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- B. $4.0 \times 10^{-5} \text{ K}^{-1}$
- C. $1.0 \times 10^{-5} \text{ K}^{-1}$
- D. $1.6 \times 10^{-4} \text{ K}^{-1}$

Answer: A

Detailed Explanation: Linear expansivity $\alpha = \frac{\Delta L}{L_0 \Delta \theta}$. Convert expansion: $4 \text{ mm} = 0.004 \text{ m}$. Temperature change $\Delta \theta = 130 - 30 = 100 \text{ K}$. $\alpha = \frac{0.004}{2 \times 100} = \frac{0.004}{200} = 2.0 \times 10^{-5} \text{ K}^{-1}$.

23. Which of the following describes Charles's Law?

- A. Volume is directly proportional to absolute temperature at constant pressure
- B. Volume is inversely proportional to pressure at constant temperature
- C. Pressure is directly proportional to absolute temperature at constant volume
- D. Volume is independent of temperature

Answer: A

Detailed Explanation: Charles's Law states $V \propto T$ when pressure is held constant. Absolute temperature scale (Kelvin) must be used.

24. Calculate the heat required to raise the temperature of a 2 kg copper block by 20 K.

[Specific heat capacity of copper = $400 \text{ J/kg} \cdot \text{K}$]

- A. 16,000 J
- B. 8,000 J
- C. 4,000 J
- D. 32,000 J

Answer: A

Detailed Explanation: Heat formula: $Q = mc\Delta \theta = 2 \times 400 \times 20 = 16,000 \text{ Joules}$.

25. The process by which heat travels through a vacuum is known as:

- A. Radiation
- B. Conduction
- C. Convection
- D. Evaporation

Answer: A

Detailed Explanation: Radiation uses electromagnetic waves and does not require a material medium to transfer thermal energy. Conduction and convection need matter.

26. Why do regular ice cubes cool drinks faster than the same mass of water at 0°C ?

- A. Ice absorbs latent heat of fusion from the drink to melt
- B. Ice has a higher specific heat capacity than liquid water
- C. Ice is colder than water at 0°C
- D. Ice conducts heat faster than water

Answer: A

Detailed Explanation: Dispersion occurs because the glass medium slows down different wavelengths by varying degrees. Violet light slows down and bends the most; red bends the least.

45. Calculate the power of a converging lens with a focal length of 25 cm.

- A. +4.0 D
- B. +0.04 D
- C. -4.0 D
- D. +2.5 D

Answer: A

Detailed Explanation: Lens power $P = \frac{1}{f(\text{in meters})}$. Convert focal length: $25\text{ cm} = 0.25\text{ m}$. $P = \frac{1}{0.25} = +4.0\text{ Diopters}$.

46. Total internal reflection can only occur when light travels from:

- A. An optically denser medium to a less dense medium
- B. An optically less dense medium to a denser medium
- C. Air into water
- D. A vacuum into glass

Answer: A

Detailed Explanation: Two criteria must be met: light must travel from a denser medium to a less dense medium, and the angle of incidence must exceed the critical angle.

47. A person cannot see distant objects clearly. This eye defect is called:

- A. Myopia
- B. Hypermetropia
- C. Presbyopia
- D. Astigmatism

Answer: A

Detailed Explanation: Myopia (short-sightedness) occurs when parallel rays from a distant object focus in front of the retina. It is corrected using concave (diverging) lenses.

48. The magnification produced by a plane mirror is always:

- A. Equal to 1
- B. Greater than 1
- C. Less than 1
- D. Zero

Answer: A

Detailed Explanation: Plane mirrors form images that are the exact same size as the object ($h_i = h_o$), so magnification $M = \frac{h_i}{h_o} = 1$.

49. An astronomical telescope in normal adjustment consists of two converging lenses. The final image formed is:

- A. Virtual, inverted, and magnified
- B. Real, inverted, and diminished

Detailed Explanation: Einstein's equation ($hf = W_0 + E_{k,max}$) states that the energy of an incoming photon (hf) is split between the energy needed to free an electron (W_0) and its remaining kinetic energy (E_k).

85. Which of the following radioactive emissions has the highest penetrating power?

- A. Gamma ray
- B. Alpha particle
- C. Beta particle
- D. Positron

Answer: A

Detailed Explanation: Gamma rays are high-energy photons with no mass or charge. They interact weakly with matter, giving them high penetrating power that requires thick lead shielding to stop.

86. Cathode rays are a stream of fast-moving:

- A. Electrons
- B. Protons
- C. Neutrons
- D. Positive ions

Answer: A

Detailed Explanation: Cathode rays are streams of electrons emitted from the negative electrode (cathode) inside a vacuum discharge tube.

87. Calculate the energy of a photon of light whose frequency is $6.0 \times 10^{14} \text{ Hz}$.
[Planck's constant $h = 6.6 \times 10^{-34} \text{ J} \cdot \text{s}$]

- A. $3.96 \times 10^{-19} \text{ J}$
- B. $1.1 \times 10^{-48} \text{ J}$
- C. $4.4 \times 10^{-19} \text{ J}$
- D. $3.96 \times 10^{-20} \text{ J}$

Answer: A

Detailed Explanation: Energy formula: $E = hf = (6.6 \times 10^{-34} \text{ J} \cdot \text{s}) \times (6.0 \times 10^{14} \text{ Hz}) = 3.96 \times 10^{-19} \text{ Joules}$.

88. The binding energy of a nucleus is responsible for:

- A. Holding protons and neutrons together in the nucleus
- B. Holding orbital electrons in their tracks
- C. Causing radioactive decay
- D. Creating isotopes

Answer: A

Detailed Explanation: Binding energy holds nucleons (protons and neutrons) together against electrostatic repulsion inside the nucleus, and it corresponds to the mass defect.

89. Atoms of the same element that have the same number of protons but different numbers of neutrons are called: