

Other problems, solutions

Problem 1:

(E) **Units (SI)**

$G = \text{Nm}^2/\text{kg}^2$, $\eta = \text{Js}$, $c = \text{m/s}$.

Only answer (E) has units of length.

Problem 2:

(C) **Line integral of a vector field = $\int \mathbf{u} \cdot d\mathbf{r}$**

In the x-y plane $z = 0$.

On the circle of radius R we have $\mathbf{u} = y \mathbf{i} - x \mathbf{j} = R \sin\theta \mathbf{i} - R \cos\theta \mathbf{j} = R \mathbf{t}$ where \mathbf{t} is a unit vector tangent to the circle at any point.

$$\int_{\text{circle}} \mathbf{u} \cdot d\mathbf{r} = \int_0^{2\pi} R R d\theta = 2\pi R^2.$$

Problem 3:

(A) **Nuclear decay**

Only processes (A) and (D) satisfy $A \rightarrow A - 4$, $Z \rightarrow Z - 1$. Process (D) does not happen.

Problem 4:

(A) **Elementary particles**

Problem 5:

(B) **X-ray emission**

The electron ejected is a 1s electron. The nucleus is most likely a heavier nucleus. After the electron has been emitted, the atom is left with a vacancy in the K shell. This hole will be filled with an electron from one of the higher shells, which have energies on the order of keV above the K-shell.

Problem 6:

(E) **Conductors and semi-conductors**

Problem 7:

(E) **Conductors**

Conduction electrons contribute to both processes.

Problem 8:

(B) **Measurements**

The non-conservation of parity in the decay $\pi^+ \rightarrow \mu^+ + \nu$ can be verified by measuring the longitudinal polarization of the μ^+ , i.e. by measuring the fraction of μ^+ with their spin aligned with their direction of travel.

(A), (E), and (C) cannot reveal parity violations, (D) cannot be measured.

Problem 9:

(E) **Buoyancy**

The glass bead can displace more water when it is resting on the wooden block since a floating body will displace a volume of liquid having the weight of the floating body. Inside the water, it can displace water having its own volume only. This volume is less since the density of glass is greater than that of water. Therefore, 'h' is decreased on transferring the glass bead to the water in the beaker. The extent (d) to which the wooden block is within water also is decreased since the weight of the glass bead is removed from the block.

Problem 10:

(C) **Equilibrium**

$$h_2 + h_1 = 45 \text{ cm}, \quad 5 \text{ cm} * 4 = (h_2 - h_1 + 5 \text{ cm}) * 1.$$

Two equations, two unknowns: $h_2 - h_1 = 15 \text{ cm}$, $h_2 = 30 \text{ cm}$, $h_1 = 15 \text{ cm}$.

Problem 11:

(C) **Nuclear properties**

Problem 12:

(A) **Mass and density**

$M = \rho V$, make reasonable estimates for ρ . (a few times density of water, 1 g/cm^3).

Problem 13:

(E) **Noble gases**

All other answers are wrong.

Problem 14:

(A) **Elementary particles**

Quarks are constituents of all the other particles.

Problem 15:

(E) **Terminal speed**

Terminal speed \rightarrow no acceleration, no net force, $mg = bv_{\text{terminal}}$.