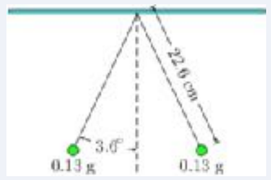
Electromagnetism

Question

Two small metallic spheres, each of mass 0.13 g are suspended as pendulums by light strings from a common point as shown. The spheres are given the same electric charge, and it is found that the two come to equilibrium when each string is at an angle of 3.6° with the vertical. If each string is 22.6 cm long, find the magnitude of the charge on each sphere. The Coulomb constant is $8.98755 \times 10^9 \frac{N \cdot m^2}{C^2}$ and the acceleration of gravity is $9.81 \frac{m}{s^2}$. Answer in units of nC.

Image



Answer

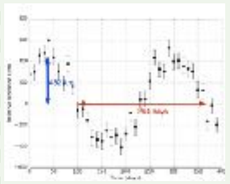
Step 1: Given data that ..
Step 2: Let magnitude ….
Answer: Magnitude of the charge on each sphere is $2.68nC$.

Relativity Physics

Question

You are a pulsar astronomer, and you have been measuring the pulses from a particular milli - second pulsar for several hundred days. You find that they do not arrive at regular intervals - sometimes they arrive a little early and sometimes a little late. You assume that this is because the pulsar is moving closer to and further from the Earth. You know that the pulsar weighs 2.8e30 kg. How far (in metres) is the planet from the Pulsar? $G = 6.67e - 11\ m^3 kg^{-1} s^{-2}$. If the planet is in an edge - on orbit, what would its mass be (in kg)?

Image



Answer

Step 1: Given that.
Step 2: Calculate Mass of Planet ….
Answer: 1. Orbital radius of planet is 2.9×10^{11} m i.e. 290 million km; 2. Planets mass is 4.2×10^{24}kg

Solid Physics

Question

Crystals like salt are, to a good approximation, a repeating lattice of positive and negative ions. The potential energy of such lattices is important for figuring out their stability and cohesion. As a toy model, imagine eight negative point charges arranged on the corners of a cube surrounding a positive point charge in the center. The central positive charge is 3e and each negative charge is -e. What is the potential energy of this configuration? Hint: There are …

Image

Answer

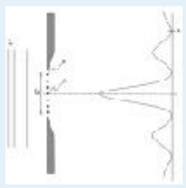
Step 1: Calculate potential energy contributions ..
Step 2: Center-to-corner ….
Answer: $U_{total} = -\frac{44ke^2}{\sqrt{3}a} + \frac{12ke^2}{a} + \frac{12ke^2}{\sqrt{2}a}$

Optics

Question

Describe Huygens wavelets that describe the far - field plane wave diffraction of $\lambda = 633$ nm light through a $b = 125\mu$m slit. What is the phase difference between the light produced by wavelets A and B at the second minimum (point P)? Hints: answer with a positive value in radians, do not use the π symbol.

Image



Answer

The disturbance that transfers …
In the question ….
Answer: The magnitude of phase difference is 12.56 rad.

xxxxxxxx

Thermodynamics

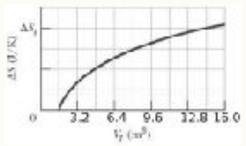
Question

A gas sample undergoes a reversible isothermal expansion. The figure gives the change ΔS in entropy of the gas versus the final volume V_f of the gas. The scale of the vertical axis is set by $\Delta S_s = 70.7$,J/K. How many moles are in the sample?

Answer

Step 1: A reversible isothermal ….
Step 2: The equation …
Answer: The number of moles in the gas sample is approximately 5.28 moles

Image

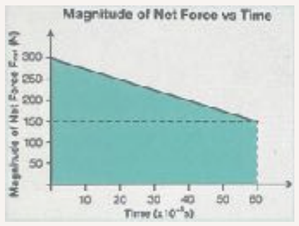


Mechanics

Question

When an archer shoots an arrow, the force of the string on the arrow is not constant. The force is large to begin with, but drops steadily until the arrow leaves the string. A graph of the force on an arrow is shown below. If the arrow has a mass of 15 grams, how fast is it going when it leaves the string? Options: A. 90 m/s B. 120 m/s C. 60 m/s D. 900 m/s E. 6 m/s

Image



Answer

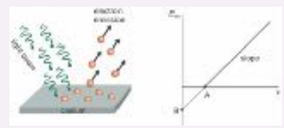
Step 1: Given data ..
Step 2: The graph is a trapezium ….
Answer: Velocity of arrow is (C) 900 m/s

Molecular Atomic & Subatomic Physics

Question

a) What nature of light is supported by the photoelectric effect? b) What is the energy (in eV) of a photon of green light of wavelength of 520 nm? c) If this photon hits metallic cesium with a work - function of 2.16 eV; are the electrons get knocked off from cesium? If so, what is the velocity of the photoelectron produced? A plot of the maximum kinetic energy E_{kin} of the escaping electrons as a function of the frequency ν of the incident light is shown below: ….

Image



Answer

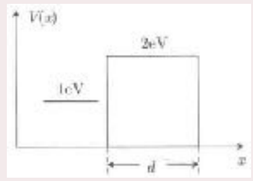
Step 1: This question involves … Step 2: The photoelectric ….
Answer: a) The photoelectric …
b) … c) …. d) …

Quantum Mechanics

Question

An electron with energy of 1 eV is incident on a rectangular potential barrier with a height of 2 eV. How wide should the barrier be to achieve a penetration probability of about 10^{-3}? See the figure for a schematic diagram of scattering from a rectangular potential barrier.

Image



Answer

According to the results of …
Answer: The expression of barrier width d is:
$d = \frac{1}{2}\hbar \cdot \frac{1}{\sqrt{2m(V_0 - E)}} \cdot \frac{3.602}{\log e} \approx 8.18$