

Other problems

Problem 1:

The characteristic distance at which quantum gravitational effects are significant, the Planck length, can be determined from a suitable combination of the physical constants G , \hbar , and c . Which of the following correctly gives the Planck length?

- (A) $G\hbar c$
- (B) $G\hbar^2 c^3$
- (C) $G^2\hbar c$
- (D) $G^{\frac{1}{2}}\hbar^2 c$
- (E) $(G\hbar/c^3)^{\frac{1}{2}}$

Problem 2:

The line integral of $\mathbf{u} = y\mathbf{i} - x\mathbf{j} + z\mathbf{k}$ around a circle of radius R in the xy -plane with center at the origin is equal to

- (A) 0
- (B) $2\pi R$
- (C) $2\pi R^2$
- (D) $\pi R^2/4$
- (E) $3R^3$

Problem 3:

Suppose that ${}^A_Z X$ decays by natural radioactivity in two stages to ${}^{A-4}_{Z-1} Y$. The two stages would most likely be which of the following?

First Stage	Second Stage
(A) β^- emission with an antineutrino	α emission
(B) β^- emission	α emission with a neutrino
(C) β^- emission	γ emission
(D) Emission of a deuteron	Emission of two neutrons
(E) α emission	γ emission

Problem 4:

Except for mass, the properties of the muon most closely resemble the properties of the

- (A) electron
- (B) graviton
- (C) photon
- (D) pion
- (E) proton

Problem 5:

Internal conversion is the process whereby an excited nucleus transfers its energy directly to one of the most tightly bound atomic electrons, causing the electron to be ejected from the atom and leaving the atom in an excited state. The most probable process after an internal conversion electron is ejected from an atom with a high atomic number is that the

- (A) atom returns to its ground state through inelastic collisions with other atoms
- (B) atom emits one or several x-rays
- (C) nucleus emits a γ -ray
- (D) nucleus emits an electron
- (E) nucleus emits a positron

Problem 6:

Which of the following statements concerning the electrical conductivities at room temperature of a pure copper sample and a pure silicon sample is NOT true?

- (A) The conductivity of the copper sample is many orders of magnitude greater than that of the silicon sample.
- (B) If the temperature of the copper sample is increased, its conductivity will decrease.
- (C) If the temperature of the silicon sample is increased, its conductivity will increase.
- (D) The addition of an impurity in the copper sample always decreases its conductivity.
- (E) The addition of an impurity in the silicon sample always decreases its conductivity.

Problem 7:

Materials that are good electrical conductors also tend to be good thermal conductors because

- (A) they have highly elastic lattice structures.
- (B) they have energy gaps between the allowed electron energy bands.
- (C) impurities aid both processes.
- (D) surface states are important in both processes.
- (E) conduction electrons contribute to both processes.

Problem 8:

The non-conservation of parity in the decay $\pi^+ \rightarrow \mu^+ + \nu$ can be verified by measuring the

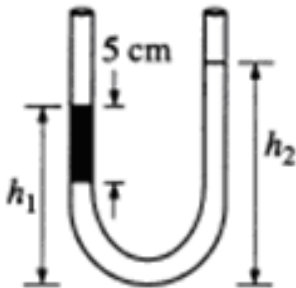
- (A) Q -value of the decay
- (B) longitudinal polarization of the μ^+
- (C) longitudinal polarization of the π^+
- (D) angular correlation between the μ^+ and the ν
- (E) time dependence of the decay process

Problem 9:

A cubical block of wood with a glass bead placed on it, is floating in water contained in a beaker. The height of water column in the beaker in this condition is 'h' and the extent to which the wooden block is within water is 'd'. If the glass bead is gently transferred to the water in the beaker,

- (A) 'h' will increase and 'd' will decrease
- (B) 'h' will decrease and 'd' will increase
- (C) 'h' and 'd' will be unchanged
- (D) 'h' and 'd' will increase
- (E) 'h' and 'd' will decrease

Problem 10:



An open-ended U-tube of uniform cross-sectional area contains water (density 1.0 gram/centimeter³) standing initially 20 centimeters from the bottom in each arm. An immiscible liquid of density 4.0 grams/centimeter³ is added to one arm until a layer 5 centimeters high forms, as shown in the figure above. What is the ratio h_2/h_1 of the heights of the liquid in the two arms?

- (A) 3/1
- (B) 5/2
- (C) 2/1
- (D) 3/2
- (E) 1/1

Problem 11:

Which of the following nuclei has the largest binding energy per nucleon? (Consider the most abundant isotope of each element.)

- (A) Helium
- (B) Carbon
- (C) Iron
- (D) Uranium
- (E) Plutonium

Problem 12:

Which of the following is most nearly the mass of the Earth? (The radius of the Earth is about 6.4×10^6 meters.)

- (A) 6×10^{24} kg
- (B) 6×10^{27} kg
- (C) 6×10^{30} kg
- (D) 6×10^{33} kg
- (E) 6×10^{36} kg

Problem 15:

A sphere of mass m is released from rest in a stationary viscous medium. In addition to the gravitational force of magnitude mg , the sphere experiences a retarding force of magnitude bv , where v is the speed of the sphere and b is a constant. Assume that the buoyant force is negligible. Which of the following statements about the sphere is correct?

- (A) Its kinetic energy decreases due to the retarding force.
- (B) Its kinetic energy increases to a maximum, then decreases to zero due to the retarding force.
- (C) Its speed increases to a maximum, then decreases back to a final terminal speed.
- (D) Its speed increases monotonically, approaching a terminal speed that depends on b but not on m .
- (E) Its speed increases monotonically, approaching a terminal speed that depends on both b and m .

Problem 13:

Solid argon is held together by which of the following bonding mechanisms?

- (A) Ionic bond only
- (B) Covalent bond only
- (C) Partly covalent and partly ionic bond
- (D) Metallic bond
- (E) van der Waals bond

Problem 14:

According to the Standard Model of elementary particles, which of the following is NOT a composite object?

- (A) Muon
- (B) Pi-meson
- (C) Neutron
- (D) Deuteron
- (E) Alpha particle