2/R$. If the resistance R is doubled, the power becomes $P' = V^2/(2R)$. This is half of the original power, so the power dissipated by the circuit will be halved. Final answer: C

Answer Option 6:

The power dissipated by a circuit is given by the formula $P = V^2/R$. If R is doubled, the new power P' is given by $P' = V^2/(2R)$. Hence, the power is halved when the resistance is doubled. So the correct answer is: 'It will be halved.' Final Answer: C.

Answer Option 7:

The power dissipated by a circuit, given by $P = IV$ (where I is the current and V is the voltage), can also be written in terms of resistance: $P = I^2R = V^2/R$ by Ohm's law ($V = IR$). If R is doubled, the new power $P' = V^2/(2R)$, which is half the original power. So, the total power dissipated by the circuit will be halved. Final answer: C.

Answer Option 8:

The total power P dissipated in the circuit is given by $P = V^2/R$. If R is doubled, the new power P' is given by $P' = V^2/(2R)$. Therefore, the power is halved when the resistance is doubled. So, the correct answer is C. 'It will be halved.'

Answer Option 9:

The power dissipated in a circuit is given by $P = I^2R$, where I is the current. If the resistance is doubled, the current in the circuit will be halved (since $I = V/R$ and V is constant), because the current has an inverse relationship with the resistance. Therefore, the new power dissipated will be $P' = (I/2)^2 \cdot 2R = I^2R/2$, which is half of the original power. Therefore, the total power dissipated by the circuit will be halved. Final answer: C.

Question 23:

'Ultraviolet light has a wavelength of about 6×10^{-8} m. What is the frequency of this light?', A. ' 5×10^{15} Hz', B. ' 0.5 Hz', C. ' 2 Hz', D. ' 20 Hz'

=====

Answer Option 1:

The speed of light is approximately 3×10^8 m/s. The frequency of a wave is given by the speed of light divided by the wavelength, which for ultraviolet light is $(3 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m}) = 5 \times 10^{15} \text{ Hz}$.

Final answer: A.

Answer Option 2:

The speed of light is approximately 3×10^8 m/s. The frequency of a wave is given by the equation speed = frequency x wavelength. Therefore, the frequency of the ultraviolet light is $(3 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m}) = 5 \times 10^{15} \text{ Hz}$. So, the correct answer is A. ' $5 \times 10^{15} \text{ Hz}$ '.

Answer Option 3:

The speed of light is approximately 3×10^8 m/s. The frequency (f) of a wave is related to its speed (v) and wavelength (λ) by the equation $v = f\lambda$. Solving this equation for frequency gives $f = v/\lambda$. Substituting the given values into this equation gives a frequency of $(3 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m}) = 5 \times 10^{15} \text{ Hz}$. Final answer: A

Answer Option 4:

The speed of light is approximately 3×10^8 m/s. The frequency of a wave can be calculated using the equation:

frequency = speed of light / wavelength

So for ultraviolet light,

frequency = $(3 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m})$

= $5 \times 10^{15} \text{ Hz}$

So the correct answer is A. ' $5 \times 10^{15} \text{ Hz}$ '.

Answer Option 5:

The speed of light in a vacuum is approximately 3×10^8 m/s. The equation that relates the speed of light (c), frequency (f), and wavelength (λ) is $c = \lambda f$. Therefore, the frequency can be calculated as $f = c/\lambda$.

Substituting the given values:

$f = (3 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m}) = 5 \times 10^{15} \text{ Hz}$

Final Answer: A

Answer Option 6:

The speed of light is approximately 3×10^8 m/s. The frequency of a wave can be calculated using the formula $f = c/\lambda$, where c is the speed of light and λ is the wavelength. Substituting the given values, we

get $f = (3 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m}) = 5 \times 10^{15} \text{ Hz}$. So, the frequency of the ultraviolet light is approximately $5 \times 10^{15} \text{ Hz}$. Final answer: A

Answer Option 7:

The speed of light c is a constant, $c = 3 \times 10^8$ m/s. The relationship between the speed of light c, its frequency f and its wavelength λ is given by the equation $c = f\lambda$. We are given that $\lambda = 6 \times 10^{-8} \text{ m}$.

Plugging these into the equation gives $f = c / \lambda = (3 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m}) = 5 \times 10^{15} \text{ Hz}$. So, the frequency of ultraviolet light is $5 \times 10^{15} \text{ Hz}$. Final Answer: A

Answer Option 8:

The speed of light in a vacuum is approximately 3.00×10^8 m/s and the relationship between wavelength (λ), frequency (v) and speed of light (c) is given by the equation $c = \lambda v$. Thus, the frequency

of the light can be found by rearranging the equation to $v = c/\lambda$. Substituting the values gives $v = (3.00 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m}) = 5 \times 10^{15} \text{ Hz}$. So, the frequency of the light is

$5 \times 10^{15} \text{ Hz}$. Final Answer: A

Answer Option 9:

The speed of light is about 3×10^8 m/s. The frequency (f) of a wave is related to its speed (v) and wavelength (λ) by the equation $v = f\lambda$. We can plug in the given values and solve for f:

$3 \times 10^8 \text{ m/s} = f \times (6 \times 10^{-8} \text{ m})$

$f = (3 \times 10^8 \text{ m/s}) / (6 \times 10^{-8} \text{ m})$

$f = 5 \times 10^{15} \text{ Hz}$

So the frequency of this ultraviolet light is approximately $5 \times 10^{15} \text{ Hz}$. Final answer: A

Question 24:

'Each of the following ionized isotopes is projected with the same speed into a uniform magnetic field B such that the isotope's initial velocity is perpendicular to B. Which combination of mass and charge would result in a circular path with the largest radius?', A. 'm = 16 u, q = -5 e', B. 'm = 17 u, q = -4 e', C. 'm = 18 u, q = -3 e', D. 'm = 20 u, q = -1 e'

=====

Answer Option 1:

The radius of the circular path for a charged particle of mass m and charge q moving with speed v in a magnetic field B is given by $r = mv / |q|B$. Since all particles are moving with the same speed and are subject to the same magnetic field, the radius is directly proportional to mass and inversely proportional to the absolute value of charge. Thus, to maximize the radius, we want the highest mass and the lowest absolute value of charge. So, the answer is D. 'm = 20 u, q = -1 e'.

Answer Option 2:

The radius of the path of a charged particle moving perpendicular to a magnetic field is given by the formula $r = \frac{mv}{|q|B}$. Thus, the radius is directly proportional to the mass of the particle and inversely proportional to its charge. To maximize the radius, we therefore want to maximize the mass and minimize the charge (in absolute value). Therefore, the isotope with the combination of highest mass and lowest absolute value of charge will have the largest radius. This corresponds to option D: 'm = 20 u, q = -1 e'. Final Answer: D

Answer Option 3:

According to the equation for the radius of the path of a charged particle in a magnetic field, $r = mv/(qB)$, where m is mass, v is velocity, q is charge, and B is the magnetic field. Since all the isotopes are projected with the same speed into the same magnetic field, we can see that the radius is directly proportional to mass and inversely proportional to the absolute value of the charge. Therefore, the isotope with the larger mass and smaller absolute value of charge combination will result in a larger radius. Hence, the answer is D.

Answer Option 4:

The radius of the path for a charged particle projected in a magnetic field is given by $r = mv/(Bq)$ where m is the mass, v is the velocity, B is the magnetic field and q is the charge. Given that v and B are constant for all isotopes, the radius is proportional to m/|q|. The isotope with the largest value of m/|q| will therefore have the largest radius. Evaluating m/|q| for the options we have:

A. $16/5 = 3.2$

B. $17/4 = 4.25$

C. $18/3 = 6$

D. $20/1 = 20$

Therefore, the isotope with mass 20 u and charge -1 e will result in the largest radius.

Final Answer: D

Answer Option 5:

The radius of a charged particle's path in a magnetic field is given by the formula $r = mv/qB$, where m is the mass of the particle, v is its velocity, q is its charge, and B is the strength of the magnetic field.

Since v and B are the same for all of the isotopes, we want to maximize m/q. Here are the m/q ratios for each option:

A: $16/5 = 3.2$

B: $17/4 = 4.25$

C: $18/3 = 6$

D: $20/1 = 20$

Therefore, the isotope with m = 20 u and q = -1 e would result in the largest circular path. Final Answer: D

Answer Option 6:

The radius of the circular path of a charge moving in a magnetic field is given by $r = mv/qB$, where m is the mass of the charge, v is its speed, q is the charge, and B is the magnetic field. To maximize the

radius, we want to maximize the mass and minimize the charge. So, we should pick the option with the largest mass and smallest (in absolute value) charge. Thus, the correct answer is D. 'm = 20 u, q = -1 e'.

Answer Option 7:

The radius of the circular path an ionized particle takes in a magnetic field is given by the equation $r = mv/qB$, where m is the mass of the particle, v is the velocity, q is the charge, and B is the magnetic field strength. We need to find the combination that gives the largest radius, and since the velocity and magnetic field are both constants, we are essentially looking for the combination which gives the largest value for m/q.

A. 'm = 16 u, q = -5 e' gives $16/5 = 3.2$

B. 'm = 17 u, q = -4 e' gives $17/4 = 4.25$

C. 'm = 18 u, q = -3 e' gives $18/3 = 6$

D. 'm = 20 u, q = -1 e' gives $20/1 = 20$

So the isotope with mass 20 u and charge -1 e will result in the largest radius.

Final Answer: D

Answer Option 8:

The radius of curvature of the path of a charged particle with mass m , charge q moving at speed v in a magnetic field B is given by $r = mv/(B|q|)$. The mass m and the speed v are directly proportional to r , while the charge q is inversely proportional to r . Therefore, to maximize the radius of curvature, we need to maximize the mass and minimize the absolute value of the charge. The mass is highest in option D and the absolute value of the charge is smallest in option D. Therefore, the correct answer is D. ' $m = 20 \text{ u}$, $q = -1 \text{ e}$ '.

Answer Option 9:

The radius of the circular path of a charged particle moving in a magnetic field is given by the formula $r = mv/qB$, where m is the mass of the particle, v is the speed, q is the charge, and B is the magnetic field. Since the speed and magnetic field are the same for all the isotopes, the isotope with the largest mass-to-charge ratio will have the largest radius.

Evaluating the mass-to-charge ratio for each option, we get:

A. $m/q = 16\text{u}/5\text{e} = 3.2 \text{ u/e}$

B. $m/q = 17\text{u}/4\text{e} = 4.25 \text{ u/e}$

C. $m/q = 18\text{u}/3\text{e} = 6 \text{ u/e}$

D. $m/q = 20\text{u}/1\text{e} = 20 \text{ u/e}$

So, the isotope with the mass and charge given in option D will result in a circular path with the largest radius. Final answer: D.

Question 25:

'An electric dipole consists of a pair of equal but opposite point charges of magnitude 4.0 nC separated by a distance of 2.0 cm . What is the electric field strength at the point midway between the charges?', A. '0', B. ' $9.0 \times 10^4\text{ N/C}$ ', C. ' $1.8 \times 10^5\text{ N/C}$ ', D. ' $7.2 \times 10^5\text{ N/C}$ '

=====

Answer Option 1:

Due to symmetry, the electric fields produced by each of the charges at the midpoint are equal in magnitude but opposite in direction. Therefore, they cancel each other out and the net electric field at the midpoint is '0'. Final Answer: A

Answer Option 2:

The electric field due to each point charge is equal in magnitude but opposite in direction at the midpoint between the charges. Therefore, the electric field strengths due to each charge cancel out, resulting in an overall electric field strength of 0 at the midpoint. So, the final answer is: A. '0'

Answer Option 3:

The electric field strength at the point midway between two equal and opposite charges will cancel out. This is because the electric field strength created by each charge at the midpoint will have the same magnitude, but opposite direction. So, they will add up to zero. Therefore, the correct answer is A. '0'.

Answer Option 4:

The electric field midway between two charges of equal magnitude but opposite sign is zero because the fields of the two charges at that point are equal in magnitude but opposite in direction, so they cancel each other out. Hence, the electric field strength at the point midway between the charges is 0 . Final answer: A.

Answer Option 5:

The electric field due to a positive charge is directed away from the charge, while the electric field due to a negative charge is directed towards the charge. At the midpoint between the two charges, these two electric fields are equal in magnitude but opposite in direction. Therefore, they cancel each other out, and the net electric field is 0 . Final answer: A.

Answer Option 6:

An electric dipole consists of a pair of point charges that are equal in magnitude but opposite in sign. The electric field strength at any point in space is given by the vector sum of the electric fields produced by each individual charge. At the midpoint between the two charges, the electric fields produced by the two charges are equal in magnitude but opposite in direction, so they cancel each other out. Therefore, the electric field strength at the midpoint is zero. Final answer: A.

Answer Option 7:

The electric field midway between the two charges will be zero because the electric field vectors due to the two charges are equal in magnitude but opposite in direction, hence they cancel each other out. The electric field due to a point charge is given by kq/r^2 , where k is the Coulomb's constant, q is the charge and r is the distance from the charge. Because the point is midway between the charges, the distances r from both charges will be equal and hence the magnitude of the electric field due to each charge will also be equal. But because the charges are of opposite sign, the direction of the electric field vectors will be opposite and hence they will cancel each other out. Therefore, the electric field strength at the point midway between the charges is '0'. Final answer: A

Answer Option 8:

The electric field at any point due to a charge is given by the equation $E = kQ/r^2$, where k is Coulomb's constant, Q is the charge and r is the distance from the charge to the point. In this case, the electric field at the midpoint due to each charge will have the same magnitude because the charges are the same magnitude and the distances are the same. However, because the charges are opposite, the electric fields due to each charge will be in opposite directions and will therefore cancel each other out. The total electric field at the midpoint is therefore 0. Final Answer: A

Answer Option 9:

The electric field strength at a point due to a point charge is given by the formula $E = kQ/r^2$, where k is Coulomb's constant, Q is the magnitude of the charge and r is the distance from the charge to the point. In this case, the electric field strength at the midpoint due to one of the charges is $E = (9 \times 10^9\text{ Nm}^2/\text{C}^2)(4 \times 10^{-9}\text{ C})/(0.01\text{ m})^2 = 3.6 \times 10^5\text{ N/C}$.

However, since the two charges are equal and opposite, the electric fields due to each charge at the midpoint are in opposite directions and therefore cancel each other out.

So, the net electric field strength at the midpoint between the charges is 0. Final Answer: A.

Question 26:

'A person can stand outside on a cold day for hours without ill effect, but falling into a cold lake can kill a person in a matter of minutes. Which of the following is the primary reason for this phenomenon?', A. 'The molecules of the person are, on average, moving faster than those of the surroundings.', B. 'Thermal energy moves from high concentration areas (hot) to low concentration areas (cold).', C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.', D. 'Water has more molecules per volume than air, increasing molecular contact with the person.'

=====

Answer Option 1:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Answer Option 2:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Answer Option 3:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Answer Option 4:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Answer Option 5:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Answer Option 6:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Answer Option 7:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Answer Option 8:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Answer Option 9:

C. 'As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.'

Question 27:

'A liquid flows at a constant flow rate through a pipe with circular cross-sections of varying diameters. At one point in the pipe, the diameter is 2 cm and the flow speed is 18 m/s. What is the flow speed at another point in this pipe, where the diameter is 3 cm?', A. '4 m/s', B. '6 m/s', C. '8 m/s', D. '12 m/s'

=====

Answer Option 1:

The volume of liquid flowing through any cross-section of the pipe per unit time is constant. Therefore, the area of the cross-section times the flow speed is constant. Hence, the flow speed at another point in the pipe, where the diameter is 3 cm, is $2^2/3^2 \cdot 18 = \boxed{8 \text{ m/s}}$. Final Answer: C

Answer Option 2:

The volume flow rate in a pipe is given by the product of the cross-sectional area and the flow speed. Because the flow rate is constant, we have $\pi(1)^2 \cdot 18 = \pi(1.5)^2 \cdot v$. Solving for v we find that $v = \frac{18}{(1.5)^2} = \boxed{8 \text{ m/s}}$. Final answer: C

Answer Option 3:

The volume flow rate, which is constant throughout the pipe, is given by the product of the flow speed and the cross-sectional area. The ratio of the cross-sectional areas is $\left(\frac{3}{2}\right)^2 = \frac{9}{4}$, and the cross-sectional area and flow speed are inversely proportional, so the flow speed at the point in the pipe with diameter 3 cm is $\frac{4}{9} \cdot 18 = \boxed{8 \text{ m/s}}$. Final Answer: C.

Answer Option 4:

The volume flow rate, which remains constant, is the product of the cross-sectional area and the speed. At the first point, the area is $\pi(1^2)$ and the speed is 18 m/s, so the flow rate is 18π cubic cm per second. At the second point, the area is $\pi(1.5^2)$, so the speed must be $\frac{18\pi}{\pi(1.5^2)} = \boxed{8 \text{ m/s}}$ in order for the flow rate to remain constant. Final answer: C.

Answer Option 5:

The flow rate of a liquid is given by the product of the cross-sectional area of the pipe and the flow speed. Because the flow rate stays constant, when the diameter of the pipe increases, the flow speed must decrease.

The cross-sectional area of a pipe with diameter d is given by $\pi(d/2)^2 = \pi d^2/4$.

So the flow rate at the point with diameter 2 cm is $\pi(2)^2/4 \cdot 18 = 9\pi \text{ m}^3/\text{s}$.

Therefore, at the point with diameter 3 cm, the flow speed is the flow rate divided by the cross-sectional area, or $9\pi / (\pi(3)^2/4) = \boxed{4 \text{ m/s}}$. Final answer: A

Answer Option 6:

The flow rate of a liquid is given by the product of the cross-sectional area of the pipe and the flow speed. Since the flow rate is constant, we have:

$$\pi(1\text{cm})^2 \cdot 18\text{m/s} = \pi(1.5\text{cm})^2 \cdot v$$

Solving for v , we get $v = 8 \text{ m/s}$. So, the flow speed at the point where the diameter is 3 cm is 8 m/s. Final Answer: C

Answer Option 7:

The flow rate of a liquid is given by the product of the area of the cross-section of the pipe and the flow speed of the liquid. If the flow rate is constant, then when the area is increased, the flow speed must decrease to compensate (and vice versa). The area of the cross-section of a pipe is proportional to the square of the diameter, so when the diameter is increased by a factor of $3/2$, the area is increased by a factor of $(3/2)^2 = 9/4$. To keep the flow rate constant, the flow speed must therefore decrease by a factor of $4/9$. Therefore, the flow speed at the point in the pipe where the diameter is 3 cm is $(18 \text{ m/s}) \cdot (4/9) = 8 \text{ m/s}$. So, the correct answer is: C. '8 m/s'

Answer Option 8:

The flow rate of a liquid is given by the product of the area of the pipe's cross-section and the speed of the liquid. If the flow rate is constant, then when the diameter of the pipe increases, the speed of the flow must decrease to maintain the same flow rate.

The area of the cross-section of the pipe is proportional to the square of the diameter ($A = \pi(d/2)^2$). So, when the diameter increases from 2 cm to 3 cm, the area increases by a factor of $(3/2)^2 = 2.25$.

Since the flow rate is constant, the speed decreases by the same factor of 2.25 to maintain the same flow rate. Therefore, the flow speed at the point in the pipe where the diameter is 3 cm is $18 \text{ m/s} \div 2.25 = 8 \text{ m/s}$. Final Answer: C. '8 m/s'

Answer Option 9:

The amount of liquid flowing through any point in the pipe per unit of time is the same. This amount is equal to the cross-sectional area of the pipe at that point times the flow speed. If we let A_1 and A_2 be the cross-sectional areas at the two points and v_1 and v_2 be the flow speeds, then we have $A_1 v_1 = A_2 v_2$.

The cross-sectional area of a pipe with diameter d is $A = \pi(d/2)^2 = \pi d^2/4$, so the cross-sectional areas at the two points are $A_1 = \pi(2^2)/4 = \pi$ square cm and $A_2 = \pi(3^2)/4 = 2.25\pi$ square cm.

Substituting these into the equation above, we have $\pi \cdot 18 = 2.25\pi \cdot v_2$, which we can solve to find $v_2 = \boxed{8 \text{ m/s}}$. Final Answer: C

Question 28:

'An ideal fluid flows through a pipe with radius Q and flow speed V . If the pipe splits up into three separate paths, each with radius $(Q/2)$, what is the flow speed through each of the paths?', A. ' $1/3 V$ ', B. ' $2/3 V$ ', C. ' $4/3 V$ ', D. ' $4V$ '

=====

Answer Option 1:

The volume flow rate is conserved in a fluid flow, meaning that the volume of fluid entering a certain section of the pipe per unit time is equal to the volume of fluid leaving that section of the pipe per unit time.

The volume flow rate is given by the product of the cross-sectional area of the pipe and the flow speed. For the initial pipe, the volume flow rate is $\pi Q^2 V$, and for each of the split pipes, the volume flow rate is $\pi (Q/2)^2 v$, where v is the flow speed in the split pipes. Setting these equal gives $\pi Q^2 V = 3\pi (Q/2)^2 v$, which simplifies to $v = \boxed{4/3 V}$. Final Answer: C.

Answer Option 2:

The total flow rate must be conserved. The flow rate is given by the cross-sectional area of the pipe times the flow speed. The area of the original pipe is πQ^2 , and the flow speed is V , so the total flow rate is $\pi Q^2 V$. Each of the three separate paths has area $\pi (Q/2)^2 = \pi Q^2/4$, and if we denote the new flow speed as V' , then the total flow rate of the three paths combined is $3\pi Q^2 V'/4$.

Setting this equal to the original flow rate gives $\pi Q^2 V = 3\pi Q^2 V'/4$, which simplifies to $V' = (4/3)V$. Final answer: C. ' $4/3 V$ '

Answer Option 3:

The volume flow rate (the volume of fluid passing through a cross-section of the pipe per unit time) is conserved. For the initial pipe, the volume flow rate is given by the cross-sectional area of the pipe times the flow speed, or $\pi Q^2 V$.

When the pipe splits into three, each of the three pipes has a cross-sectional area of $\pi (Q/2)^2 = \pi Q^2/4$. Let's denote the new flow speed as V' . Then the total volume flow rate for the three pipes is $3\pi Q^2 V'/4$.

Setting these two equal gives $\pi Q^2 V = 3\pi Q^2 V'/4$, which simplifies to $V' = \boxed{4/3 V}$. Final answer: C.

Answer Option 4:

The continuity equation in fluid dynamics states that the mass flow rate must be conserved. Mass flow rate is the product of the cross-sectional area of the pipe and the flow speed of the fluid.

The total cross-sectional area before the split is $\pi Q^2 = \pi Q^2$, and the total cross-sectional area after the split is $3\pi (Q/2)^2 = 3\pi Q^2/4$.

According to the continuity equation, the total flow speed after the split must be $(\pi Q^2 V) / (3\pi Q^2/4) = 4/3 V$.

But this is the total flow speed through all three paths. Since the pipes are identical, the flow speed in each pipe is equal, so the flow speed through each of the paths is $(4/3 V) / 3 = \boxed{4/9 V}$.

However, this option is not available in the given choices. The problem may have a mistake or misunderstanding. The flow speed can't be represented by any of the given options (A, B, C, D).

Answer Option 5:

The flow rate, or the volume of fluid that moves past a given point per unit time, is conserved in a fluid flow. The flow rate is given by the cross-sectional area of the pipe times the fluid speed.

For the initial pipe, the flow rate is $\pi Q^2 V$. Each of the three smaller pipes has a cross-sectional area of $\pi (Q/2)^2 = \pi Q^2/4$, so if the speed in them is V' , the total flow rate for the three smaller pipes is $3\pi Q^2 V'/4$.

Setting the initial flow rate equal to the final flow rate gives $\pi Q^2 V = 3\pi Q^2 V'/4$. Solving for V' yields $V' = \boxed{4/3 V}$. Final Answer : C

Answer Option 6:

The flow rate of a fluid is given by the product of the cross-sectional area of the pipe and the flow speed of the fluid. Since the flow rate must be conserved in this case, we have the initial flow rate equals to the sum of the flow rates in the three separate pipes.

The initial cross-sectional area is πQ^2 and the initial flow speed is V , so the initial flow rate is $\pi Q^2 V$.

Each of the smaller pipes has a cross-sectional area of $\pi (Q/2)^2 = \pi Q^2/4$. If we denote the flow speed in the smaller pipes as V' , then the flow rate in each smaller pipe is $\pi Q^2 V'/4$.

Since the pipe splits into three paths, the final flow rate is $3\pi Q^2 V'/4$, hence we have the equation:

$$\pi Q^2 V = 3\pi Q^2 V'/4.$$

Solving for V' gives $V' = 4V/3$.

So the flow speed through each of the paths is $4V/3$. Final answer: C.

Answer Option 7:

The flow rate of a fluid is given by the product of the cross-sectional area of the pipe and the flow speed. In this case, the flow rate before the split is $\pi Q^2 V$ (the cross-sectional area is πQ^2 , and the flow speed is V).

After the split, the cross-sectional area of each pipe is $\pi (Q/2)^2 = \pi Q^2/4$. Let's denote the flow speed in each of the smaller pipes as V' . The total flow rate after the split is $3\pi Q^2 V'/4$, since there are three pipes.

According to the principle of conservation of flow rate (the flow rate before the split equals the flow rate after the split), we have:

$$\pi Q^2 V = 3\pi Q^2 V'/4$$

Solving for V' , $V' = 4V/3$

So the final answer is C. ' $4/3 V$ '

Answer Option 8:

The conservation of mass dictates that the mass flow rate before the split must equal the total mass flow rate after the split. In fluid dynamics, the mass flow rate can be represented as the product of the cross-sectional area (A) and the flow speed (V).

Before the split, the mass flow rate is $A \cdot V = \pi \cdot (Q/2)^2 \cdot V$.

After the split, the total mass flow rate is the sum of the mass flow rates through each of the three paths, which each have an area of $\pi \cdot ((Q/2)/2)^2 = \pi \cdot (Q/4)^2$. If we denote the flow speed after the split as V' , then the total mass flow rate is $3 \cdot A' \cdot V' = 3 \cdot \pi \cdot (Q/4)^2 \cdot V' = \pi \cdot (3Q/4)^2 \cdot V'$.

Setting these two expressions for the mass flow rate equal to each other gives:

$$\pi \cdot (Q/2)^2 \cdot V = \pi \cdot (3Q/4)^2 \cdot V'$$

Solving for V' gives $V' = (4/3) \cdot V$.

So the flow speed through each of the paths is 4/3 the original flow speed. Final answer: C

Answer Option 9:

According to the principle of conservation of mass, the total volume flow rate must be the same before and after the split, i.e., the fluid flowing per unit time through the main pipe must be equal to the sum of the fluid flowing per unit time through each of the three smaller pipes.

The volumetric flow rate is given by the cross-sectional area of the pipe times the flow speed, $A \cdot V$.

For the main pipe, the area is $\pi(Q/2)^2$ and the flow speed is V , so the flow rate is $\pi(Q/2)^2 \cdot V$.

When the pipe splits into three smaller pipes, the area of each smaller pipe is $\pi((Q/2)/2)^2 = \pi(Q/4)^2$, and the flow speed is v (let's determine it). Because of the conservation of the flow rate, the total flow rate of the three smaller pipes is $3 \cdot \pi(Q/4)^2 \cdot v$.

Setting the two flow rates equal to each other, we get that $\pi(Q/2)^2 \cdot V = 3 \cdot \pi(Q/4)^2 \cdot v$, so $V = 3v/4$, which means $v = 4V/3$.

So, the flow speed through each of the smaller pipes is 4V/3. Final Answer: C.

Question 29:

'A very slow-moving positron interacts with a stationary electron. Which of the following statements correctly describes a possible outcome of this reaction and why it would occur?'. A. 'Conservation of mass indicates that if a single new particle were created in the reaction, it must have a total mass equal to the combined masses of the electron and positron.'. B. 'Conservation of charge indicates that all new particles created in the reaction would have no electric charge.'. C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'. D. 'Conservation of energy indicates that the antimatter positron could annihilate into energy, leaving the stationary electron behind.'

=====

Answer Option 1:

C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'

Answer Option 2:

C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'

Answer Option 3:

C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'

Answer Option 4:

C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'

Answer Option 5:

C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'

Answer Option 6:

C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'

Answer Option 7:

C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'

Answer Option 8:

A. 'Conservation of mass indicates that if a single new particle were created in the reaction, it must have a total mass equal to the combined masses of the electron and positron.'

Answer Option 9:

C. 'Conservation of momentum indicates that two identical gamma rays moving off in opposite directions could be created.'

Question 30:

'A box sits on an inclined plane without sliding. As the angle of the plane (measured from the horizontal) increases, the normal force', A. 'increases linearly', B. 'decreases linearly', C. 'does not change', D. 'decreases nonlinearly'

=====

Answer Option 1:

B. 'decreases linearly'

Answer Option 2:

B. 'decreases linearly'

Answer Option 3:

The normal force is the component of the box's weight that acts perpendicular to the inclined plane. As the angle of the plane increases, the normal force decreases as the cosine of the angle. Since the cosine function decreases nonlinearly between 0 and 90 degrees, the normal force also decreases nonlinearly. Hence, the correct answer is D. 'decreases nonlinearly'.

Answer Option 4:

The normal force on an object on an inclined plane is equal to the weight of the object times the cosine of the angle of the plane. As the angle increases from 0 to 90 degrees, the cosine of the angle decreases from 1 to 0. Therefore, the normal force B. 'decreases linearly' with the angle. Final answer: B.

Answer Option 5:

The normal force on an object on an inclined plane is equal to the weight of the object multiplied by the cosine of the angle of the plane. As the angle increases, the cosine of the angle decreases, so the normal force decreases. However, the relationship between the cosine of an angle and the angle itself is not linear, so the normal force decreases nonlinearly. The correct answer is D. 'decreases nonlinearly'.

Answer Option 6:

The normal force on an object on an inclined plane is equal to the weight of the object times the cosine of the angle of the plane. As the angle increases, the cosine of the angle decreases, so the normal force decreases. However, the relationship between the cosine of an angle and the angle itself is not linear, so the normal force decreases nonlinearly. Final answer: D.

Answer Option 7:

The normal force on the box is equal to the component of the weight of the box perpendicular to the plane. As the angle of the plane increases, this component decreases following the relation $N = mg \cos \theta$, where m is the mass of the box, g is the gravitational acceleration, and θ is the angle of the plane. The cosine function decreases nonlinearly from 1 to 0 as the angle increases from 0 to 90 degrees. Therefore, the normal force 'decreases nonlinearly'. Final answer: D.

Answer Option 8:

The normal force decreases as the angle of the plane increases. This is because the normal force is equal to the component of the gravitational force perpendicular to the inclined plane. Specifically, if θ is the angle of the incline, m is the mass of the box, and g is the acceleration due to gravity, then the normal force F is given by $F = mg \cos \theta$. As θ increases, $\cos \theta$ decreases, so the normal force decreases. However, the relationship is not linear because the cosine function is not a linear function. So, the normal force 'decreases nonlinearly'. Final Answer: D

Answer Option 9:

The normal force on an object resting on an inclined plane is given by $N = mg \cos(\theta)$ where m is the mass, g is the gravitational acceleration, and θ is the angle of the plane. As θ increases, $\cos(\theta)$ decreases, so the normal force N decreases. However, since $\cos(\theta)$ does not decrease linearly with θ , the normal force does not decrease linearly either. Therefore, the correct answer is: D. 'decreases nonlinearly'.

Question 31:

'A small cart of mass m is initially at rest. It collides elastically with a large cart of mass $4m$ and velocity v . The large cart loses half its kinetic energy to the little cart. The little cart now has a velocity of', A. ' $1.41v$ ', B. ' v ', C. ' $2v$ ', D. ' $4v$ '

=====

Answer Option 1:

In an elastic collision, momentum is conserved. Before the collision, the total momentum is $4mv$. After the collision, the total momentum is $4mv/2 + mv_f = 2mv + mv_f$, where v_f is the final velocity of the small cart.

Solving for v_f , we get $v_f = 2v$. Therefore, the little cart now has a velocity of $\boxed{2v}$. Final answer: C.

Answer Option 2:

The large cart loses half its kinetic energy to the little cart. Kinetic energy is given by $\frac{1}{2}mv^2$. Half of this is $\frac{1}{4}mv^2$.

The little cart now has this kinetic energy, and we can solve for its velocity: $\frac{1}{2}mv^2 = \frac{1}{2}m \cdot V^2$ where V is the new velocity of the small cart. Solving for V gives $V = \sqrt{2}v$. So, the final answer is $\boxed{1.41v}$. Final Answer: A.

Answer Option 3:

When the large cart loses half its kinetic energy, it gets transferred to the small cart. The kinetic energy of the small cart becomes half that of the large cart after the collision. In terms of velocity, the kinetic energy is given by $\frac{1}{2}mv^2$. Thus, the speed of the little cart after the collision is $\sqrt{2}$ times the speed of the large cart. This is because $\frac{1}{2}m(2v)^2 = 2 \cdot \frac{1}{2}mv^2$. Therefore, the velocity of the small cart is $\sqrt{2}v$ which is approximately $1.41v$. Therefore, the answer is A. ' $1.41v$ '

Answer Option 4:

The large cart loses half its kinetic energy, so the small cart gains half the kinetic energy of the large cart. The kinetic energy of the large cart before collision is $\frac{1}{2}(4m)(v^2) = 2mv^2$. The kinetic energy of the small cart after collision is $\frac{1}{2}mv^2_{(s)}$. Because the small cart is gaining half the kinetic energy of the large cart, we have $\frac{1}{2}mv^2_{(s)} = \frac{1}{2} \cdot 2mv^2$, so $v^2_{(s)} = 2v^2$ and $v_{(s)} = \sqrt{2}v$ which is approximately $\boxed{1.41v}$. Final Answer: A

Answer Option 5:

In an elastic collision, the total momentum and total kinetic energy are conserved. Initially, the momentum of the system is $4mv$, and the kinetic energy is $2mv^2$. After the collision, the momentum of the system is $mv_1 + 4mv_2$, and the kinetic energy is $\frac{1}{2}mv_1^2 + \frac{1}{2}4mv_2^2$.

Since the large cart loses half its kinetic energy to the small cart, this means that $\frac{1}{2}4mv_2^2 = mv^2$, or $v_2^2 = v^2/2$, or $v_2 = v/\sqrt{2}$. Substituting this into the momentum conservation equation gives $mv_1 = 4mv - 4m(v/\sqrt{2}) = 4mv(1 - 1/\sqrt{2})$, or $v_1 = 4v(1 - 1/\sqrt{2}) = 4v\sqrt{2} - 4v = (4\sqrt{2} - 4)v$.

Therefore, the little cart now has a velocity of $(4\sqrt{2} - 4)v$, which is approximately $1.66v$. Hence, the closest answer is B. ' v '. Final Answer: B

Answer Option 6:

The final velocity of the small cart can be found using the equation for the velocity of a particle after a one-dimensional elastic collision. In this case, the equation becomes $v_{\text{final_small}} = ((m - 4m)/(m + 4m)) \cdot v + (2 \cdot 4m/(m + 4m)) \cdot v = v/3 + 8v/3 = 3v$. However, it is given that the large cart loses half of its kinetic energy to the small cart. The initial kinetic energy of the large cart is $\frac{1}{2}4mv^2$; therefore the final kinetic energy of the small cart should be $\frac{1}{2}mv^2$. Using the equation for kinetic energy, we find $\frac{1}{2}m \cdot v_{\text{final_small}}^2 = \frac{1}{2}mv^2$, which implies $v_{\text{final_small}} = v$. Final Answer: B

Answer Option 7:

In an elastic collision, kinetic energy and momentum are conserved. The initial momentum of the system is $0 + 4mv = 4mv$. After the collision, the momentum is $mv_1 + 4mv_2 = 4mv$ where v_1 and v_2 are the velocities of the small cart and large cart respectively. Solving for v_1 , we get $v_1 = 4v - v_2$.

The kinetic energy of the large cart before the collision is $\frac{1}{2}4mv^2 = 2mv^2$. After the collision, the large cart loses half its kinetic energy, so it has $1mv^2$ left. The kinetic energy of the large cart after the collision is $\frac{1}{2}4mv_2^2 = 2m \cdot v_2^2$.

Setting these equal, we get $2m \cdot v_2^2 = 1mv^2$, or $v_2 = v/\sqrt{2}$. Substituting this into the earlier equation gives $v_1 = 4v - v/\sqrt{2} = v(4 - 1/\sqrt{2}) = v\sqrt{2}$. So, the small cart's velocity is $\sqrt{2}$ times the initial velocity of the large cart, or $1.41v$.

Final Answer: A

Answer Option 8:

By definition, an elastic collision is one in which both momentum and kinetic energy are conserved. In this case, the momentum of the system before the collision is $p_{\text{initial}} = 4mv$. After the collision, the large cart loses half its kinetic energy, so its new velocity is $v_{\text{large}} = v/\sqrt{2}$. Therefore, its momentum after the collision is now $4mv_{\text{large}} = 4mv/\sqrt{2} = 2mv\sqrt{2}$. The total momentum of the system must remain the same, so the momentum of the small cart after the collision is $p_{\text{small}} = p_{\text{initial}} - p_{\text{large}} = 4mv - 2mv\sqrt{2} = 2mv(2 - \sqrt{2})$. As the mass of the small cart is m , its velocity after the collision is $v_{\text{small}} = p_{\text{small}}/m = 2v(2 - \sqrt{2}) \approx 0.59v$. However, this is not one of the options, so there might be a mistake in the problem statement. With the given options and problem statement, we can't determine the correct answer.

Answer Option 9:

The large cart loses half its kinetic energy to the little cart. The initial kinetic energy of the large cart is $(1/2) \cdot 4m \cdot v^2$. After the collision, the large cart has $(1/2) \cdot 4m \cdot (v')^2$ kinetic energy, where v' is the velocity of the large cart after the collision. So, according to the problem, $(1/2) \cdot 4m \cdot v^2 = 2 \cdot (1/2) \cdot 4m \cdot (v')^2$. This simplifies to $v^2 = 4 \cdot (v')^2$, or $v' = v/2$.

The law of conservation of momentum tells us that the total momentum before the collision equals the total momentum after the collision. Before the collision, the total momentum is $4m \cdot v$ (the momentum of the large cart). After the collision, the total momentum is $m \cdot v_{\text{small}} + 4m \cdot v'$, where v_{small} is the velocity of the small cart after the collision. Substituting $v' = v/2$, we get $4m \cdot v = m \cdot v_{\text{small}} + 4m \cdot (v/2)$. This simplifies to $v_{\text{small}} = 4m \cdot v/m - 2v = 4v - 2v = 2v$. So, the small cart now has a velocity of $2v$. Final Answer: C.

Question 32:

'A circuit consists of a battery and a light bulb. At first, the circuit is disconnected. Then, the circuit is connected, and the light bulb lights. After the light bulb has been lit for a few moments, how has the net charge residing on the circuit elements changed?', A. 'The net charge has become more positive.', B. 'The net charge has become more negative.', C. 'The net charge has not changed.', D. 'Whether the net charge becomes more positive or more negative depends on the initial net charge residing on the circuit elements before the bulb was lit.'

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Answer Option 1:

C. 'The net charge has not changed.'

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Answer Option 2:

C. 'The net charge has not changed.'

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Answer Option 3:

C. 'The net charge has not changed.'

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Answer Option 4:

C. 'The net charge has not changed.'

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Answer Option 5:

C. 'The net charge has not changed.'

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Answer Option 6:

C. 'The net charge has not changed.'

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Answer Option 7:

C. 'The net charge has not changed.'

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Answer Option 8:

C. 'The net charge has not changed.'

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Answer Option 9:

C. 'The net charge has not changed.'

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Question 33:

'If the force of gravity between the Moon and the Earth were to stop, which statement best describes the resulting motion of the moon?'. A. 'It would continue rotating on its axis, and it would revolve around the Earth as usual.', B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.', C. 'It would stop rotating on its axis, but it would revolve around the Earth as usual.', D. 'It would stop rotating on its axis, and it would stop revolving around the Earth.'

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Answer Option 1:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Answer Option 2:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Answer Option 3:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Answer Option 4:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Answer Option 5:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Answer Option 6:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Answer Option 7:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Answer Option 8:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Answer Option 9:

B. 'It would continue rotating on its axis, but it would stop revolving around the Earth.'

Question 34:

'A person stands on a scale in an elevator. He notices that the scale reading is less than his usual weight. Which of the following could possibly describe the motion of the elevator?', A. 'It is moving downward and slowing down.', B. 'It is moving upward and slowing down.', C. 'It is moving upward at a constant speed.', D. 'It is moving downward at a constant speed.'

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Answer Option 1:

A. 'It is moving downward and slowing down.'

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Answer Option 2:

A. 'It is moving downward and slowing down.'

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Answer Option 3:

A. 'It is moving downward and slowing down.'

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Answer Option 4:

A. 'It is moving downward and slowing down.'

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Answer Option 5:

A. 'It is moving downward and slowing down.'

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Answer Option 6:

A. 'It is moving downward and slowing down.'

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Answer Option 7:

A. 'It is moving downward and slowing down.'

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Answer Option 8:

A. 'It is moving downward and slowing down.'

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Answer Option 9:

A. 'It is moving downward and slowing down.'

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Question 35:

'A whiffle ball is tossed straight up, reaches a highest point, and falls back down. Air resistance is not negligible. Which of the following statements are true?

I. The ball's speed is zero at the highest point.

II. The ball's acceleration is zero at the highest point.

III. The ball takes a longer time to travel up to the highest point than to fall back down.' A. 'I only', B. 'II only', C. 'I & II only', D. 'I & III only'

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Answer Option 1:

I. The ball's speed is zero at the highest point. This is true. The ball reaches its maximum height when the upward speed is zero.

II. The ball's acceleration is zero at the highest point. This is false. The acceleration is due to the force of gravity, which is present regardless of whether the ball is moving or not.

III. The ball takes a longer time to travel up to the highest point than to fall back down. This is true. The air resistance works against the ball on the way up and helps the ball on the way down.

So the correct answer is D. 'I & III only'.

Answer Option 2:

Statement I is true as the ball's speed does become zero at the highest point, which is when it changes direction to fall back down.

Statement II is false. Even at the highest point, the ball experiences acceleration due to gravity. The presence of air resistance also contributes to the acceleration, so the acceleration is not zero.

Statement III is true because air resistance acts against the ball on the way up, causing it to take longer to reach the highest point. On the way down, air resistance still acts on the ball but gravity is also acting in the same direction, causing the ball to fall faster.

So, the correct answer is 'I & III only'. Final Answer: D

Answer Option 3:

When the ball reaches the highest point, its velocity (and therefore speed) is indeed zero, so I is true. However, even though the ball's speed is momentarily zero at the highest point, it is still under the constant influence of gravity, so its acceleration is not zero, thus II is false. Because air resistance acts against the motion of the ball, it slows the ball more on the way up than on the way down, so it takes longer to reach the highest point than to fall back down, thus III is true. Therefore, the answer is $\boxed{\text{I \& III only}}$ (Choice D).

Answer Option 4:

I. The ball's speed is zero at the highest point. - True. The ball stops momentarily at the highest point before it starts its descent.

II. The ball's acceleration is zero at the highest point. - False. Even at the highest point, the ball is under the influence of gravity. This means it is accelerating downwards, even though its speed is momentarily zero.

III. The ball takes a longer time to travel up to the highest point than to fall back down. - True. This is due to air resistance. When the ball is thrown up, it works against gravity and air resistance. But when it falls down, it is aided by gravity and only needs to overcome air resistance, so it falls faster.

So, the answer is D. 'I & III only'.

Answer Option 5:

The speed of the ball is indeed zero at the highest point, so statement I is correct.

However, gravity is still acting on the ball even at its highest point, so its acceleration is not zero. Thus statement II is incorrect.

Because of air resistance, the ball will take longer to travel up than to fall back down, so statement III is correct.

Therefore, the correct answer is D: 'I & III only'.

Answer Option 6:

The correct answer is 'I & III only'. The ball's speed will indeed be zero at the highest point as it transitions from moving upwards to moving downwards. However, the ball's acceleration is not zero at the highest point. Even though the ball is momentarily stationary, it is still being affected by gravity (acceleration due to gravity isn't nullified). Lastly, due to air resistance, the ball does take longer to travel up to the highest point than to fall back down. So, the correct answer is D. 'I & III only'.

Answer Option 7:

The correct answer is D. 'I & III only'

I. The ball's speed is zero at the highest point. This is True. The speed of the ball is zero at the highest point since it momentarily stops before it starts to fall back down.

II. The ball's acceleration is zero at the highest point. This is False. Even at the highest point, the ball is still under the influence of gravity which is constantly accelerating it downwards.

III. The ball takes a longer time to travel up to the highest point than to fall back down. This is True. Due to air resistance, the ball is slowed down on the way up and is sped up on the way down. Thus, it takes longer to travel up to the highest point than to fall back down.

Answer Option 8:

At the highest point, the ball momentarily stops before it starts falling back down, so statement I is true.

Acceleration due to gravity acts on the ball during the entire trajectory, so the acceleration is not zero at the highest point; thus statement II is false.

Air resistance slows the ball on the way up more than on the way down (since on the way down it helps rather than hinders the ball's motion). Therefore the ball does take a longer time to go up than to come down, so statement III is true.

So, the correct answer is 'I & III only'. Final Answer: D.

Answer Option 9:

The ball's speed is indeed zero at the highest point, because it momentarily stops before starting to fall back down. So statement I is true.

However, the ball's acceleration is not zero at the highest point. Even at the peak of the motion, the ball is still subject to the force of gravity, which is causing it to accelerate downwards. So statement II is false.

Considering air resistance, it would take the ball longer to travel up to the highest point than to fall back down. This is because on the way up, the ball is working against both gravity and air resistance, while on the way down, gravity is helping it overcome air resistance. So statement III is true.

Therefore, of the given choices, the correct answer is 'boxed{I & III only}'. Final answer: D

Question 36:

'If L, M, and T denote the dimensions of length, mass, and time, respectively, what are the dimensions of impulse?', A. ' LM/T^3 ', B. ' LM/T^2 ', C. ' LM/T ', D. ' L^2M/T^2 '

=====

Answer Option 1:

Impulse is defined as force multiplied by the time interval over which it acts. Force is mass times acceleration, and acceleration is length per time squared. Therefore, the dimensions of impulse are mass times length per time squared, times time, or mass*length/time. Final answer: C.

=====

Answer Option 2:

Impulse is equal to the change in momentum over time. Momentum is mass times velocity (which is length over time). Therefore, the units of impulse are mass*length/time, or $\boxed{LM/T}$. Final Answer: C

=====

Answer Option 3:

Impulse is defined as force applied over time. Force is defined as mass times acceleration. Acceleration is defined as length divided by time squared. Therefore, the dimensions of impulse are mass times length divided by time squared, all times time, which simplifies to mass times length divided by time. The answer is $\boxed{LM/T}$. Final answer: C

=====

Answer Option 4:

Impulse is defined as force multiplied by time. Force itself is mass times acceleration. Acceleration is length divided by time squared. Putting it all together, we have mass times length divided by time squared (for force) times time (for impulse), making the final dimensions of impulse mass*length/time. Final answer: C.

=====

Answer Option 5:

Impulse is the integral of force over time. Force is mass times acceleration, and acceleration is distance divided by time squared. Therefore, force can be written in terms of dimensions as ML/T^2 . Since impulse is force times time, its dimensions would be ML/T^2 times T, leading to dimensions of ML/T . Therefore, the correct answer is C. ' LM/T '

=====

Answer Option 6:

Impulse is defined as the change in momentum of an object when an external force is applied. The momentum of an object is the product of its mass and velocity. Considering that velocity is displacement (length) per unit time, the momentum of an object has dimensions of mass times length per unit time (ML/T). Since impulse is just change in momentum, it also has the dimensions of ML/T . So, the final answer is C.

=====

Answer Option 7:

Impulse is defined as the change in momentum over a period of time. Momentum itself is the product of mass and velocity. Velocity is length per unit time. Therefore, the dimensions of impulse are mass * length/time, which gives us the dimensions ML/T . Hence, the correct answer is option C. ' LM/T '.

=====

Answer Option 8:

Impulse is the integral of a force over the time during which it acts. Force is mass times acceleration, and acceleration is length over time squared. So the dimensions of force are ML/T^2 , and since impulse is this integrated over time, its dimensions are ML/T^2 times T, or ML/T . So the answer is C.

=====

Answer Option 9:

Impulse is defined as the integral of a force, F, over the time period for which it acts. The force itself is defined in terms of the mass of an object and its acceleration ($F=ma$). Acceleration is a measure of how velocity changes with time, so it has dimensions LT^{-2} . Therefore, force has dimensions MLT^{-2} and when integrated over time to obtain impulse, we add another factor of T, giving final dimensions MLT^{-1} . So, the correct answer is C. ' LM/T '.

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Question 37:

"Traveling at an initial speed of 1.5×10^6 m/s, a proton enters a region of constant magnetic field of magnitude 1.5 T. If the proton's initial velocity vector makes an angle of 30° with the magnetic field, compute the proton's speed 4 s after entering the magnetic field.", A. ' 5.0×10^6 m/s', B. ' 7.5×10^6 m/s', C. ' 1.5×10^6 m/s', D. ' 3.0×10^6 m/s'

=====

Answer Option 1:

The magnetic field only changes the direction of the velocity of the proton, not its magnitude. Therefore, the speed remains constant at 1.5×10^6 m/s. Final answer: C.

Answer Option 2:

A magnetic field only changes the direction of a charged particle's velocity, not its magnitude. Therefore, the speed of the proton stays the same, 1.5×10^6 m/s, even after 4 s in the magnetic field. Final answer: C.

Answer Option 3:

The magnetic field can only alter the direction of the proton's motion, not its speed. Therefore, 4 seconds after entering the magnetic field, the proton's speed is still 1.5×10^6 m/s. Final

Answer: C

Answer Option 4:

The magnetic force on a charged particle is always perpendicular to its direction of motion. This means that the magnetic field can change the direction of the particle's velocity, but not the magnitude of the velocity. So, the speed of the proton remains constant and equals to its initial speed, which is 1.5×10^6 m/s. Final answer: C.

Answer Option 5:

When a charged particle enters a magnetic field, the component of its velocity perpendicular to the field causes it to move in a circular path, while the component of its velocity parallel to the field remains unchanged. The speed of the particle remains constant because the magnetic field does no work on the particle. So, the proton's speed 4 s after entering the magnetic field remains 1.5×10^6 m/s. Final

answer: C.

Answer Option 6:

The speed of a charged particle moving in a magnetic field remains constant. This is because the magnetic force is always perpendicular to the velocity of the particle, which means that the magnetic field can change the direction of the particle's velocity, but not its speed. Therefore, the speed of the proton remains 1.5×10^6 m/s even after 4 s. Final answer: C.

Answer Option 7:

The magnetic field doesn't do any work on the proton because the magnetic force is always perpendicular to the velocity of the proton. Therefore, the speed of the proton remains constant throughout its motion in the magnetic field, no matter how long it stays in the magnetic field or the angle it makes with the magnetic field. So, the proton's speed 4 s after entering the magnetic field is still 1.5×10^6 m/s.

Final Answer: C.

Answer Option 8:

When a charged particle enters a magnetic field at an angle, the component of its velocity parallel to the field is unaffected, while the component perpendicular to the field undergoes circular motion. The speed of the proton, which is the magnitude of the velocity vector, remains constant. Therefore, the proton's speed 4 s after entering the magnetic field is still 1.5×10^6 m/s. Final Answer: C.

Answer Option 9:

The magnetic field can only exert a force perpendicular to the direction of motion of a charged particle, causing the particle to move in a circular path. However, the component of the proton's velocity parallel to the magnetic field is unaffected.

The initial speed of the proton parallel to the magnetic field can be calculated by multiplying the initial speed by the cosine of the angle, giving 1.5×10^6 m/s $\times \cos(30^\circ) = 1.3 \times 10^6$ m/s.

This component of the velocity remains unchanged, so the speed of the proton 4 s after entering the magnetic field is still 1.5×10^6 m/s. Final answer: C.

Question 38:

'A man stands on a platform scale in an elevator. The elevator moves upward, speeding up. What is the action-reaction force pair to the man's weight?', A. 'The force of the elevator cable on the man', B. 'The force of the man on the scale', C. 'The force of the elevator cable on the elevator', D. 'The force of the man on the Earth'

=====

Answer Option 1:

D. 'The force of the man on the Earth'

Answer Option 2:

The action-reaction force pair to the man's weight is 'The force of the man on the Earth'. Final answer: D

Answer Option 3:

The action-reaction force pair to the man's weight would be 'The force of the man on the Earth'. Final Answer: D.

Answer Option 4:

The action-reaction pair to the man's weight (which is the force of the Earth pulling the man downward) is D. 'The force of the man on the Earth'

Answer Option 5:

The action-reaction force pair to the man's weight is 'The force of the man on the Earth'. Final Answer: D

Answer Option 6:

According to Newton's third law of motion, every action has an equal and opposite reaction. This means the action-reaction force pair to the man's weight is 'The force of the man on the Earth'. Final answer:

D

Answer Option 7:

The action-reaction force pair to the man's weight (which is the force of the Earth on the man) is the force of the man on the Earth. According to Newton's third law, for every action, there is an equal and opposite reaction. Therefore, the answer is D. 'The force of the man on the Earth'.

Answer Option 8:

The action-reaction pair to the man's weight (which is the force of the Earth on the man) is the force that the man exerts on the Earth. According to Newton's third law, for every action, there is an equal and opposite reaction. Thus, the correct answer is 'The force of the man on the Earth'. Final Answer: D

Answer Option 9:

The action-reaction force pair to the man's weight is D. 'The force of the man on the Earth'. According to Newton's third law, for every action, there is an equal and opposite reaction. This means that as the Earth pulls the man down (which is the man's weight), the man is also pulling the Earth up with an equal amount of force.

Question 39:

'During an isothermal expansion, a confined ideal gas does 150 J of work against its surroundings. Which of the following describes the heat transfer during this process?', A. '150 J of heat was added to the gas.', B. '150 J of heat was removed from the gas.', C. '300 J of heat was added to the gas.', D. '300 J of heat was removed from the gas.'

=====

Answer Option 1:

During an isothermal expansion of an ideal gas, the work done by the gas is exactly balanced by the heat flowing into the gas. So, the correct answer would be: A. '150 J of heat was added to the gas.'

Answer Option 2:

During an isothermal expansion, the system does work on the surroundings by expanding, and to maintain constant temperature, the same amount of heat must be put into the system. Hence, '150 J of heat was added to the gas.' The correct answer is A. '150 J of heat was added to the gas.'

Answer Option 3:

In an isothermal process, the internal energy of the system remains constant. Therefore, all the work done by the gas is provided by the heat absorbed from the surroundings. So, 150 J of heat must have been added to the gas. Hence, the answer is A. '150 J of heat was added to the gas.'

Answer Option 4:

During an isothermal expansion, the total internal energy of an ideal gas remains constant because the temperature remains constant. If the gas does work on its surroundings (expands), this energy must be supplied by heat added to the gas. So, if the gas does 150 J of work on its surroundings, 150 J of heat must be added to the gas to keep its internal energy constant. Hence, the correct answer is: A. '150 J of heat was added to the gas.'

Answer Option 5:

During an isothermal (constant temperature) expansion, the work done by the gas is equal to the heat added to the gas. This is because in an isothermal process, the internal energy of the gas doesn't change (since the temperature remains constant), and thus the heat added to the system must be equal to the work done by the system. So, 150 J of work done by the gas means that 150 J of heat was added to the gas. Final answer: A.

Answer Option 6:

In an isothermal (constant temperature) expansion of an ideal gas, the work done by the gas is equal to the heat added to the gas. This is because, in an ideal gas, all energy added to the gas (in the form of heat) is converted into work done by the gas (as it expands). Therefore, if the gas does 150 J of work, then 150 J of heat was added to the gas. So, the answer is A. '150 J of heat was added to the gas.'

Answer Option 7:

During an isothermal expansion, the temperature of the gas remains constant. According to the first law of thermodynamics, the change in internal energy of a system is equal to the heat added to the system minus the work done by the system. But for an isothermal process, the change in internal energy is zero (since the temperature remains constant). Therefore, the heat added to the system must be equal to the work done by the system. So, the correct answer is '150 J of heat was added to the gas.'. Final Answer: A

Answer Option 8:

In an isothermal expansion, the temperature of the system remains constant. According to the first law of thermodynamics, the change in internal energy (ΔU) of the system is equal to the heat added to the system (Q) minus the work done by the system (W). Mathematically, it is represented as $\Delta U = Q - W$. For an isothermal process, ΔU is zero because the temperature (and therefore the internal energy) remains constant. So, $Q = W$. Since the gas does 150 J of work, 150 J of heat must be added to the gas to keep the internal energy constant. So, the correct option is A. 150 J of heat was added to the gas.

Final answer: A.

Answer Option 9:

During an isothermal expansion, the temperature of the system remains constant. According to the first law of thermodynamics, the change in internal energy of a system is equal to the heat added to the system minus the work done by the system. For an isothermal process involving an ideal gas, the change in internal energy is zero (because internal energy of an ideal gas is a function of temperature only). Thus, the heat added to the system is equal to the work done by the system. So, if the gas does 150 J of work against its surroundings, 150 J of heat must have been added to the gas to maintain the constant temperature. Final answer: A. '150 J of heat was added to the gas.'

Question 40:

'An object carries a charge of -1 C . How many excess electrons does it contain?', A. ' 6.25×10^{18} ', B. ' 8.00×10^{18} ', C. ' 1.60×10^{19} ', D. ' 3.20×10^{19} '

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Answer Option 1:

The charge of one electron is approximately $-1.60 \times 10^{-19}\text{ C}$. Therefore, an object with a charge of -1 C will contain about $-1\text{ C} / -1.60 \times 10^{-19}\text{ C/electron} = 6.25 \times 10^{18}$ electrons. Hence, the answer is A.

' 6.25×10^{18} '

=====

Answer Option 2:

The charge of one electron is $-1.6 \times 10^{-19}\text{ C}$. To find the number of excess electrons, divide the total charge by the charge of one electron, which is $-1\text{ C} \div -1.6 \times 10^{-19}\text{ C/electron} = 6.25 \times 10^{18}$ electrons.

So, the object contains 6.25×10^{18} excess electrons. Final answer: A.

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Answer Option 3:

The charge of one electron is approximately $-1.6 \times 10^{-19}\text{ C}$. Therefore, if an object carries a charge of -1 C , it contains approximately $1/-1.6 \times 10^{-19} = 6.25 \times 10^{18}$ excess electrons. So, the answer is A.

' 6.25×10^{18} '.

=====

Answer Option 4:

The charge of an electron is approximately $-1.6 \times 10^{-19}\text{ C}$. Therefore, an object carrying a charge of -1 C contains approximately $1\text{ C} / 1.6 \times 10^{-19}\text{ C/electron} = 6.25 \times 10^{18}$ electrons. This is the number of excess electrons needed to give the object a charge of -1 C . Final Answer: A

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Answer Option 5:

The charge of a single electron is about $1.60 \times 10^{-19}\text{ C}$. Therefore, a charge of -1 C would correspond to an excess of approximately $1/1.60 \times 10^{-19}$ electrons. Simplifying, we get 6.25×10^{18} excess electrons. The negative sign indicates an excess of negative charge, which corresponds to extra electrons. So the answer is 6.25×10^{18} . Final Answer: A

=====

Answer Option 6:

The charge of one electron is $1.60 \times 10^{-19}\text{ C}$. Therefore, the number of electrons in a 1 C charge is $1/(1.60 \times 10^{-19}) = 6.25 \times 10^{18}$. Since the object carries a charge of -1 C , it contains 6.25×10^{18} excess electrons. So, the final answer is: A. ' 6.25×10^{18} '.

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Answer Option 7:

The charge of one electron is approximately $-1.6 \times 10^{-19}\text{ C}$. To find the number of excess electrons, we divide the total charge by the charge of one electron:

$-1\text{ C} / -1.6 \times 10^{-19}\text{ C/electron} = 6.25 \times 10^{18}$ electrons.

So, the object contains 6.25×10^{18} excess electrons. Final answer: A

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Answer Option 8:

The charge of a single electron is $-1.6 \times 10^{-19}\text{ C}$. Therefore, if an object carries a charge of -1 C , it contains $-1\text{ C} / -1.6 \times 10^{-19}\text{ C/electron} = 6.25 \times 10^{18}$ electrons. The object contains an excess of 6.25×10^{18} electrons. Final answer: A

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Answer Option 9:

The fundamental unit of charge is the charge carried by a single electron, which is $1.6 \times 10^{-19}\text{ C}$. Therefore, to carry a 1 C charge, an object will contain $1 / 1.6 \times 10^{-19} = 6.25 \times 10^{18}$ electrons. This is for a positive charge. Because the object carries a negative charge, it has an excess of electrons. Therefore, the object contains 6.25×10^{18} excess electrons. So, the correct answer is A. ' 6.25×10^{18} '.

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Question 41:

'A guitar string creates a sound wave of known frequency. Which of the following describes a correct and practical method of measuring the wavelength of the sound wave with a meterstick?'; A. 'Lightly touch the guitar string in the middle such that a single node is created. Measure the length of the string; this is the wavelength.', B. 'Measure the length of the guitar string; this is half the wavelength.', C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.', D. 'Measure the peak-to-peak distance of the wave as it passes; this is the wavelength.'

=====

Answer Option 1:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Answer Option 2:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Answer Option 3:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Answer Option 4:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Answer Option 5:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Answer Option 6:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Answer Option 7:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Answer Option 8:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Answer Option 9:

C. 'Adjust the length of a pipe placed near the string so that resonances are heard. Measure the difference between the pipe lengths for consecutive resonances; this is half the wavelength.'

Question 42:

'Which of the following statements about images is true?', A. 'Images produced by concave lenses are always real.', B. 'Images produced by concave mirrors are always real.', C. 'Images produced by convex lenses can be both real and virtual.', D. 'Images produced by convex mirrors can be both real and virtual.'

=====

Answer Option 1:

C. 'Images produced by convex lenses can be both real and virtual.'

Answer Option 2:

C. 'Images produced by convex lenses can be both real and virtual.'

Answer Option 3:

C. 'Images produced by convex lenses can be both real and virtual.'

Answer Option 4:

C. 'Images produced by convex lenses can be both real and virtual.'

Answer Option 5:

C. 'Images produced by convex lenses can be both real and virtual.'

Answer Option 6:

The correct statement is: C. 'Images produced by convex lenses can be both real and virtual.'

Answer Option 7:

The correct statement is: 'Images produced by convex lenses can be both real and virtual.' Final answer: C.

Answer Option 8:

The correct answer is C. 'Images produced by convex lenses can be both real and virtual.' This is because the image formed by a convex lens can be real if the object is placed beyond the focus of the lens, and virtual if the object is placed between the lens and the focus. Final Answer: C.

Answer Option 9:

The correct statement is C. 'Images produced by convex lenses can be both real and virtual.'

Explanation: Convex lenses can produce both real and virtual images depending on the position of the object. If the object is at a distance greater than the focal length of the lens, a real image is formed. If the object is at a distance less than the focal length, a virtual image is formed.

Option A is incorrect because concave lenses always produce virtual images. Option B is incorrect because concave mirrors can produce both real and virtual images. Option D is incorrect as convex mirrors always produce virtual images.

Therefore, the correct final answer is C.

Question 43:

'Pretend someone actually managed to dig a hole straight through the center of the Earth all the way to the other side. If an object were dropped down that hole, which of the following would best describe its motion? Assume ideal conditions and that the object cannot be destroyed.', A. 'It would fall to the center of the Earth and stop there.', B. 'It would fall through the hole to the other side, continue past the opposite side's opening, and fly into space.', C. 'It would oscillate back and forth from one opening to the other indefinitely.', D. 'It would fall to the other side and stop there.'

=====

Answer Option 1:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

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Answer Option 2:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

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Answer Option 3:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

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Answer Option 4:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

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Answer Option 5:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

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Answer Option 6:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

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Answer Option 7:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

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Answer Option 8:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

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Answer Option 9:

C. 'It would oscillate back and forth from one opening to the other indefinitely.'

=====

Question 44:

'A horizontal spring-block oscillator is in motion when a second block of equal mass falls on top of the oscillating block. If the two blocks stick together, what effect will this have on the amplitude of the oscillations?', A. 'It will increase the amplitude.', B. 'It will decrease the amplitude.', C. 'It will have no effect.', D. 'It would depend on where the original block was in its cycle when the second block fell.'

=====

Answer Option 1:

B. 'It will decrease the amplitude.'

=====

Answer Option 2:

B. 'It will decrease the amplitude.'

=====

Answer Option 3:

B. 'It will decrease the amplitude.'

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Answer Option 4:

B. 'It will decrease the amplitude.'

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Answer Option 5:

B. 'It will decrease the amplitude.'

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Answer Option 6:

B. 'It will decrease the amplitude.'

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Answer Option 7:

B. 'It will decrease the amplitude.'

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Answer Option 8:

B. 'It will decrease the amplitude.'

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Answer Option 9:

B. 'It will decrease the amplitude.'

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Question 45:

'In which of the following situations involving a source of sound and a detector of the sound is it possible that there is NO perceived Doppler shift?'; A. 'The source travels toward the stationary detector.'; B. 'The detector travels toward the stationary source.'; C. 'Both the source and detector travel in the same direction.'; D. 'Both the source and detector travel in opposite directions, with the source and detector moving away from each other.'

=====

Answer Option 1:

The Doppler shift occurs when there is relative motion between the source and the observer. However, if both the source and the detector are moving in the same direction at the same speed, then there is no relative motion. Hence, there will be no perceived Doppler shift. So, the correct answer is C. 'Both the source and detector travel in the same direction.'

Answer Option 2:

The Doppler effect is the change in frequency or wavelength of a wave for an observer moving relative to the wave source. The only situation in which there will be no perceived Doppler shift is when the source and the detector are moving at the same speed in the same direction because there is no relative motion between the two. So, the correct answer is C. 'Both the source and detector travel in the same direction.'

Answer Option 3:

The correct answer is C: 'Both the source and detector travel in the same direction.' As long as the source and detector are moving at the same speed, there will be no perceived Doppler shift. The Doppler shift is a change in frequency or wavelength of a wave for an observer who is moving relative to the wave source. If both source and observer are moving at the same speed and in the same direction, the observer will not perceive any change in the frequency of the sound.

Answer Option 4:

The Doppler shift occurs when there is a relative velocity between a source of a wave and an observer. If they are both moving at the same velocity and direction, then there is no relative velocity. Thus, the answer is C. 'Both the source and detector travel in the same direction.'

Answer Option 5:

The perceived Doppler shift is zero when the source and the detector are stationary with respect to each other. This means that they could either be both stationary or moving with the same velocity in the same direction. Therefore, the correct answer is C. 'Both the source and detector travel in the same direction.'

Answer Option 6:

The perceived Doppler shift will be zero only if the source and the detector are either both stationary or both moving with the same speed in the same direction. Therefore, the correct answer is C. 'Both the source and detector travel in the same direction.'

Answer Option 7:

The perceived Doppler shift occurs when there is relative motion between the source and the detector of the sound. If both the source and the detector are moving in the same direction at the same speed, there would be no relative motion between them, and therefore no perceived Doppler shift. Therefore, the correct answer is C. 'Both the source and detector travel in the same direction.'

Answer Option 8:

The Doppler effect refers to the change in frequency or wavelength of a wave in relation to an observer who is moving relative to the wave source. However, if both the source and the detector are moving in the same direction and at the same speed, there will be no relative motion between them, and therefore no perceived Doppler shift. So, the correct answer is C. 'Both the source and detector travel in the same direction.'

Answer Option 9:

The Doppler effect refers to the change in frequency or wavelength of a wave for an observer moving relative to the source of the wave. If both the source of the sound and the detector of the sound are moving in the same direction at the same speed, there would be no relative motion between them, and thus there would be no perceived Doppler shift. Therefore, the correct answer is C. 'Both the source and detector travel in the same direction.'

Question 46:

'A solid plastic cube with uniform density (side length = 0.5 m) of mass 100 kg is placed in a vat of fluid whose density is 1200 kg/m³. What fraction of the cube's volume floats above the surface of the fluid?',

A. '1.0/9', B. '1.0/3', C. '2.0/3', D. '4.0/5'

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Answer Option 1:

The density of the cube is mass/volume = 100 kg / (0.5 m)³ = 800 kg/m³. Applying Archimedes' principle, the fraction of the cube's volume submerged in the fluid is the ratio of the cube's density to the fluid's density, or 800 kg/m³ / 1200 kg/m³ = 2/3. Therefore, the fraction of the cube's volume that is floating above the fluid's surface is 1 - 2/3 = 1/3. Final Answer: B.

Answer Option 2:

The cube's density is given by its mass divided by its volume, so the cube's density is 100 kg / (0.5 m)³ = 800 kg/m³. The fraction of the cube's volume that is submerged is given by the ratio of the cube's density to the fluid's density, so the fraction submerged is 800 kg/m³ / 1200 kg/m³ = 2/3. Therefore, the fraction of the cube's volume that floats above the surface is 1 - 2/3 = 1/3. Final answer: B

Answer Option 3:

The density of the cube is its mass divided by its volume, which is (100 kg)/(0.5 m)³ = 800 kg/m³. According to Archimedes' principle, the volume of fluid displaced by a submerged object is equal to the volume of an object made from fluid with the same mass as the submerged object. Therefore, the fraction of the cube's volume that is submerged is the ratio of the cube's density to the fluid's density, or 800/1200 = 2/3. Hence, the fraction of the cube's volume that is above the surface of the fluid is 1 - 2/3 = 1/3. Final answer: B.

Answer Option 4:

The density of the cube is mass/volume = 100 kg / (0.5 m)³ = 1600 kg/m³.

According to Archimedes' principle, the volume of fluid displaced by the cube is equal to the weight of the cube. Therefore, the volume of the cube submerged in the fluid is (density of cube / density of fluid) * volume of cube = (1600 kg/m³ / 1200 kg/m³) * (0.5 m)³ = (4/3) * (0.5 m)³ = (2/3) * (0.5 m)³.

The volume of the cube that floats above the surface of the fluid is the total volume of the cube minus the volume of the cube submerged in the fluid, which is (0.5 m)³ - (2/3) * (0.5 m)³ = (1/3) * (0.5 m)³.

Therefore, the fraction of the cube's volume that floats above the surface of the fluid is ((1/3) * (0.5 m)³) / (0.5 m)³ = 1/3. Final answer: B

Answer Option 5:

The density of the cube is its mass divided by its volume, or 100 kg / (0.5 m)³ = 800 kg/m³.

Archimedes' principle states that the buoyant force on an object submerged in a fluid is equal to the weight of the fluid displaced by the object. The cube floats so that the weight of the cube is equal to the weight of the fluid it displaces, or (mass of cube)(gravity) = (volume of cube submerged)(density of fluid)(gravity).

The gravity term cancels out, and the volume of cube submerged divided by the total volume of the cube is (mass of cube)/(density of fluid) = 800 kg/m³ / 1200 kg/m³ = 2/3.

Thus, 2/3 of the cube's volume is submerged, so 1 - 2/3 = 1/3 of the cube's volume floats above the surface of the fluid. The answer is B, '1.0/3'.

Answer Option 6:

The density of the plastic cube is its mass divided by its volume. The volume of the cube is (0.5 m)³ = 0.125 m³, so the density of the plastic is 100 kg / 0.125 m³ = 800 kg/m³.

In order for the cube to float, the weight of the fluid displaced must equal the weight of the cube. The weight of the cube is its mass (100 kg) multiplied by gravity (approximated as 9.8 m/s²), so the weight of the cube is 980 N.

The weight of the fluid displaced is the volume of the fluid displaced multiplied by the density of the fluid and gravity. Since the cube and the fluid displaced are in equilibrium, the volume of the fluid displaced must be equal to the volume of the cube that is submerged in the fluid.

Let V be the volume of the cube that is submerged in the fluid. Therefore, V * 1200 kg/m³ * 9.8 m/s² = 980 N. Solving for V, we get V = 0.08 m³.

Since the volume of the cube is 0.125 m³, the fraction of the cube's volume that floats above the surface of the fluid is 1 - 0.08/0.125 = \boxed{0.36}. However, none of the options matches this result, implying that there might be an error in the question or the provided options.

Answer Option 7:

The cube's density is its mass divided by its volume, or 100 kg / (0.5 m)³ = 800 kg/m³. The fraction of the cube's volume that is submerged is equal to the cube's density divided by the fluid's density, or 800 kg/m³ / 1200 kg/m³ = 2/3. Therefore, the fraction of the cube's volume that floats above the surface of the fluid is 1 - 2/3 = \boxed{1/3}. Final Answer: B

Answer Option 8:

The density of the cube is its mass divided by its volume, which is $100 \text{ kg} / (0.5 \text{ m})^3 = 800 \text{ kg/m}^3$.

According to Archimedes' principle, the volume of fluid displaced by an object submerged in the fluid is equal to the volume of the object that is submerged. Thus, in order for the cube to float, it must displace a volume of fluid whose mass is equal to the mass of the cube.

The mass of the fluid displaced by the cube is equal to its volume times its density, so the volume of the cube that is submerged is $100 \text{ kg} / 1200 \text{ kg/m}^3 = 0.0833 \text{ m}^3$.

The total volume of the cube is $(0.5 \text{ m})^3 = 0.125 \text{ m}^3$, so the fraction of the cube's volume that is submerged is $0.0833 / 0.125 = 2/3$.

Therefore, the fraction of the cube's volume that floats above the surface of the fluid is $1 - 2/3 = \boxed{1/3}$. Final Answer: B

Answer Option 9:

The density of the cube is its mass divided by its volume, or $100 \text{ kg} / (0.5 \text{ m})^3 = 800 \text{ kg/m}^3$. The fraction of the cube's volume that floats above the surface of the fluid is equal to the fraction of the cube's weight that is not supported by the buoyant force, which in turn is equal to the fraction by which the cube's density exceeds the fluid's density. Therefore, the fraction of the cube's volume that floats above the surface is $(800 \text{ kg/m}^3 - 1200 \text{ kg/m}^3) / 800 \text{ kg/m}^3 = -400 \text{ kg/m}^3 / 800 \text{ kg/m}^3 = -0.5$. The negative sign indicates that the cube sinks rather than floats, so the correct answer is that none of the cube's volume floats above the surface. However, given the choices in the question, we can reinterpret the question as asking for the fraction of the cube that is submerged, which is $1.0 - 0.5 = 0.5$. This is not one of the given choices, but the closest answer is B. '1.0/3'. However, the correct and precise answer should have been 1.0/2 which is not in the options.

Question 47:

'A person standing on a horizontal floor is acted upon by two forces: the downward pull of gravity and the upward normal force of the floor. These two forces', A. 'have equal magnitudes and form an action-reaction pair', B. 'have equal magnitudes and do not form an action-reaction pair', C. 'have unequal magnitudes and form an action-reaction pair', D. 'have unequal magnitudes and do not form an action-reaction pair'

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Answer Option 1:

B. 'have equal magnitudes and do not form an action-reaction pair'

Answer Option 2:

B. 'have equal magnitudes and do not form an action-reaction pair'

Answer Option 3:

B. 'have equal magnitudes and do not form an action-reaction pair'

Answer Option 4:

The downward pull of gravity and the upward normal force of the floor do have equal magnitudes (which is why the person is not accelerating), but they do not form an action-reaction pair. According to Newton's third law, the action-reaction pair to the pull of gravity on the person is the pull of the person on the Earth. The reaction to the normal force would be the force the person applies downward on the floor. So the correct answer is 'B. have equal magnitudes and do not form an action-reaction pair'.

Answer Option 5:

The downward pull of gravity and the upward normal force of the floor have equal magnitudes (which is why the person remains stationary and doesn't start floating or sinking into the floor). However, they do not form an action-reaction pair as per Newton's third law. The reaction to the force of gravity (action) is the gravitational pull exerted by the person on Earth, and the reaction to the normal force (action) is the force exerted by the person on the floor. Thus, the correct answer is B. 'have equal magnitudes and do not form an action-reaction pair'.

Answer Option 6:

The downward pull of gravity and the upward normal force of the floor have equal magnitudes (which is why the person doesn't sink into the floor or float into the air), but they do not form an action-reaction pair. The action-reaction pair to the pull of gravity would be the person's own gravitational pull on the Earth, and the action-reaction pair to the normal force would be the person's force on the floor. So the correct answer is B. 'have equal magnitudes and do not form an action-reaction pair'.

Answer Option 7:

The correct answer is B. 'have equal magnitudes and do not form an action-reaction pair'. The forces have equal magnitudes as they are balanced (the person is not moving). However, they do not form an action-reaction pair according to Newton's third law. The action-reaction pair would be the person's weight acting on Earth and Earth's gravitational pull on the person. The normal force is a reaction to the person's weight but isn't part of an action-reaction pair with the weight.

Answer Option 8:

The downward pull of gravity and the upward normal force of the floor have equal magnitudes (otherwise the person would either be sinking into the floor or floating off of it). However, they do not form an action-reaction pair according to Newton's third law. The action-reaction pair for the gravitational force is the force that the person exerts on the Earth. The action-reaction pair for the normal force is the force that the person exerts on the floor (which is also equal and opposite to the normal force). So, the correct answer is B. 'have equal magnitudes and do not form an action-reaction pair'

Answer Option 9:

The correct answer is B. 'have equal magnitudes and do not form an action-reaction pair'.

The forces have equal magnitudes because the person is not accelerating, indicating that the net force acting on the person is zero. This means the upward force (normal force from the floor) must balance the downward force (gravity).

However, these two forces do not form an action-reaction pair. According to Newton's third law, action-reaction pairs occur when two objects interact, and the forces are of equal magnitude but opposite directions. In this case, the action-reaction pair for the force of gravity would be the force that the person exerts on the Earth. Similarly, the action-reaction pair for the normal force would be the downward force that the person exerts on the floor.

Question 48:

'A particle of mass m and charge Q and velocity V is directed toward a uniform electric field of strength E and travels a distance d . How far does the particle travel if the original velocity is doubled and the mass is cut in half?', A. ' $4d$ ', B. ' $2d$ ', C. ' d ', D. ' $1/2d$ '

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Answer Option 1:

The force that the electric field exerts on the charged particle is $F = QE$. According to Newton's second law, $F = ma$, so $a = QE/m$. The time it takes for the particle to stop is $t = V/a = Vm/(QE)$. The distance the particle travels is $d = Vt/2 = V^2m/(2QE)$. When the velocity is doubled and the mass is cut in half, the new distance is $(2V)^2(m/2)/(2QE) = 2d$. So the particle travels twice as far. Final Answer: B. ' $2d$ '

Answer Option 2:

The force experienced by a charged particle in an electric field is $F = QE$. This force changes the kinetic energy of the particle, which is $(1/2)mv^2$. Thus, the distance the particle travels depends on the change in kinetic energy.

When the velocity is doubled and the mass is halved, the kinetic energy becomes $(1/2)(m/2)(2v)^2 = mv^2$, which is double the original kinetic energy. Since the distance the particle travels is proportional to the change in kinetic energy, doubling the kinetic energy will double the distance traveled.

Final Answer: B. ' $2d$ '

Answer Option 3:

The electrical force on the particle is given by $F = QE$, and the acceleration of the particle due to this force is $a = F/m = QE/m$. The distance d traveled by the particle under this constant acceleration from an initial velocity V is given by the equation $d = V^2/(2a) = V^2m/(2QE)$. If the velocity is doubled and the mass is cut in half, the distance d' is given by $d' = (2V)^2/(2(QE/(m/2))) = 4V^2m/(2QE) = 4d$. So the particle travels four times the original distance. Final Answer: A

Answer Option 4:

The force on the particle in the electric field is given by $F = EQ$. The acceleration of the particle is then $F/m = EQ/m$. Given the acceleration and initial velocity, the distance travelled by the particle under constant acceleration is given by $d = V^2/(2a) = V^2m/(2EQ)$.

If we double the initial velocity and cut the mass in half, the new distance d' traveled by the particle is given by $(2V)^2/(2(m/2)EQ) = 4V^2/(mEQ) = 4d$.

So the particle travels a distance four times its original distance. Final answer: A. ' $4d$ '

Answer Option 5:

The force on the particle in the electric field is $F = QE$. According to Newton's second law, this force causes an acceleration $a = F/m = QE/m$. The distance the particle travels before stopping is given by the kinematic equation $d = V^2/(2a) = mV^2/(2QE)$. If the velocity is doubled and the mass halved, the new distance d' will be $(1/2)(2V)^2/(2(QE)) = 2d$. So, the particle will travel twice as far. Final Answer:

B. ' $2d$ '

Answer Option 6:

The force exerted on the particle by the electric field is $F = QE$. This force will cause the particle to decelerate, and the deceleration $a = F/m = QE/m$. The time it takes for the particle to come to rest is $t = V/a = Vm/QE$. The distance traveled by the particle is $d = Vt/2 = V^2m/2QE$.

If the original velocity is doubled and the mass is cut in half, the new distance traveled is $d' = (2V)^2(m/2)/2QE = 2V^2m/QE = 2d$. So, the particle will travel twice as far. Final answer: B

Answer Option 7:

The force acting on the particle due to the electric field is given by $F = QE$. The acceleration of the particle is then $F/m = QE/m$. The distance travelled under constant acceleration is given by $d = 0.5at^2$, where t is the time. If the velocity is doubled and the mass is cut in half, the acceleration becomes $4QE/(m/2) = 8QE/m$. However, the time for the particle to travel will be halved (since velocity = distance/time), so the distance travelled becomes $d' = 0.5 \cdot 8QE/m \cdot (t/2)^2 = 2d$. Therefore, the particle travels twice the original distance, so the answer is B. ' $2d$ '.

Answer Option 8:

The force on the particle due to the electric field is $F = EQ$. According to Newton's second law, the acceleration of the particle is $a = F/m = EQ/m$.

The distance it travels before stopping is given by $d = V^2/2a = V^2m/2EQ$.

If the velocity is doubled and the mass is cut in half, the distance it travels before stopping becomes $d' = (2V)^2/(2(m/2))/(2EQ) = 4V^2m/2EQ = 4d$.

Therefore, the particle travels 4 times the original distance. So, the final answer is A. ' $4d$ '.

Answer Option 9:

The force on the particle due to the electric field is $F = EQ$. According to Newton's second law, $F = ma$, so $a = EQ/m$. The time it takes for the particle to stop (when its velocity becomes zero) is $t = V/a = Vm/EQ$. The distance the particle travels in this time is $d = Vt/2 = V^2m/2EQ$. If the velocity is doubled and the mass is cut in half, this becomes $d' = (2V)^2(m/2)/2EQ = 2V^2m/EQ = 2d$. So the new distance is twice the old distance. Final answer: B.

Question 49:

'An object of mass m_1 experiences a linear, elastic collision with a stationary object of unknown mass. In addition to m_1 , what is the minimum necessary information that would allow you to determine the mass of the second object?', A. 'The final speed of object 1', B. 'The initial speed of object 1', C. 'The final speed of object 2', D. 'Any 2 of the above values'

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Answer Option 1:

D. 'Any 2 of the above values'

Answer Option 2:

D. 'Any 2 of the above values'

Answer Option 3:

D. 'Any 2 of the above values'

Answer Option 4:

D. 'Any 2 of the above values'

Answer Option 5:

D. 'Any 2 of the above values'

Answer Option 6:

D. 'Any 2 of the above values'

Explanation: From the principles of conservation of momentum and conservation of kinetic energy, we know that when two objects collide, the total momentum and total kinetic energy of the two objects must be the same before and after the collision. Therefore, in this case, to find the unknown mass m_2 , we need at least two pieces of information. So, the correct answer is D. 'Any 2 of the above values'.

Answer Option 7:

D. 'Any 2 of the above values'

In an elastic collision, both momentum and kinetic energy are conserved.

The conservation of momentum gives us the equation: $m_1 \cdot v_{1_initial} = m_1 \cdot v_{1_final} + m_2 \cdot v_{2_final}$

The conservation of kinetic energy gives us the equation: $0.5 \cdot m_1 \cdot v_{1_initial}^2 = 0.5 \cdot m_1 \cdot v_{1_final}^2 + 0.5 \cdot m_2 \cdot v_{2_final}^2$

So, we have 2 equations with 2 unknowns (m_2 and v_{2_final}), therefore, we need 2 values from the list (initial speed of object 1, final speed of object 1, final speed of object 2) to solve these equations and find the mass m_2 of the second object.

Answer Option 8:

D. 'Any 2 of the above values'

Linear, elastic collisions obey two laws: conservation of momentum and conservation of kinetic energy. Conservation of momentum states that the total momentum before the collision equals the total momentum after the collision. Conservation of kinetic energy states that the total kinetic energy before the collision equals the total kinetic energy after the collision.

In this case, to determine the mass of the second object (m_2), it's necessary to have two independent equations because there are two unknowns (the mass m_2 and the final speed of the second object).

Therefore, you need at least two pieces of information from the list. You could use the initial speed of the first object (m_1), the final speed of the first object and the final speed of the second object. Hence, the correct answer is D. 'Any 2 of the above values'.

Answer Option 9:

D. 'Any 2 of the above values'

In order to determine the mass of the second object, you must know the initial and final momenta of the first object. The momentum of an object is the product of its mass and velocity, so knowing both the initial and final velocities of the first object, in addition to its mass, allows you to calculate the change in its momentum. Since momentum is conserved in a linear, elastic collision, this change in momentum of the first object must equal the final momentum of the second object. Therefore, knowing the mass of the first object and any two of the above values would allow you to determine the mass of the second object.

Question 50:

'In an experiment designed to study the photoelectric effect, it is observed that low-intensity visible light of wavelength 550 nm produced no photoelectrons. Which of the following best describes what would occur if the intensity of this light were increased dramatically?'. A. 'Almost immediately, photoelectrons would be produced with a kinetic energy equal to the energy of the incident photons.'. B. 'Almost immediately, photoelectrons would be produced with a kinetic energy equal to the energy of the incident photons minus the work function of the metal.'. C. 'After several seconds, necessary for the electrons to absorb sufficient energy from the incident light, photoelectrons would be produced with a kinetic energy equal to the energy of the incident photons minus the work function of the metal.'. D. 'Nothing would happen.'

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Answer Option 1:

D. 'Nothing would happen.'

Answer Option 2:

D. 'Nothing would happen.'

Answer Option 3:

D. 'Nothing would happen.'

Answer Option 4:

D. 'Nothing would happen.'

Answer Option 5:

D. 'Nothing would happen.'

Answer Option 6:

D. 'Nothing would happen.'

Answer Option 7:

D. 'Nothing would happen.'

Answer Option 8:

D. 'Nothing would happen.'

Answer Option 9:

D. 'Nothing would happen.'
