NIOS Class 12 Physics Sample Paper-2

Duration: 180 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **43** Questions. The paper is divided into two sections: **Section A – 40** marks, **Section B – 40** marks.
- **Section A** consists of
  - **Q.No. 1 to 16** – Multiple Choice type questions (MCQs) carrying 1 mark each. Select and write the most appropriate option out of the four options given in each of these questions. An internal choice has been provided in some of these questions. You have to attempt only one of the given choices in such questions.
  - **Q. No. 17 to 28**– Objective-type questions. Q. No. 17 to 28 carry 02 marks each (with 2 sub- parts of 1 mark each). Attempt these questions as per the instructions given for each of the questions 17 –28.
- **Section B** consists of
  - **Q.No. 29 to 37** – Very Short questions carrying 02 marks each to be answered in the range of 30 to 50 words.
  - **Q.No. 38 to 41** – Short Answer type questions carrying 03 marks each to be answered in the range of 50 to 80 words.
  - **Q.No. 42 and 43** – Long Answer type questions carrying 05 marks each to be answered in the range of 80 to 120 words.
- There is **No Negative marking**.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Section: A

Q1. A person of mass 60 kg stands in a lift moving upward with acceleration $2\,\text{m}\,\text{s}^{-2}$. Taking $g = 10\,\text{m}\,\text{s}^{-2}$, the apparent weight of the person is: **(1)**

(A) 480 N

(B) 600 N

(C) 720 N

(D) 120 N

Q2. A uniform wire has resistance 10 Ω. It is stretched uniformly to twice its original length, keeping its volume unchanged. Its new resistance is: **(1)**

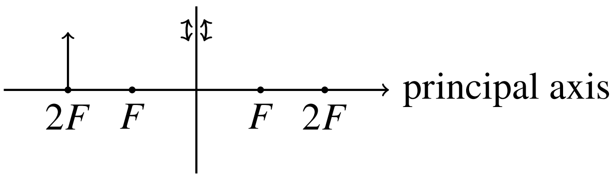
(A) 5 Ω

(B) 10 Ω

(C) 20 Ω

(D) 40 Ω

Q3. An object is placed at $2F$ in front of a convex lens. The nature and position of the image will be: **(1)**



(A) virtual, erect and at F

(B) real, inverted and beyond $2F$

(C) real, inverted and at $2F$

(D) virtual, magnified and on the same side

Q4. For a NOT gate, if the input is logic 1, the output is: **(1)**

(A) 1

(B) 0

(C) unchanged

(D) undefined

Q5. A small sphere falling through a viscous liquid attains terminal velocity when: **(1)**

(A) its weight becomes zero

(B) viscous force becomes zero

(C) net force on it becomes zero

(D) buoyant force becomes greater than weight

Q6. If the momentum of a moving electron is doubled, its de Broglie wavelength becomes: **(1)**

(A) double

(B) half

(C) four times

(D) unchanged

Q7. During adiabatic compression of an ideal gas, its temperature generally: **(1)**

(A) decreases

(B) increases

(C) remains constant

(D) becomes absolute zero

Q8. Two tuning forks of frequencies 256 Hz and 260 Hz are sounded together. The beat frequency is: **(1)**

(A) 2 Hz

(B) 3 Hz

(C) 4 Hz

(D) 516 Hz

Q9. Two capacitors of 2 μF and 3 μF are connected in parallel. Their equivalent capacitance is: **(1)**

(A) 1.2 μF

(B) 2.5 μF

(C) $3.0\,\mu$F

(D) $5.0\,\mu$F

Q10. The work done in stretching a spring of spring constant k from natural length to extension x is: **(1)**

(A) kx

(B) $\frac{1}{2}kx^2$

(C) kx^2

(D) $\frac{1}{2}kx$

Q11. The reddish colour of the Sun near sunset is mainly due to: **(1)**

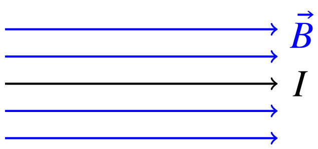
(A) stronger scattering of shorter wavelengths by the atmosphere

(B) total internal reflection in clouds

(C) interference of red and blue light

(D) diffraction at the horizon only

Q12. A straight conductor carrying current I is placed parallel to a uniform magnetic field $\vec{B}$. The magnetic force on the conductor is: **(1)**



(A) BIl

(B) $2BIl$

(C) $BIl/2$

(D) zero

Q13. A full-wave rectifier is preferred over a half-wave rectifier because it: **(1)**

(A) uses only one half-cycle

(B) uses both half-cycles of AC

(C) gives zero DC output

(D) blocks current in both directions

Q14. If the mass defect of a nucleus is 0.01 u, its binding energy is approximately (1 u = 931 MeV): **(1)**

(A) 0.093 MeV

(B) 9.31 MeV

(C) 93.1 MeV

(D) 931 MeV

Q15. The peak value of a sinusoidal alternating current is 10 A. Its rms value is nearly: **(1)**

(A) 5.00 A

(B) 6.00 A

(C) 7.07 A

(D) 14.14 A

Q16. In Young's double-slit experiment, if the screen distance is doubled while slit separation and wavelength remain unchanged, the fringe width becomes: **(1)**

(A) double

(B) half

(C) four times

(D) unchanged

Note: Q. No. 17 to 28 are the objective type questions of 2 marks each.

Q17. Read the passage given below and answer the following questions:

A rocket moves forward because hot gases are expelled backward at high speed. The rocket and the gases exert equal and opposite forces on each other. Similarly, when a gun fires a bullet, the bullet moves forward and the gun recoils backward. In these examples, momentum is conserved when external forces are negligible. **(2)**

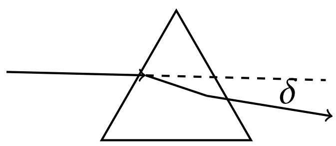
1. Which law of motion explains rocket propulsion?
2. Why does a gun recoil when a bullet is fired?

Q18. Complete the following by using the options given below:
(amplitude, wavelength, frequency, phase, velocity) **(2)**

1. The distance between two consecutive compressions in a longitudinal wave is called . . . .
2. The maximum displacement of a vibrating particle from its mean position is called . . . .

Q19. Read the passage and answer the questions that follow it.

A ray of monochromatic light enters a triangular glass prism and emerges after bending towards the base of the prism. The angle between the incident ray and emergent ray is called angle of deviation. For a particular angle of incidence, the deviation becomes minimum and the path of light inside the prism becomes symmetrical. **(2)**



1. What is meant by angle of deviation?
2. What special property does the light path have at minimum deviation?

Q20. Fill in the blanks: **(2)**

1. The efficiency of a Carnot engine depends only on the temperatures of the and sink.
2. For an ideal gas at constant volume, the work done by the gas is . . . .

Q21. Match the items in Column I with the most appropriate items in Column II: **(2)**

Column I	**Column II**
(a) Streamline flow	(i) Drag force $6\pi\eta rv$
(b) Turbulent flow	(ii) Fluid layers do not cross each other
(c) Stokes' law	(iii) Irregular eddy motion
(d) Terminal velocity	(iv) Constant maximum speed in a viscous medium

Q22. Fill in the blanks: **(2)**

1. In an n-type semiconductor, the majority charge carriers are . . . .
2. The forbidden energy gap of a semiconductor is smaller than that of an . . .

Q23. Write TRUE (T) for the correct statement and FALSE (F) for the incorrect statement: **(2)**

1. Alpha particles have high ionising power but low penetrating power.
2. Beta particles are helium nuclei containing two protons and two neutrons.

Q24. Match the items in Column I with the most appropriate items in Column II: **(2)**

Column I	**Column II**
(a) Wheatstone bridge	(i) Detects small current
(b) Potentiometer	(ii) Measures emf by null method
(c) Moving-coil galvanometer	(iii) Balances four resistances
(d) Transformer	(iv) Changes AC voltage

Q25. Fill in the blanks: **(2)**

1. At Brewster's angle, the reflected and refracted rays are mutually . . . .
2. According to Malus' law, the transmitted intensity through an analyser is $I = I_0$ . . . .

Q26. Match the items in Column I with the most appropriate items in Column II: **(2)**

Column I	Column II
(a) Centripetal force	(i) $\frac{1}{2}mv^2$
(b) Impulse	(ii) mgh near Earth's surface
(c) Kinetic energy	(iii) Directed towards centre of circular path
(d) Gravitational potential energy	(iv) Change in momentum

Q27. Write TRUE (T) for the correct statement and FALSE (F) for the incorrect statement: **(2)**

1. No work is done in moving a charge along an equipotential surface.
2. The capacitance of an isolated conductor depends on the charge placed on it.

Q28. Match the items in Column I with the most appropriate items in Column II: **(2)**

Column I	Column II
(a) Modulation	(i) Extracting information from carrier wave
(b) Demodulation	(ii) Superimposing signal on high-frequency carrier
(c) Bandwidth	(iii) Range of frequencies occupied by a signal
(d) Logic gate	(iv) Performs a Boolean operation

Section: B

Q29. State Pascal's law. Explain briefly how a hydraulic lift works on this principle. **(2)**

Q30. A force of 25 N acts on a body of mass 5 kg initially at rest for 4 s on a smooth surface. Find the acceleration and final velocity. **(2)**

Q31. (i) Write the expression for electric potential due to a point charge and mention whether potential is scalar or vector.

OR

(ii) Three capacitors, each of 6 μF, are connected in series. Find the equivalent capacitance. **(2)**

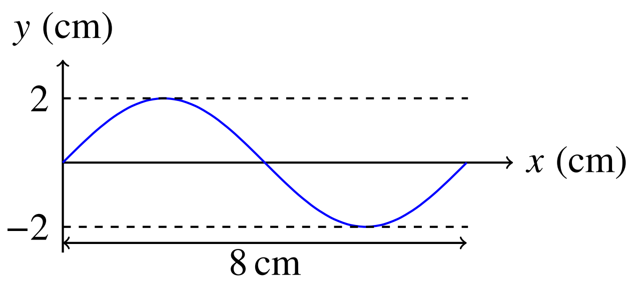
Q32. (i) Explain why the sky appears blue on a clear day.

OR

(ii) State Brewster's law and write its mathematical form. **(2)**

Q33. A gas is supplied 800 J of heat. Its internal energy increases by 300 J. Calculate the work done by the gas. **(2)**

Q34. The following graph represents a transverse wave at an instant. Find its amplitude and wavelength from the graph. **(2)**



Q35. (i) State two important conclusions of Rutherford's alpha-particle scattering experiment.

OR

(ii) Write de Broglie's relation and mention one application of matter waves. **(2)**

Q36. An engine pulls a train with a constant force of 4.0×10^4 N at a speed of 20 m s^{-1}. Calculate the power developed by the engine in kilowatt. **(2)**

Q37. A proton moves perpendicular to a magnetic field of 0.5 T with speed 2×10^6 m s^{-1}. Calculate the magnetic force on it. Take charge of proton = 1.6×10^{-19} C. **(2)**

Q38. Define the following terms with one example each:

A. p-n junction diode

B. Transistor

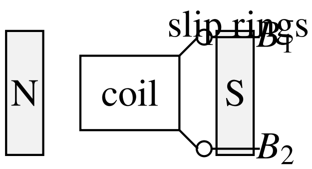
C. Logic gate **(3)**

Q39. (i) In a Young's double-slit experiment, the wavelength of light is 500 nm, slit separation is 0.25 mm and screen distance is 1 m. Calculate the fringe width.

OR

(ii) An object is placed 30 cm in front of a concave mirror of focal length 15 cm. Find the image distance and magnification. **(3)**

Q40. State the principle of an AC generator. Draw a simple labelled diagram and explain the role of slip rings. **(3)**



Q41. (i) Derive the relation $P = Fv$ for a body moving with uniform velocity under a constant force. A machine applies a force of 200 N and moves a load at 3 m s^{-1}. Find its power.

OR

(ii) State the law of conservation of linear momentum. Two carts of masses 2 kg and 3 kg move together after collision with common speed 4 m s^{-1}. If the second cart was initially at rest, find the initial speed of the first cart. **(3)**

Q42. (i) (a) With a ray diagram, explain image formation by a concave mirror when the object is beyond the centre of curvature.

(b) Write Einstein's photoelectric equation. If the frequency of incident radiation is increased above threshold frequency, what happens to the maximum kinetic energy?

OR

(ii) (a) State the conditions for constructive and destructive interference in terms of path difference.

(b) Distinguish between nuclear fission and nuclear fusion with one example of each. **(5)**

Q43. (i) (a) Using energy conservation, derive the maximum height reached by a body projected vertically upward with speed u.

(b) State Archimedes' principle.

(c) Define a reversible thermodynamic process.

(d) What is modulation in communication?

(e) Two sound waves of frequencies 300 Hz and 305 Hz are superposed. Find the beat frequency.

OR

(ii) (a) State the law of conservation of momentum with one example.

(b) What is streamline flow?

(c) Write the first law of thermodynamics.

(d) What is the function of an AND gate?

(e) Define resonance and give one example. **(5)**

Detailed Solutions

Q1.

Solution

Concept: The apparent weight of an individual inside a moving elevator is defined physically as the normal reaction force exerted upward by the floor surface. When the elevator accelerates vertically upward, the net normal force must overcome gravity and also supply the necessary upward acceleration, which is expressed by the equation $N = m(g + a)$.

Step 1: The problem provides the following parameters: the passenger's mass $m = 60\,\text{kg}$, the acceleration due to gravity $g = 10\,\text{m}\,\text{s}^{-2}$, and the upward acceleration of the lift $a = 2\,\text{m}\,\text{s}^{-2}$.
Step 2: Applying Newton's second law of motion along the vertical axis of motion yields the force equation: $N - mg = ma$. This can be rewritten to isolate the normal reaction force vector.
Step 3: Substituting the given numbers into the rearranged equation yields: $N = m(g + a) = 60\,\text{kg} \times (10\,\text{m}\,\text{s}^{-2} + 2\,\text{m}\,\text{s}^{-2}) = 60 \times 12 = 720\,\text{N}$. This calculated normal force is equivalent to the passenger's apparent weight.
Final Answer: $720\,\text{N}$

Answer: (C)

Go Back to Question 1

Q2.

Solution

Concept: The electrical resistance of a uniform conductor is given by the formula $R = \rho L/A$. When a metallic wire is stretched uniformly without breaking, its total physical volume remains constant. If the length is doubled, the cross-sectional area must decrease to half, causing the resistance to increase to four times its original value.

Step 1: The original electrical resistance of the wire before stretching is given as $R = 10\,\Omega$.
Step 2: The new length of the stretched wire is $L' = 2L$. Because the volume $V = L \times A$ must remain constant during stretching, the new cross-sectional area becomes $A' = A/2$.
Step 3: Substituting these new dimensions into the resistance formula yields: $R' = \rho L'/A' = \rho(2L)/(A/2) = 4(\rho L/A) = 4R$. This confirms that the total resistance scales with the square of the length change.
Step 4: Substituting the initial resistance value of $10\,\Omega$ into this relation gives: $R' = 4 \times 10\,\Omega = 40\,\Omega$.
Final Answer: $40\,\Omega$

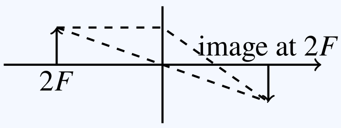
Answer: (D)

Go Back to Question 2

Q3.

Solution

Concept: For a thin convex lens, placing a real object exactly at a distance of twice the focal length ($2F$) produces an image located precisely at twice the focal length on the opposite side. The resulting image is real, inverted, and maintains the exact same dimensions as the original object.



Step 1: The object is positioned at a distance equal to twice the focal length, $2F$.
Step 2: Tracing standard geometric light rays reveals that a parallel ray refracts through the principal focus, while a central ray passes undeviated through the optical center, intersecting at $2F$ on the other side.
Step 3: Because the refracted light rays physically converge at this intersection point, the image is real. Since it forms completely beneath the horizontal principal axis, its orientation is inverted.
Final Answer: real, inverted and at 2F

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept: A digital NOT gate acts as a logical inverter within a circuit. Its primary electronic function is to output the mathematical complement of its input signal level. Consequently, an input of logic high (1) results in a logic low (0), and a logic low (0) yields a logic high (1).

Step 1: The problem specifies that the digital input level supplied to the terminal of the NOT gate is a logic 1.
Step 2: The logic operation performed by the inversion gate changes the true value into its false counterpart. Therefore, an input of 1 is inverted to an output level of 0.
Final Answer: 0

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: Terminal velocity is the steady, maximum velocity achieved by an object falling through a viscous fluid. At terminal velocity, the downward force of gravity is perfectly balanced by the sum of the upward buoyant force and the viscous drag force, reducing the net force to zero.

Step 1: When a solid sphere is initially dropped into a viscous fluid, its downward weight exceeds the upward forces, causing it to accelerate downward and gain speed.
Step 2: According to Stokes' law, the upward viscous drag force increases linearly with the sphere's velocity.
Step 3: Eventually, the increasing upward forces match the downward gravitational force. At this point, the net force drops to zero, the acceleration vanishes, and the sphere continues downward at a constant terminal velocity.
Final Answer: net force on it becomes zero

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept: According to the de Broglie hypothesis, a moving particle exhibits wave-like properties, and its associated wavelength is given by $\lambda = h/p$, where h is Planck's constant and p is linear momentum. This formula shows that the de Broglie wavelength is inversely proportional to the particle's momentum.

Step 1: The initial state of the moving particle is defined by its momentum p and its corresponding de Broglie wavelength, expressed by the relationship $\lambda = h/p$.
Step 2: The problem states that the momentum of the particle is doubled, which gives a new momentum value of $p' = 2p$.
Step 3: Substituting this new momentum into the de Broglie equation yields the new wavelength: $\lambda' = h/(2p) = \frac{1}{2}(h/p) = \lambda/2$. This confirms that doubling the momentum halves the wavelength.
Final Answer: half

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept: An adiabatic process is a thermodynamic change during which no heat is exchanged between the system and its surroundings ($Q = 0$). When a gas is compressed adiabatically, work is performed on the gas, which increases its internal energy and raises its temperature.

Step 1: For an adiabatic compression process, the system is thermally insulated from its environment, which sets the net heat exchange variable to $Q = 0$.
Step 2: According to the first law of thermodynamics, $\Delta U = Q - W$. Since work is performed on the gas during compression, W is negative, which results in a positive change in internal energy ($\Delta U > 0$).
Step 3: For an ideal gas, internal energy depends exclusively on temperature. Because the internal energy increases during compression, the absolute temperature of the gas must also increase.
Final Answer: increases

Answer: (B)
Go Back to Question 7

Q8.

Solution

Concept: Beat frequency is an acoustic phenomenon that occurs when two sound waves of slightly different frequencies overlap. The resulting interference causes a periodic variation in sound intensity, and the beat frequency is equal to the absolute difference between the two source frequencies: $f_b = |f_1 - f_2|$.

Step 1: The problem specifies two distinct acoustic wave frequencies: $f_1 = 256\,\text{Hz}$ and $f_2 = 260\,\text{Hz}$.
Step 2: Substituting these values into the beat frequency formula yields: $f_b = |260\,\text{Hz} - 256\,\text{Hz}| = 4\,\text{Hz}$. This means the listener will hear four intensity maximums every second.
Final Answer: 4 Hz

Answer: (C)
Go Back to Question 8

Q9.

Solution

Concept: When electrical capacitors are connected in a parallel configuration, the potential difference across each capacitor is identical. The total equivalent capacitance (C_{eq}) of the network is calculated by directly summing the individual capacitances: $C_{eq} = C_1 + C_2$.

Step 1: The circuit parameters are given as two individual capacitances: $C_1 = 2\,\mu\text{F}$ and $C_2 = 3\,\mu\text{F}$.
Step 2: Substituting these values into the parallel capacitance formula gives: $C_{eq} = 2\,\mu\text{F} + 3\,\mu\text{F} = 5\,\mu\text{F}$. This directly increases the total charge storage capacity of the network.
Final Answer: $5.0\,\mu\text{F}$

Answer: (D)

Go Back to Question 9

Q10.

Solution

Concept: The restoring force of an ideal spring increases linearly with its extension according to Hooke's law, $F = kx$. Because this force varies during stretching, the total mechanical work performed is equal to the area under the force-extension graph, which forms a triangle with a base of x and a height of kx.

Step 1: According to Hooke's law, the force required to maintain a spring at a steady linear extension x is equal to kx, where k represents the spring constant.
Step 2: The total mechanical work performed during stretching is calculated using the geometric area under the linear force graph: Work $= \frac{1}{2} \times \text{base} \times \text{height}$.
Step 3: Substituting the extension base x and the force height kx into this area formula yields the strain energy expression: $W = \frac{1}{2} \times x \times kx = \frac{1}{2}kx^2$. **Final Answer:** $1_{\overline{2kx^2}}$

Answer: (B) **Go Back to Question 10**

Q11.

Solution

Concept: The physical phenomenon of Rayleigh scattering describes how electromagnetic radiation is scattered by particles much smaller than its wavelength, with an intensity that scales inversely with the fourth power of the wavelength, written as $I \propto 1/\lambda^4$. This relationship dictates that shorter wavelengths, such as violet and blue, experience much stronger atmospheric scattering than longer red wavelengths.

Step 1: During sunrise or sunset, the sun is positioned near the horizon, meaning sunlight must traverse a significantly longer path through the dense, lower layers of Earth's atmosphere to reach an observer.
Step 2: Due to this extended atmospheric path, the shorter blue and violet components of the solar spectrum undergo intense scattering and are dispersed away from the observer's direct line of sight.
Step 3: Consequently, the direct, unscattered light that successfully passes through the atmosphere and reaches the observer is highly enriched in the remaining longer, less-scattered wavelengths, which primarily consist of red and orange.
Final Answer: stronger scattering of shorter wavelengths

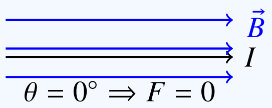
Answer: (A)

Go Back to Question 11

Q12.

Solution

Concept: The net magnetic force experienced by a straight, current-carrying electrical conductor placed within a uniform magnetic field is given by the vector cross-product relation, which evaluates to the scalar formula $F = BIl \sin\theta$. In this expression, θ represents the specific geometric angle formed between the direction of the current flow and the magnetic field vector.



Step 1: The problem states that the straight conductor is oriented completely parallel to the uniform magnetic field lines, which means that the geometric angle between the current vector and the field lines is exactly $\theta = 0°$.
Step 2: Evaluating the trigonometric function for this parallel alignment gives $\sin 0° = 0$. Substituting this value into the force equation gives: $F = BIl \sin 0° = BIl \times 0 = 0$. Thus, no magnetic force acts on the wire.
Final Answer: 0

Answer: (D)

Go Back to Question 12

Q13.

Solution

Concept: Electronic rectification is the process of converting an alternating current (AC) signal into a unidirectional direct current (DC) signal. A half-wave rectifier utilizes a single diode to conduct current during only one half-cycle of the input wave, whereas a full-wave rectifier employs multiple diodes to utilize both half-cycles.

Step 1: In a full-wave rectifier circuit, the arrangement of diodes ensures that the electrical current directed through the output load resistor flows in the exact same direction during both the positive and negative half-cycles of the input alternating voltage.
Step 2: Because both halves of the input waveform are utilized, the resulting output current is significantly smoother, contains fewer ripples, and provides a much higher average DC output voltage than a standard half-wave configuration.
Final Answer: uses both half-cycles of AC

Answer: (B)
Go Back to Question 13

Q14.

Solution

Concept: Nuclear binding energy represents the total energy released when a nucleus is assembled from its constituent nucleons, and it is directly proportional to the net mass defect. In nuclear physics, a mass defect of exactly one atomic mass unit (1 u) corresponds to an energy equivalent of approximately 931 MeV.

Step 1: The problem provides the total mass defect for the nuclear reaction or nucleus as $\Delta m = 0.01$ u, which represents the missing mass converted into binding energy during formation.
Step 2: Using Einstein's mass-energy equivalence conversion factor where 1 u $\approx$ 931 MeV, the total binding energy can be calculated using the direct multiplication equation: $E = \Delta m \times 931$ MeV.
Step 3: Substituting the mass defect value into this equation yields: $E = 0.01 \times 931$ MeV $=$ 9.31 MeV. This energy measures the stability of the bound system.
Final Answer: 9.31 MeV

Answer: (B)
Go Back to Question 14

Q15.

Solution

Concept: For a sinusoidal alternating current system, the root-mean-square (rms) value represents the effective steady direct current equivalent that would generate the exact same heating effect in a resistor. This effective value is related to the peak current by the mathematical formula $I_{rms} = I_0/\sqrt{2}$.

Step 1: The problem gives the maximum or peak amplitude of the alternating current wave passing through the circuit as $I_0 = 10\,\text{A}$.
Step 2: Substituting this peak current parameter into the sinusoidal root-mean-square relationship yields the expression: $I_{rms} = 10\,\text{A}/\sqrt{2}$. This can be evaluated numerically by using the approximation $\sqrt{2} \approx 1.414$.
Step 3: Performing the numerical division gives: $I_{rms} \approx 10/1.414 \approx 7.07\,\text{A}$. This means a steady direct current of 7.07 A would produce identical power dissipation in the same load.
Final Answer: 7.07 A

Answer: (C)
Go Back to Question 15

Q16.

Solution

Concept: In Young's double-slit interference experiment, the linear spatial width of the resulting interference fringes on the observation screen is given by the formula $\beta = \lambda D/d$. This shows that the fringe width is directly proportional to the separation distance D between the slits and the screen.

Step 1: The initial configuration of the optical interference setup establishes a baseline fringe width, which is defined mathematically by the algebraic ratio: $\beta = \lambda D/d$.
Step 2: The problem states that the distance from the double slits to the observation screen is doubled, changing to $2D$, while the light wavelength λ and slit separation d remain constant.
Step 3: Substituting this new distance into the formula gives the modified fringe width: $\beta' = \lambda(2D)/d = 2(\lambda D/d) = 2\beta$. This shows that the spatial separation between adjacent bright fringes doubles.
Final Answer: double

Answer: (A) Go Back to Question 16

Q17.

Solution

Concept: Newton's third law of motion states that for every action force, there is an equal and opposite reaction force. In closed physical systems like a launching rocket or a firing firearm, if external forces are negligible during the brief interaction, the total linear momentum of the system is conserved.

Step 1: Rocket propulsion is a direct application of Newton's third law of motion. The rocket's engines forcefully expel exhaust gases backward, and these expanding gases exert an equal and opposite reaction force that drives the rocket forward.

Step 2: Similarly, when a firearm is discharged, the expanding gunpowder gases push the bullet forward inside the barrel, imparting a significant forward linear momentum to the projectile.

Step 3: To maintain a total linear momentum of zero for the isolated system, the firearm must experience a change in momentum of equal magnitude in the opposite direction, causing it to jump backward in a motion known as recoil.

Final Answer: Newton's third law; recoil occurs due to conservation of momentum.

Answer: (See above)

Go Back to Question 17

Q18.

Solution

Concept: In mechanical wave motion, the physical parameter of wavelength describes the spatial repetition period of the wave profile, while the amplitude defines the maximum physical disturbance from equilibrium. For a periodic longitudinal wave, consecutive high-pressure compressions represent corresponding points oscillating in the exact same phase.

Step 1: The linear distance measured between any two consecutive high-density compressions or two consecutive low-density rarefactions in a medium is equal to exactly one complete spatial wavelength.

Step 2: The maximum displacement or peak pressure variation of a medium's particles from their central, undisturbed equilibrium positions as the wave passes through is defined as the wave amplitude.

Final Answer: wavelength; amplitude

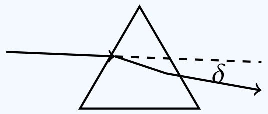
Answer: (See above)

Go Back to Question 18

Q19.

Solution

Concept: An optical glass prism deviates an incident light ray because refraction occurs at two non-parallel boundaries. The total angle of deviation (δ) is defined as the angular difference between the original path of the incident ray and the final direction of the emergent ray.



Step 1: The angle of deviation (δ) is measured between the forward extension of the incident ray and the backward extension of the emergent ray, quantifying the net change in direction.
Step 2: When the angle of incidence is adjusted such that the deviation reaches its absolute minimum value, the light path passing through the prism becomes perfectly symmetrical.
Step 3: Under this minimum deviation condition, the angle of incidence equals the angle of emergence, and the internal refracted ray travels parallel to the base of an equilateral prism.
Final Answer: δ is the angle between incident and emergent directions; at minimum deviation the path is symmetrical.

Answer: (See above)

Go Back to Question 19

Q20.

Solution

Concept: The thermodynamic efficiency of a reversible Carnot heat engine represents the maximum possible efficiency for any engine operating between two thermal reservoirs, and it depends exclusively on their absolute temperatures. Conversely, mechanical work performed during an isochoric process is zero because the volume remains constant.

Step 1: A standard heat engine absorbs thermal energy from a high-temperature source and rejects a portion to a low-temperature sink. The efficiency of a Carnot cycle is given by the formula $\eta = 1 - T_2/T_1$.
Step 2: This mathematical expression shows that the efficiency of the cycle depends exclusively on the absolute thermodynamic temperatures of the hot source and the cold sink.
Step 3: During an isochoric thermodynamic process, the volume of the gas system is held perfectly constant, meaning $\Delta V = 0$. Because work is defined as $W = P\Delta V$, the net work performed by the system is zero. **Final Answer:** source; zero

Answer: (See above) Go Back to Question 20

Q21.

Solution

Concept: Fluid dynamics classifies flow profiles into steady or erratic regimes depending on velocity vectors. The resistive viscous drag acting upon a miniature sphere moving through a laminar fluid matrix is quantified precisely by Stokes' law, and terminal velocity is reached when the net accelerating force balances the cumulative resistive forces.

Step 1: Streamline flow is characterized by a steady regime where every passing fluid particle follows an identical geometric path relative to preceding particles without intersecting, matching smoothly with description (a)–(ii).
Step 2: Turbulent flow represents an irregular, chaotic fluid regime characterized by rapid velocity fluctuations and the continuous formation of erratic swirling eddies, matching with description (b)–(iii).
Step 3: Stokes' law defines the viscous drag force experienced by a spherical body in a continuous medium via the classic equation $F = 6\pi\eta rv$, mapping to expression (c)–(i).
Step 4: Terminal velocity constitutes the steady maximum speed achieved by an object falling through a fluid when the net force drops to zero, mapping to definition (d)–(iv).
Final Answer: (a)–(ii), (b)–(iii), (c)–(i), (d)–(iv)

Answer: (See above)

Go Back to Question 21

Q22.

Solution

Concept: The deliberate introduction of specific chemical impurities, known as doping, selectively alters the dominant charge carrier concentration within a crystalline semiconductor. Introducing donor impurities creates an n-type material with an excess of conduction electrons, while the intrinsic energy band gap of a semiconductor remains smaller than that of an insulator.

Step 1: In an n-type semiconductor configuration, pentavalent impurity atoms substitute into the lattice matrix and donate weakly bound valence electrons to the conduction band. Consequently, the majority charge carriers driving conduction are free electrons.
Step 2: Electrical insulators are characterized by a broad forbidden energy gap that prevents electron excitation under standard conditions. In comparison, semiconductors feature a narrow energy gap, making the first material an electron-rich conductor and the second a robust insulator.
Final Answer: electrons; insulator

Answer: (See above)

Go Back to Question 22

Q23.

Solution

Concept: Alpha particles are composed of fast-moving helium nuclei and possess a significantly larger rest mass compared to light beta particles. Due to this high mass and double positive charge, alpha particles cause intense local ionization in matter but exhibit poor penetration depth, whereas beta particles consist of high-speed electrons or positrons.

Step 1: Statement 1 is true because alpha particles lose their kinetic energy rapidly through frequent ionizing collisions with surrounding atoms. This high ionization density limits their range, allowing them to be stopped by a thin sheet of paper.
Step 2: Statement 2 is false because a beta particle is a high-energy electron or positron emitted from a nucleus during radioactive decay. The description of a bound helium nucleus containing two protons and two neutrons applies strictly to alpha radiation.
Final Answer: T; F

Answer: (See above)

Go Back to Question 23

Q24.

Solution

Concept: Electrical diagnostic instrumentation and alternating current components are classified according to their fundamental operational physics. A bridge network evaluates resistance via balance conditions, a potentiometer utilizes null-deflection principles, a galvanometer measures weak current indicators, and a transformer modifies alternating voltage amplitudes via electromagnetic induction.

Step 1: A Wheatstone bridge circuit uses a balanced four-resistor network to determine an unknown resistance when the detector current drops to zero, mapping directly to option (a)–(iii).
Step 2: A potentiometer accurately evaluates the electromotive force of a cell using a null-deflection method that draws no current from the source, mapping to option (b)–(ii).
Step 3: A moving-coil galvanometer uses a magnetic torque mechanism to detect and measure tiny electric currents, mapping to option (c)–(i).
Step 4: A power transformer alters alternating current voltage levels between circuits through mutual magnetic flux linkage, mapping to option (d)–(iv).
Final Answer: (a)–(iii), (b)–(ii), (c)–(i), (d)–(iv)

Answer: (See above)

Go Back to Question 24

Q25.

Solution

Concept: Brewster's law defines the specific optical conditions required to achieve polarization by reflection from a dielectric interface. Conversely, Malus' law determines the resulting intensity of a plane-polarized light beam after it passes through an analyzer oriented at a specific angle relative to the polarization plane.

Step 1: According to Brewster's law, when unpolarized light strikes a boundary at the polarizing angle, the reflected light becomes completely plane-polarized. At this specific angle, the reflected and refracted light rays travel perpendicular to each other.

Step 2: Malus' law states that the transmitted light intensity through an analyzer varies with the orientation angle θ according to the equation $I = I_0 \cos^2 \theta$, where θ represents the angle between the transmission axes of the polarizer and analyzer.

Final Answer: perpendicular; $\cos^2 \theta$

Answer: (See above)

Go Back to Question 25

Q26.

Solution

Concept: Uniform circular motion requires a continuous inward centripetal force directed toward the rotation center. A mechanical impulse quantifies the net change in a particle's linear momentum, while kinetic and potential energies are described by standard equations based on velocity and elevation.

Step 1: A centripetal force acts on a rotating body and is always directed radially inward toward the center of curvature, mapping to option (a)–(iii).

Step 2: A mechanical impulse represents the integral of a force over a time interval, which equals the total change in linear momentum, mapping to option (b)–(iv).

Step 3: Kinetic energy is the scalar measure of translational motion, given by the expression $\frac{1}{2}mv^2$, mapping to option (c)–(i).

Step 4: Gravitational potential energy represents the stored configuration energy near Earth's surface, calculated as mgh, mapping to option (d)–(ii).

Final Answer: (a)–(iii), (b)–(iv), (c)–(i), (d)–(ii)

Answer: (See above)

Go Back to Question 26

Q27.

Solution

Concept: An equipotential surface is defined as a continuous geometric locus where every point shares the exact same electric potential value. The work required to move a charge between two points is given by $W = q\Delta V$, while capacitance depends on the geometry and medium rather than the stored charge.

Step 1: Because every point on an equipotential surface shares the same potential, the potential difference between any two points on it is zero ($\Delta V = 0$). The work formula $W = q\Delta V$ confirms that the net work performed is zero, so Statement 1 is true.
Step 2: The electrical capacitance of an isolated conductor is an intrinsic property determined solely by its size, geometric shape, and the permittivity of the surrounding medium. It remains independent of the charge on the conductor, making Statement 2 false.
Final Answer: T; F

Answer: (See above)
Go Back to Question 27

Q28.

Solution

Concept: Telecommunication transmission networks utilize high-frequency carrier waves to transmit information signals efficiently over long distances. In digital processing, electronic logic gates process input signals by performing specific Boolean algebraic operations.

Step 1: Modulation is the process of superimposing a low-frequency information signal onto a high-frequency carrier wave to enable efficient long-distance transmission, mapping to option (a)–(ii).
Step 2: Demodulation is the inverse process performed at the receiver to separate and extract the original information signal from the carrier wave, mapping to option (b)–(i).
Step 3: Bandwidth defines the total frequency range occupied by a modulated signal or required by a communication channel, mapping to option (c)–(iii).
Step 4: A logic gate is a digital circuit element that executes a specific Boolean algebraic operation on input signals, mapping to option (d)–(iv).
Final Answer: (a)–(ii), (b)–(i), (c)–(iii), (d)–(iv)

Answer: (See above)
Go Back to Question 28

Q29.

Solution

Concept: Pascal's law describes how pressure propagates through an enclosed fluid. It states that any pressure change applied to an enclosed, incompressible fluid is transmitted undiminished throughout the fluid and acts equally on all parts of the containing vessel.

Step 1: In a hydraulic system, applying an input force F_1 to a small piston with cross-sectional area A_1 generates an internal fluid pressure given by the ratio $P = F_1/A_1$.
Step 2: According to Pascal's law, this pressure propagates undiminished through the fluid network and acts directly on the larger output piston, which has a cross-sectional area A_2.
Step 3: The resulting output force is given by $F_2 = P \times A_2 = (F_1/A_1)A_2$. Since the output area A_2 is much larger than A_1, a small input force is multiplied into a large output force capable of lifting heavy loads.
Final Answer: Pascal's law: pressure is transmitted equally; hydraulic lift multiplies force using larger area.

Answer: (See above)

Go Back to Question 29

Q30.

Solution

Concept: Newton's second law of motion states that the net force acting on an object is equal to the product of its mass and its acceleration, expressed as $F = ma$. Once this constant acceleration is determined, the final velocity can be calculated using the kinematic equation $v = u + at$.

Step 1: The problem provides the net force acting on the object as $F = 25\,\text{N}$ and the total mass of the object as $m = 5\,\text{kg}$.
Step 2: Rearranging Newton's second law allows us to calculate the acceleration: $a = F/m = 25\,\text{N}/5\,\text{kg} = 5\,\text{m}\,\text{s}^{-2}$. This constant acceleration acts in the direction of the applied force.
Step 3: The object starts from rest, which sets the initial velocity to $u = 0\,\text{m}\,\text{s}^{-1}$, and the force is applied for a duration of $t = 4\,\text{s}$.
Step 4: Substituting these parameters into the first kinematic equation gives the final velocity: $v = u + at = 0 + (5\,\text{m}\,\text{s}^{-2} \times 4\,\text{s}) = 20\,\text{m}\,\text{s}^{-1}$.
Final Answer: a=$5\,\text{m}\,\text{s}^{-2}$, $v = 20\,\text{m}\,\text{s}^{-1}$

Answer: (See above)

Go Back to Question 30

Q31.

Solution

Concept: Electric potential is a scalar physical quantity defined as the total mechanical work performed per unit positive test charge in translating it from an infinite distance to a specific point in an electrostatic field. For an electrical network containing capacitors connected in a series configuration, each individual component accumulates the exact same amount of electric charge, and the reciprocal of the total equivalent capacitance is computed by summing the reciprocals of the individual capacitances.

Alternative (i): Step 1: The absolute electric potential V established by an isolated point charge q located at a radial distance r in a vacuum environment is expressed mathematically by the classic electrostatic formulation $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$.
Step 2: Because electric potential possesses an absolute magnitude and an algebraic sign determined by the polarity of the source charge but lacks spatial direction, it is classified fundamentally as a scalar quantity.
Alternative (ii): Step 1: For a series combination composed of three identical capacitors each having a capacitance of $6\,\mu$F, the equivalent circuit capacitance C_{eq} is determined using the reciprocal addition rule: $1/C_{eq} = 1/6 + 1/6 + 1/6 = 3/6\,\mu\text{F}^{-1}$.
Step 2: Taking the mathematical reciprocal of this combined fractional value yields the net network parameter: $C_{eq} = 6/3 = 2\,\mu$F.
Final Answer: V=1$\frac{}{4\pi\varepsilon_0\frac{q}{r}, scalar; C_{eq}=2\,\mu\text{F}}$

Answer: (See above)

Go Back to Question 31

Q32.

Solution

Concept: The brilliant blue appearance of a clear sky is explained by the physical principle of Rayleigh scattering of electromagnetic radiation by microscopic atmospheric particles. Conversely, Brewster's law states that when unpolarized light strikes a boundary at a specific angle of incidence, the reflected ray undergoes complete plane polarization such that the reflected and refracted rays are perpendicular.

Alternative (i): Step 1: Gaseous molecules and suspended particles in the atmosphere intercept incoming solar rays and scatter them in all directions.
Step 2: According to Rayleigh's formulation, the intensity of scattered light varies inversely with the fourth power of its wavelength ($I \propto 1/\lambda^4$), making shorter wavelengths scatter much more intensely than longer ones.
Step 3: Because blue light has a significantly shorter wavelength than red light, it undergoes intense scattering throughout the upper atmosphere, filling the sky and entering our eyes from every direction.
Alternative (ii): Step 1: Brewster's law defines the condition where light incident at the unique polarizing angle i_p yields a completely polarized reflected beam.
Step 2: Mathematically, this boundary condition is given by the relation $\tan i_p = n$, where n represents the relative refractive index of the medium.
Final Answer: Blue sky is due to Rayleigh scattering; Brewster's law: $\tan i_p = n$

Answer: (See above)

Go Back to Question 32

Q33.

Solution

Concept: The first law of thermodynamics represents the fundamental principle of conservation of energy applied to a thermal system. It states that the net heat energy Q supplied to a thermodynamic system is split into two parts: it increases the internal thermal energy of the working gas by an amount ΔU and drives external mechanical work W performed by the expanding gas against its surroundings, written as $Q = \Delta U + W$.

Step 1: The problem specifies that a total quantity of heat energy $Q = 800\,\text{J}$ is transferred into the gas system, while the measured increase in the internal energy of the gas is $\Delta U = 300\,\text{J}$.
Step 2: To find the mechanical work performed during this expansion, we rearrange the conservation of energy equation to isolate the work variable: $W = Q - \Delta U$.
Step 3: Substituting the given numbers into this formula yields: $W = 800\,\text{J} - 300\,\text{J} = 500\,\text{J}$. This positive result indicates that 500 J of energy is expended by the gas to perform mechanical work.
Final Answer: 500 J

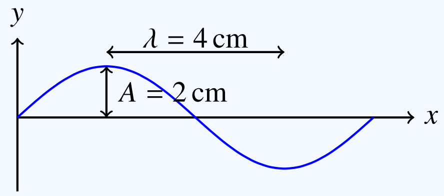
Answer: (See above)

Go Back to Question 33

Q34.

Solution

Concept: In the physics of wave motion, amplitude is defined as the maximum spatial displacement of an oscillating particle from its central equilibrium position. The wavelength (λ) represents the total linear distance between any two consecutive points that oscillate in the exact same phase, such as the distance from one wave crest to the next.



Step 1: Examining the provided wave profile graph shows that the peak positive displacement reaches +2 cm and the maximum negative displacement drops to −2 cm. Therefore, the wave amplitude is $A = 2$ cm.

Step 2: The horizontal axis labels show that a total distance of 8 cm contains exactly two complete, consecutive wave cycles from start to finish.

Step 3: Dividing this total measured spatial distance by the number of complete wave cycles yields the individual wavelength parameter: $\lambda = 8\,\text{cm}/2 = 4\,\text{cm}$.

Final Answer: A=2 cm, $\lambda = 4$ cm

Answer: (See above)

Go Back to Question 34

Q35.

Solution

Concept: Rutherford's historic alpha particle scattering experiment provided foundational evidence for the nuclear model of the atom by tracking angular deflections. In modern quantum physics, de Broglie's hypothesis describes the dual wave-particle nature of matter, assigning a characteristic wavelength to any moving particle based on its momentum.

Alternative (i): Step 1: The observation that the vast majority of alpha projectiles pass straight through a thin gold foil without experiencing any angular deviation indicates that most of the volume of an atom consists of empty space.
Step 2: The deflection of a tiny fraction of alpha particles through angles greater than 90° proves that the entire positive charge and nearly all the atomic mass are concentrated in a dense core called the nucleus.
Alternative (ii): Step 1: The de Broglie relation defines a matter wavelength using the ratio of Planck's constant to momentum: $\lambda = h/p = h/(mv)$.
Step 2: These matter waves explain electron diffraction and form the basis of high-resolution electron microscopes, where tiny electron wavelengths enable imaging far beyond the limits of optical light.
Final Answer: Atom is mostly empty with a tiny positive nucleus; $\lambda = h/p, usedinelectronmicroscopy.$

Answer: (See above)
Go Back to Question 35

Q36.

Solution

Concept: In classical mechanics, mechanical power is defined as the time rate at which work is performed on a system. When a constant external driving force moves an object at a steady, uniform speed along a straight line in the exact direction of the applied force vector, the power output can be calculated using the scalar product formula $P = Fv$.

Step 1: The problem states that a locomotive or vehicle exerts a constant forward tractive force of $F = 4.0 \times 10^4$ N while maintaining a steady, uniform velocity of $v = 20\,\text{m}\,\text{s}^{-1}$.
Step 2: Substituting these values into the linear power formulation yields the raw wattage computation: $P = F \times v = (4.0 \times 10^4\,\text{N}) \times (20\,\text{m}\,\text{s}^{-1}) = 8.0 \times 10^5\,\text{W}$.
Step 3: To convert this power value from watts into standard kilowatts (kW), we divide the result by one thousand: $P = (8.0 \times 10^5)/1000 = 800\,\text{kW}$.
Final Answer: 800 kW

Answer: (See above)
Go Back to Question 36

Q37.

Solution

Concept: The magnetic Lorentz force experienced by an electrically charged particle traveling through a uniform magnetic field depends on its charge, velocity, field strength, and direction. This force is quantified by the vector cross-product equation $F = qvB\sin\theta$, where θ represents the angle between the particle's velocity vector and the magnetic field lines.

Step 1: The problem provides the following parameters: an electron or proton with a elementary charge $q = 1.6 \times 10^{-19}$ C, a velocity $v = 2 \times 10^6\,\mathrm{m\,s^{-1}}$, and a magnetic flux density $B = 0.5$ T.
Step 2: Because the particle's path is explicitly perpendicular to the magnetic field lines, the angle $\theta = 90^\circ$, which simplifies the directional term to $\sin 90^\circ = 1$ and reduces the formula to $F = qvB$.
Step 3: Substituting these values yields: $F = (1.6 \times 10^{-19}\,\mathrm{C}) \times (2 \times 10^6\,\mathrm{m\,s^{-1}}) \times 0.5\,\mathrm{T} = 1.6 \times 10^{-13}\,\mathrm{N}$.
Final Answer: $1.6{\times}10^{-13}$ N

Answer: (See above)
Go Back to Question 37

Q38.

Solution

Concept: Solid-state semiconductor electronics relies on specialized material junctions and controlled charge carrier dynamics to manipulate electrical signals. A junction diode permits current flow primarily in one direction, a bipolar transistor acts as an amplifier or digital switch, and logic gates execute Boolean operations.

Step 1: A p-n junction diode is constructed by joining a p-type and an n-type semiconductor material. It conducts current efficiently under forward-bias conditions but blocks it under reverse bias, making it ideal for rectification applications.
Step 2: A transistor is a three-terminal semiconductor device designed to control a large output current with a small input signal. This allows it to function as a signal amplifier or an electronic switch in digital circuits.
Step 3: A logic gate is an integrated switching circuit designed to execute basic Boolean algebraic functions. Examples include AND, OR, and NOT gates, which serve as the building blocks of digital processors.
Final Answer: Diode: one-way device; transistor: amplifier/switch; logic gate: Boolean circuit.

Answer: (See above)
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Q39.

Solution

Concept: In wave optics, the linear spatial width of an interference fringe produced in Young's double-slit system is given by $\beta = \lambda D/d$. In geometrical optics, the behavior of spherical mirrors is governed by the mirror formula $1/f = 1/v + 1/u$, which utilizes the standard Cartesian sign convention.

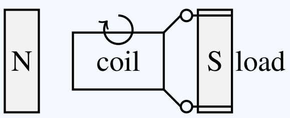
Alternative (i): Step 1: Converting all given parameters into standard SI units yields: $\lambda = 500\,\text{nm} = 5 \times 10^{-7}\,\text{m}$, slit separation $d = 0.25\,\text{mm} = 2.5 \times 10^{-4}\,\text{m}$, and screen distance $D = 1\,\text{m}$. **Step 2:** Substituting these values into the fringe width equation gives: $\beta = (5 \times 10^{-7} \times 1)/(2.5 \times 10^{-4}) = 2 \times 10^{-3}\,\text{m}$. **Step 3:** Converting meters back into millimeters results in a final fringe width of $\beta = 2\,\text{mm}$.
Alternative (ii): Step 1: A concave mirror has a focal length of $f = -15\,\text{cm}$ and an object distance of $u = -30\,\text{cm}$. **Step 2:** Applying the mirror formula gives $-1/15 = 1/v - 1/30$, which simplifies to $1/v = -1/15 + 1/30 = -1/30$, yielding an image distance of $v = -30\,\text{cm}$. **Step 3:** The lateral magnification is $m = -v/u = -(-30)/(-30) = -1$.
Final Answer: $\beta = 2\,\text{mm}$; $v = -30\,\text{cm}$, $m = -1$

Answer: (See above)
Go Back to Question 39

Q40.

Solution

Concept: An alternating current (AC) generator converts mechanical energy into electrical energy based on Faraday's law of electromagnetic induction. When a conductive coil is rotated within a uniform magnetic field, the magnetic flux linking the coil changes periodically, which induces a time-varying alternating electromotive force.



Step 1: The underlying principle of the generator is Faraday's law, which states that an electromotive force is induced in a circuit whenever the total magnetic flux linking that circuit changes over time.
Step 2: As the internal armature coil rotates at a steady angular velocity between the magnetic poles, the magnetic flux oscillates continuously between positive maximum, zero, and negative maximum values.
Step 3: Concentric slip rings are fixed to the ends of the rotating armature coil. These rings maintain continuous sliding electrical contact with stationary carbon brushes, transmitting the induced alternating voltage to the external load.
Final Answer: AC generator works on electromagnetic induction; slip rings transfer alternating emf to the external circuit.

Answer: (See above)
Go Back to Question 40

Q41.

Solution

Concept: Mechanical power represents the time rate of performing work or transferring energy. The law of conservation of linear momentum states that the total momentum of an isolated system remains constant over time provided that the net external force acting on the system is zero.

Alternative (i): Step 1: The mechanical work performed over a brief time interval t by a constant force acting along the direction of displacement is given by the formula $W = Fs$. **Step 2:** Power is defined as the work per unit time, $P = W/t = F(s/t) = Fv$, where v represents the instantaneous velocity of the object. **Step 3:** Substituting a force of $F = 200\,\text{N}$ and a velocity of $v = 3\,\text{m}\,\text{s}^{-1}$ into this relation yields: $P = 200 \times 3 = 600\,\text{W}$.
Alternative (ii): Step 1: In a completely isolated multi-body system, the initial total momentum before an interaction must equal the final total momentum after the interaction. **Step 2:** The initial momentum of the two masses is calculated as: $P_i = (2\,\text{kg} \times u) + (3\,\text{kg} \times 0) = 2u$. **Step 3:** After combining during a collision, their final total momentum is: $P_f = (2\,\text{kg} + 3\,\text{kg}) \times 4\,\text{m}\,\text{s}^{-1} = 20\,\text{kg}\,\text{m}\,\text{s}^{-1}$. **Step 4:** Equating these values gives $2u = 20$, which yields an initial velocity of $u = 10\,\text{m}\,\text{s}^{-1}$.
Final Answer: P=600 W; u=10 $\text{m}\,\text{s}^{-1}$

Answer: (See above)

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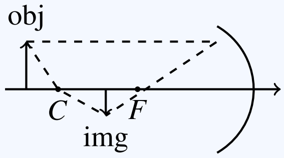
Q42.

Solution

Concept: A concave mirror forms a real, inverted image when an object is placed beyond its principal focus. Photoelectric emission is governed by Einstein's equation, while optical interference depends on path differences, and nuclear energy is released via fission or fusion.



Alternative (i): Step 1: When an object is placed beyond the center of curvature of a concave mirror, rays parallel to the principal axis reflect through the focus F. **Step 2:** A second ray passing through the center of curvature C reflects back along its original path. **Step 3:** These rays intersect between C and F, forming a real, inverted, and diminished image. **Step 4:** Einstein's photoelectric equation is $K_{\text{max}} = h\nu - \phi$. Since the work function ϕ is constant for a given metal, increasing the frequency causes a linear increase in maximum kinetic energy.

Alternative (ii): Step 1: Constructive interference occurs when the optical path difference equals an integer multiple of the wavelength, $\Delta = n\lambda$. **Step 2:** Destructive interference occurs when the path difference equals an odd half-integer multiple, $\Delta = (2n + 1)\lambda/2$. **Step 3:** Nuclear fission involves splitting a heavy nucleus into lighter fragments, such as uranium-235 absorbing a neutron. Nuclear fusion combines light nuclei to form a heavier nucleus, which powers stars.

Final Answer: Concave mirror image: real, inverted, diminished between C and F; $\text{K}_{\text{max}} = h\nu - \phi; \Delta = n\lambda \; or \; (2n + 1)\lambda/2$.

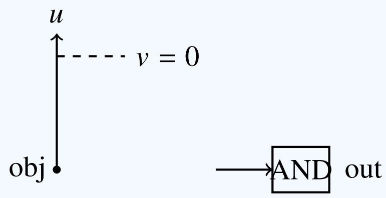
Answer: (See above)

Go Back to Question 42

Q43.

Solution

Concept: This comprehensive review covers fundamental principles in mechanics, fluid dynamics, thermodynamics, wave optics, and digital communications. Each distinct section requires stating the governing physical principle and applying it systematically to obtain the solution.



Alternative (i): Step 1: Equating initial kinetic energy $\frac{1}{2}mu^2$ to peak gravitational potential energy mgh yields the maximum vertical height formula for a projectile: $h = u^2/(2g)$. **Step 2:** Archimedes' principle states that a body immersed in a fluid experiences an upward buoyant force equal to the weight of the fluid it displaces. **Step 3:** A reversible process is an ideal thermodynamic path that can be retraced in reverse order without altering the system or its surroundings. **Step 4:** Modulation superimposes a signal onto a high-frequency carrier wave. The beat frequency between 305 Hz and 300 Hz is $|305 - 300| = 5$ Hz.

Alternative (ii): Step 1: Linear momentum is conserved when the net external force is zero, explaining firearm recoil. **Step 2:** Streamline flow is a stable fluid regime where particle velocities at any point remain constant and paths never cross. **Step 3:** The first law of thermodynamics is given by the expression $Q = \Delta U + W$. **Step 4:** An AND logic gate produces an output of 1 only when all inputs are high (1). Resonance occurs when an external driving frequency matches a system's natural frequency, maximizing amplitude.

Final Answer: $\text{h=u}^2 \frac{}{2g;\ F_b\text{=weight of displaced fluid; } Q\text{=}\Delta U\text{+}W\text{; } f_b\text{=5 Hz; AND output is 1 only for all inputs 1.}}$

Answer: (See above)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	D	3	C	4	B	5	C
6	B	7	B	8	C	9	D	10	B
11	A	12	D	13	B	14	B	15	C
16	A								