Subject Name Solutions

4300005 – Summer 2024

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

Define derived physical quantities and give three examples with their S.I. unit and symbol.

> **Solution**
>
> Derived physical quantities are those which are obtained by multiplication or division of fundamental physical quantities.
>
> Table 1: Examples of Derived Physical Quantities
>
> | Derived Quantity | S.I. Unit | Symbol |
> |---|---|---|
> | Force | Newton (N) | F |
> | Energy | Joule (J) | E |
> | Electric Current | Ampere (A) | I |

> **Mnemonic**
>
> "FEI: Force-Energy-Current derive from fundamentals"

Question 1(b) [4 marks]

The length of a metal rod is 64.522 cm at $12^t emperature and 64.576 cm at 90^t emperature. Find the coefficient of linear expan

> **Solution**
>
> **Formula:** $= (\mathbf{L}_2 - L_1)/[L_1 \times (T_2 - T_1)]$
> **Calculation:**
> - **Initial length ($\mathbf{L}_1$)** $= 64.522 cm$
> - **Final length ($\mathbf{L}_2$)** $= 64.576 cm$
> - **Initial temperature ($\mathbf{T}_1$)** $= 12$
> - **Final temperature ($\mathbf{T}_2$)** $= 90$
>
> $= \textbf{(64.576 - 64.522)}/[\textbf{64.522} \times (90 - 12)]$
> $= \textbf{0.054}/(\textbf{64.522} \times 78)$
> $= \textbf{0.054/5032.716}$
> $= \textbf{1.073} \times 10^{-5}/$

> **Mnemonic**
>
> **"Change in Length over Original Length times Change in Temperature"**

Question 1(c) [7 marks]

Explain with figure: The principle, construction and working of a vernier calliper.

> **Solution**
>
> **Principle:** Vernier caliper works on the principle of vernier scale, which allows measurements with accuracy greater than the main scale.
> **Construction:**
>
> **Mermaid Diagram (Code)**
>
> {Shaded}
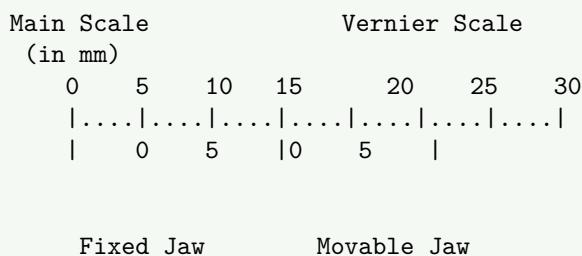
```
{Highlighting}[]
graph TD
    A[Vernier Caliper] {-{-}{} B[Main Scale]}
    A {-{-}{} C[Vernier Scale]}
    A {-{-}{} D[Fixed Jaw]}
    A {-{-}{} E[Movable Jaw]}
    A {-{-}{} F[Depth Probe]}
    A {-{-}{} G[Locking Screw]}
{Highlighting}
{Shaded}
```

Working:
- **Zero error check: Close jaws and note if zero of vernier coincides with zero of main scale**
- **External measurement: Place object between fixed and movable jaws**
- **Reading process: Note main scale reading + (coinciding vernier division $\times least count$)**
- **Least count = (Smallest division on main scale)/(Number of divisions on vernier scale)**

Diagram:

```
Main Scale              Vernier Scale
  (in mm)
    0    5    10   15      20   25   30
    |....|....|....|....|....|....|....|
    |    0    5    |0    5    |

       Fixed Jaw        Movable Jaw
```

Question 1(c) OR [7 marks]

Explain with figure: The principle, construction and working of a micrometre screw gauge.

Solution

Principle: Micrometer screw gauge works on the principle of screw motion - rotational motion is converted into linear motion.

Construction:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[Micrometer Screw Gauge] {-{-}{} B[Frame]}
    A {-{-}{} C[Anvil]}
    A {-{-}{} D[Spindle]}
    A {-{-}{} E[Sleeve/Main Scale]}
    A {-{-}{} F[Thimble/Circular Scale]}
    A {-{-}{} G[Ratchet]}
    A {-{-}{} H[Lock Nut]}
{Highlighting}
{Shaded}
```

Working:
- **Zero error check: Close anvil and spindle, note if zero of circular scale aligns with reference line**
- **Measurement process: Place object between anvil and spindle**
- **Reading: Main scale reading + (Circular scale reading $\times Least count$)**
- **Least Count = Pitch/Number of divisions on circular scale**

Diagram:

```
                    Ratchet

        Frame                   Thimble/Circular Scale


Anvil     O          O O



          Spindle          Sleeve/Main Scale
```

Question 2(a) [3 marks]

Find the diameter of a sphere if pitch of micrometer screw gauge is 1 mm and there are 100 divisions on circular scale. The edge of circular scale lies between **7** and **8 mm** of the main scale and **65th** division of the circular scale coincides with the horizontal line of the main scale.

Solution

Formula: Diameter = Main scale reading + (Circular scale reading $\times Least count$)
Calculation:
- **Main scale reading = 7 mm**
- **Circular scale reading = 65 divisions**
- **Least count = Pitch/Number of divisions = 1/100 = 0.01 mm**

Diameter = 7 + (65 $\times 0.01$) = $7 + 0.65 = 7.65 mm$

Question 2(b) [4 marks]

Explain phase difference and coherence.

Solution

Phase Difference: The difference in phase angle between two waves of the same frequency.

Table 3: Phase Difference Characteristics

Phase Difference	Interference Type	Result
$0° or 360°$	**Constructive**	**Maximum amplitude**
$180°$	**Destructive**	**Minimum amplitude**

Coherence: Property of waves that have a constant phase relationship.
Types of Coherence:
- **Temporal coherence: Related to frequency stability**
- **Spatial coherence: Related to wavefront uniformity**

Question 2(c) [7 marks]

Explain capacitor, its capacitance and the effect of dielectric material on the capacitance of parallel plate capacitor.

Solution

Capacitor: Device that stores electric charge and electrical energy in an electric field.
**Capacitance:** Ratio of charge stored to potential difference applied.
Formula: C = Q/V
Parallel Plate Capacitor: Capacitance formula: **C =** $\epsilon_0 A/d$
- $\epsilon_0 = Permittivity\,of\,free\,space$
- **A = Area of plates**
- **d = Distance between plates**
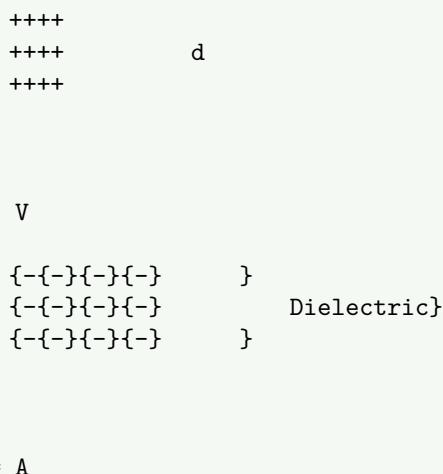
Effect of Dielectric:
- **Increases capacitance by K times (K = dielectric constant)**
- **New formula: C = K** $\epsilon_0 A/d$

Diagram:

```
        ++++
        ++++           d
        ++++



         V

        {-{-}{-}{-}       }
        {-{-}{-}{-}           Dielectric}
        {-{-}{-}{-}       }



    Area = A
```

Mnemonic

"KIDS: K Increases Dielectric Storage"

Question 2(a) OR [3 marks]

If the lengths of two cylinders are $(6.52 \pm 0.01) cm$ and $(4.48 \pm 0.02) cm$ respectively. Find the difference in their length with perc

Solution

Calculation:
- **Length of first cylinder ($\mathbf{L_1}$)** $= 6.52 \pm 0.01 cm$
- **Length of second cylinder ($\mathbf{L_2}$)** $= 4.48 \pm 0.02 cm$
- **Difference in length ($\mathbf{\Delta L}$) = $\mathbf{L_1 - L_2}$** $= 6.52 - 4.48 = 2.04 cm$

Absolute error in difference = $\sqrt{(0.01)^2 + (0.02)^2} = \sqrt{(0.0001 + 0.0004)} = \sqrt{0.0005} = 0.022 cm$
Percentage error = (Absolute error/Measured value) $\times 100 = (0.022/2.04) \times 100 = 1.08\%$

Mnemonic

"Add errors in quadrature for difference calculations"

Question 2(b) OR [4 marks]

Explain the types of interference with relevant figures.

> **Solution**
>
> **Types of Interference:**
>
> Table 5: Interference Types
>
> | Type | Phase Difference | Result | Wave Amplitude |
> |------|------------------|--------|----------------|
> | **Constructive** | $0°, 360°, 720° \ldots$ | **Reinforcement** | **Maximum** |
> | **Destructive** | $180°, 540°, 900° \ldots$ | **Cancellation** | **Minimum** |
>
> **Constructive Interference: When crest meets crest or trough meets trough.**
> **Destructive Interference: When crest meets trough.**
> **Diagram:**
>
> ```
> Constructive Interference:
>             Wave 1
>             Wave 2
>
>             Result: Larger amplitude
>
> Destructive Interference:
>             Wave 1
>             Wave 2
>     {-{-}{-}{-}{-}{-}{-}{-} Result: Flat line (cancellation)}
> ```

> **Mnemonic**
>
> **"Crest + Crest = Constructive, Crest + Trough = Destructive"**

Question 2(c) OR [7 marks]

Derive the expression for potential due to point charge with necessary figure.

> **Solution**
>
> **Potential at a point due to point charge:**
> **Formula development:**
> - **Definition: Work done per unit charge to bring a test charge from infinity to that point**
> - **Expression: $V = W/q_0 = \int(F dr)$**
>
> **Step-by-step derivation:**
> 1. **Force between charges (Coulomb's law): $F = (1/4\pi\varepsilon_0) \times (Qq/r^2)$**
> 1. **Work done moving test charge: $W = \int(F dr)$**
> 1. **For radial motion: $W = (Q/4\pi\varepsilon_0) \times \int(1/r^2)dr \, from \, \infty \, to \, r$**
> 1. **Integrating: $W = (Q/4\pi\varepsilon_0) \times [-1/r]\infty$**
> 1. **Final result:**
> $V = W/q_0 = (1/4\pi\varepsilon_0) \times (Q/r)$
>
> **Final formula: $V = (1/4\pi\varepsilon_0) \times (Q/r)$**
> **Diagram:**
>
> ```
>             P (Point where
>               potential is calculated)
>             *
>
>
>               r
>
>
>         Q
>
>     Point Charge at origin
> ```

Question 3(a) [3 marks]

Explain in brief charging by friction and induction methods.

> **Solution**
>
> **Charging by Friction:** Process of charging by rubbing two different materials together.
> **Steps in friction charging:**
> - **Electrons transfer from one material to another**
> - **Material losing electrons becomes positively charged**
> - **Material gaining electrons becomes negatively charged**
>
> **Charging by Induction:** Process of charging without direct contact.
> **Steps in induction charging:**
> - **Bring charged body near a neutral conductor**
> - **Redistribution of charges in neutral body**
> - **Ground the conductor and remove ground**
> - **Remove the charged body**

> **Mnemonic**
>
> "FTEE: Friction Transfers Electrons Easily"

Question 3(b) [4 marks]

A tuning fork vibrates at frequency of 256 Hz. If its velocity is 340 m/s, find (a) wavelength and (b) distance travelled by it in 50 oscillations.

> **Solution**
>
> **Formulas:**
> - **Wavelength ( ) = Velocity (v) / Frequency (f)**
> - **Distance (d) = Number of oscillations (n)** $\times Wavelength()$
>
> **Calculation: (a) Wavelength ( ) = v/f = 340/256 = 1.328 m**
> 1. **Distance (d) = n $\times$**
>
> **= 50** $\times 1.328 = 66.4m$

> **Mnemonic**
>
> "VFD: Velocity, Frequency and Distance are connected"

Question 3(c) [7 marks]

Write the principle and construction of a bimetallic thermometer with a labelled diagram. Also mention its advantages and disadvantages.

> **Solution**
>
> **Principle: Different metals expand differently when heated, causing the strip to bend.**
> **Construction:**
>
> <div align="center">
>
> **Mermaid Diagram (Code)**
> </div>
>
> ```
> {Shaded}
> {Highlighting}[]
> graph TD
>     A[Bimetallic Thermometer] {-{-}{} B[Fixed End]}
>     A {-{-}{} C[Bimetallic Strip]}
>     A {-{-}{} D[Pointer]}
> ```

```
    A {-{-}{} E[Scale]}
    A {-{-}{} F[Protective Case]}
    C {-{-}{} G[Metal with Higher Expansion]}
    C {-{-}{} H[Metal with Lower Expansion]}
{Highlighting}
{Shaded}
```

Working:
- **Temperature change causes different expansion rates**
- **Bimetallic strip bends toward metal with lower expansion coefficient**
- **Pointer movement indicates temperature**

Diagram:

```
        Pointer




Scale




    Bimetallic Strip
 (Two different metals laminated)

 At higher temperature:







            {}
             { (bends due to }
               { different expansion)}
```

Advantages:
- **Simple, robust design**
- **No power supply needed**
- **Wide temperature range**

Disadvantages:
- **Less accurate than other types**
- **Slow response time**
- **Subject to mechanical wear**

Mnemonic

"BEDS: Bimetallic Elements Deform with Stress"

Question 3(a) OR [3 marks]

Explain work done on a point charge in an electric field.

Solution

Work Done on Point Charge: The work done to move a point charge q in an electric field E.
Formula: W = q($V_a - V$) = qV
Where:
- **q = charge being moved**

- $V_a = potential\,at\,initial\,position$
- **V** = potential at final position
- **ΔV** = potential difference

Key properties:
- **Work is independent of path taken**
- **Work is positive when moving against electric field**
- **Work is negative when moving along electric field**

Question 3(b) OR [4 marks]

What will be the distance travelled by a sound wave in 75 vibrations if its speed is 0.33 km/s and frequency is 660 Hz.

Solution

Formulas:
- **Wavelength ( ) = Velocity (v) / Frequency (f)**
- **Distance (d) = Number of vibrations (n)** $\times Wavelength()$

Calculation:
- **Convert velocity:**
  v = 0.33 km/s = 330 m/s
- **Wavelength:**
  = v/f = 330/660 = 0.5 m
- **Distance:**
  d = n ×
= 75 $\times 0.5 = 37.5 m$

Question 3(c) OR [7 marks]

Write the principle and construction of a Mercury thermometer with a labelled diagram. Also mention its advantages and disadvantages.

Solution

Principle: Mercury thermometer works on the principle of thermal expansion of mercury when heated.
Construction:

Mermaid Diagram (Code)
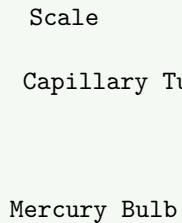
```
{Shaded}
{Highlighting}[]
graph TD
    A[Mercury Thermometer] {-{-}{} B[Glass Bulb]}
    A {-{-}{} C[Capillary Tube]}
    A {-{-}{} D[Scale]}
    A {-{-}{} E[Mercury]}
    A {-{-}{} F[Vacuum/Nitrogen Space]}
    A {-{-}{} G[Safety Bulb]}
{Highlighting}
{Shaded}
```

Working:
- **Mercury expands when heated**

- **Expansion causes mercury to rise in capillary**
- **Height of mercury column indicates temperature**

Diagram:

```
        Scale

       Capillary Tube



       Mercury Bulb
```

Advantages:
- **High accuracy**
- **Wide temperature range (-38$^t o 357$)**
- **Linear expansion of mercury**
- **Good visibility of mercury thread**

Disadvantages:
- **Mercury is toxic**
- **Fragile glass construction**
- **Cannot be used below -38**
- **Slow response to temperature changes**

Mnemonic

"MELT: Mercury Expands Linearly with Temperature"

Question 4(a) [3 marks]

**The electric force between two positive ions of equal magnitude separated by distance $5 \times 10^{-10} m$ from each other is $3.$
$10^{-9} N$. How many electrons would have been removed from each atom.**

Solution

Formula: $F = (1/4 \pi \epsilon_0) \times (q_1 q_2/r^2)$
Calculation:
- **$F = 3.7 \times 10^{-9} N$**
- **$r = 5 \times 10^{-10} m$**
- **$q_1 = q_2 = ne (n = number of electrons,$**

e = electron charge)
- **$1/4 \pi \epsilon_0 = 9 \times 10^9 Nm^2/C^2$**
- **$e = 1.6 \times 10^{-19} C$**

**$3.7 \times 10^{-9} = (9 \times 10^9) \times (n^2 e^2/(5 \times 10^{-10})^2) 3.7 \times 10^{-9} = (9 \times 10^9) \times (n^2 \times (1.6 \times 10^{-19})^2/25 \times 10^{-20}) Solving:$
$n = 1 (1 electron removed from each atom)$**

Mnemonic

"FACE: Force Affects Charge Equally"

Question 4(b) [4 marks]

State Snell's law and derive its formula.

Solution
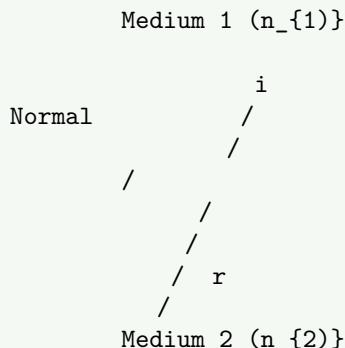
Snell's Law: The ratio of sine of angle of incidence to sine of angle of refraction is constant for a given pair of media.

Formula: (sin i)/(sin r) = $n_2/n_1 = constant$

Derivation steps:

1. **Light travels at different speeds in different media**
2. **When light passes from one medium to another, it changes direction**
3. **Using Fermat's principle of least time**
4. **Ratio of speeds equals ratio of refractive indices**
5. **Final formula: $n_1 sini = n_2 sinr$**

Diagram:

```
        Medium 1 (n_{1})


                 i
Normal           /
                /
        /      /
            /
           /
          /  r
         /
        Medium 2 (n_{2})
```

Question 4(c) [7 marks]

Explain any three applications of Ultrasonic waves.

Solution

Applications of Ultrasonic Waves:

Table 7: Ultrasonic Applications

Application	Principle	Use
Medical Imaging	Reflection from tissues	Visualize internal organs
NDT (Non-Destructive Testing)	Reflection from defects	Find flaws in materials
Cleaning	Cavitation effect	Clean jewelry, surgical instruments

1. **Medical Imaging (Sonography):**
   - **Frequencies: 1-10 MHz**
   - **Principle: Pulse-echo technique**
   - **Uses: Fetal imaging, organ scanning, blood flow measurement**
2. **Industrial NDT:**
   - **Detects cracks, voids, and flaws in materials**
   - **Quality control in manufacturing**
   - **Thickness measurement of materials**
3. **Ultrasonic Cleaning:**
   - **Creates microscopic bubbles (cavitation)**
   - **Removes contaminants from surfaces**
   - **Used for jewelry, optical components, surgical instruments**

Question 4(a) OR [3 marks]

Obtain the equivalent capacitance for series and parallel combinations of 3 capacitors having capacitances 5 µF, 10 µF and 15 µF respectively.

> **Solution**
>
> **Parallel Combination: $C_p = C_1 + C_2 + C_3 = 5 + 10 + 15 = 30F$**
> **Series Combination: $1/C_s = 1/C_1 + 1/C_2 + 1/C_3 \quad 1/C_s = 1/5 + 1/10 + 1/15 \quad 1/C_s = 0.2 + 0.1 + 0.067 = 0.367 \quad C_s = 1/0.367 = 2.72F$**

> **Mnemonic**
>
> **"ASAP: Add for Series, Add inverse for Parallel"**

Question 4(b) OR [4 marks]

Explain the construction of an optical fibre with a neat diagram.

> **Solution**
>
> **Construction of Optical Fiber:**
> **Components:**
> - **Core: Light transmission medium**
> - **Cladding: Outer layer with lower refractive index**
> - **Buffer coating: Protective plastic covering**
>
> **Parameters:**
> - **Core diameter: 8-50 m (single mode), 50-100 m (multimode)**
> - **Cladding diameter: 125-140 m**
> - **Core refractive index > Cladding refractive index**
>
> **Diagram:**
>
> ```
> Cross{-section:}
> ```
>
> ```
>     Buffer   Cladding   Core
> ```
>
> ```
> Longitudinal view:
> ```
>
> ```
>             Core                Light
>                                 ray
> ```
>
> ```
>             Cladding
> ```

> **Mnemonic**
>
> **"CBC: Core-Buffer-Cladding from inside out"**

Question 4(c) OR [7 marks]

Explain production of ultrasonic waves by magnetostriction method.

> **Solution**
>
> **Magnetostriction Method:** The process of generating ultrasonic waves using the property of ferromagnetic materials to change dimensions when placed in a magnetic field.
>
> **Principle:** Ferromagnetic materials change length when magnetized, producing mechanical vibrations that create ultrasonic waves.
>
> **Construction:**
>
> ### Mermaid Diagram (Code)
>
> ```
> {Shaded}
> {Highlighting}[]
> graph TD
>     A[Magnetostriction Generator] {-{-}{} B[AC Power Supply]}
>     A {-{-}{} C[Coil/Solenoid]}
>     A {-{-}{} D[Ferromagnetic Rod]}
>     A {-{-}{} E[Acoustic Medium]}
>     A {-{-}{} F[Cooling System]}
> {Highlighting}
> {Shaded}
> ```
>
> **Working Process:**
> 1. AC current passes through solenoid
> 2. Alternating magnetic field produced
> 3. Ferromagnetic rod expands and contracts
> 4. Vibrations transmitted to medium
> 5. Ultrasonic waves generated
>
> **Diagram:**
>
> AC Power Supply
>
> Coil   Coil
>
> Ferromagnetic   Ultrasonic
> Rod (Nickel)   Waves
>
> **Advantages:**
> - Simple construction
> - High power output
> - Suitable for liquids
>
> **Disadvantages:**
> - Limited to frequencies below 100 kHz
> - Heating effects
> - Lower efficiency

Question 5(a) [3 marks]

Explain in brief the three modes of heat transfer.

Solution

Three Modes of Heat Transfer:

Table 9: Heat Transfer Modes

Mode	Medium Requirement	Example
Conduction	Physical contact	Heat through metal rod
Convection	Fluid medium	Hot air rising
Radiation	No medium needed	Heat from sun

1. **Conduction:**
   - **Transfer through direct molecular collision**
   - **No bulk movement of matter**
   - **Good in solids, especially metals**
2. **Convection:**
   - **Transfer through fluid movement**
   - **Requires density differences**
   - **Natural or forced convection**
3. **Radiation:**
   - **Transfer through electromagnetic waves**
   - **Works in vacuum**
   - **Depends on temperature and surface properties**

Mnemonic

"CCR: Conduction Contact, Convection Current, Radiation Rays"

Question 5(b) [4 marks]

Calculate the numerical aperture and acceptance angle of an optical fibre if the refractive indices of core and cladding of an optical fibre are 1.55 and 1.5 respectively.

Solution

Formulas:
   - **Numerical Aperture (NA) $= \sqrt{(n_1^2 - n_2^2)}$**
   - **Acceptance angle (θ_a) $= sin^{-1}(NA)$**

Calculation:
   - **Core refractive index (n_1) $= 1.55$**
   - **Cladding refractive index (n_2) $= 1.5$**

NA $= \sqrt{(1.55^2 - 1.5^2)}$ $NA = \sqrt{(2.4025 - 2.25)}$ $NA = \sqrt{0.1525}$ $NA = 0.391$

Acceptance angle (θ_a) $= sin^{-1}(0.391)$ $\theta_a = 23.03°$

Mnemonic

"CORE: Calculate Optical Refractive-index Exactly"

Question 5(c) [7 marks]

Explain any three applications of optical fibres.

Applications of Optical Fibers:

Table 11: Major Optical Fiber Applications

Application	Advantage	Example
Communications	High bandwidth	Internet, phone networks
Medical	Flexibility, imaging	Endoscopy
Sensors	Immunity to EMI	Temperature sensing

1. **Communication Networks:**
   - **Telecommunications and internet**
   - **Higher bandwidth than copper cables**
   - **Less signal attenuation over long distances**
   - **More secure against tapping**
2. **Medical Applications:**
   - **Endoscopy for minimally invasive procedures**
   - **Light delivery for photodynamic therapy**
   - **Dental procedures**
   - **Surgical illumination**
3. **Sensing Applications:**
   - **Temperature and pressure sensors**
   - **Strain gauges for structural monitoring**
   - **Chemical sensors**
   - **Gyroscopes for navigation**

Mnemonic

"CMS: Communication, Medical, Sensing applications"

Question 5(a) OR [3 marks]

Give a detailed explanation of specific heat.

Solution

Specific Heat: Amount of heat required to raise the temperature of 1 kg of a substance by 1 Kelvin (or $1^)$.
Formula: Q = mc T
Where:
- **Q = Heat energy (J)**
- **m = Mass (kg)**
- **c = Specific heat capacity (J/kg · K)**
- **T = Temperature change (K)**

Units: J/kg · K or J/kg ·
Significance:
- **Measures thermal inertia of materials**
- **Higher specific heat means material requires more energy to heat up**
- **Water has unusually high specific heat (4,186 J/kg · K)**

Mnemonic

"STEM: Specific heat measures Temperature change per Energy and Mass"

Question 5(b) OR [4 marks]

If the refractive indices of core and cladding of an optical fibre are 1.48 and 1.45 respectively. Calculate its acceptance angle and critical angle.

Formulas:
- **Numerical Aperture (NA)** = $\sqrt{(n_1^2 - n_2^2)}$
- **Acceptance angle ($_a$)** = $sin^{-1}(NA)$
- **Critical angle ($_c$)** = $\sin^{-1}(n_2/n_1)$

Calculation:
- **Core refractive index (n_1)** = 1.48
- **Cladding refractive index (n_2)** = 1.45

NA = $\sqrt{(1.48^2 - 1.45^2)} NA = \sqrt{(2.1904 - 2.1025)} NA = \sqrt{0.0879} NA = 0.296$

Acceptance angle ($_a$) = $sin^{-1}(0.296)_a = 17.2°$

Critical angle ($_c$) = $\sin^{-1}(n_2/n_1)c = sin^{-1}(1.45/1.48)c = sin^{-1}(0.9797)c = 78.4°$

Mnemonic

"NA leads to AA, ratio leads to Critical Angle"

Question 5(c) OR [7 marks]

Explain the applications of LASER in engineering and medical field.

Solution

Applications of LASER:

Table 13: LASER Applications

Field	Application	Example
Engineering	Cutting/Welding	Metal fabrication
Engineering	Measurements	Distance measurement
Medical	Surgery	Eye surgery (LASIK)
Medical	Therapy	Cancer treatment

Engineering Applications:
1. Material Processing:
- **Precision cutting of metals, plastics, ceramics**
- **Welding of dissimilar materials**
- **Surface treatment and hardening**
- **3D printing and rapid prototyping**

2. Metrology and Measurement:
- **Distance measurement with high precision**
- **Alignment in construction and manufacturing**
- **Interferometry for surface analysis**
- **Holography for 3D imaging**

Medical Applications:
1. Surgical Procedures:
- **Eye surgery (LASIK, cataract removal)**
- **Minimally invasive procedures**
- **Dermatological treatments**
- **Dental procedures**

2. Therapeutic Uses:
- **Photodynamic therapy for cancer**
- **Low-level laser therapy for pain**
- **Treatment of vascular lesions**
- **Cosmetic procedures**

Diagram:

```
Engineering Applications:
    LASER    Material Processing

         Measurements

         Communications

Medical Applications:
    LASER    Surgical Procedures

         Diagnostic Tools

         Therapeutic Treatments
```

Mnemonic

"SMART: Surgery, Measurement, Analysis, Repair, and Treatment"