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Naneng 307
Assignment 2

1)

[1] $\boxed{B}$ lighting a gas stove; Applying Force on crystal induces pressure on piezoelectric material creating an electrical signal or current spark so used as piezoelectric lighter in kitchen.

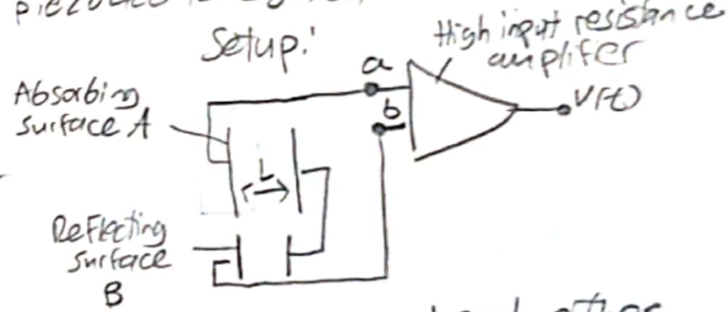
[2] $\boxed{A}$ True; Spark from piezoelectric transducer used to light cigarette.

[3] $\boxed{D}$ A self-generating transducer; Doesn't need applied voltage for operation due to natural piezoelectric effect.

2) Develop a pyroelectric detector; ∵ Temperature change δT induces a change δP in polarization of the Barium titanate piezoelectric crystal, leads to δV change.

Concept: ∴ $\delta T \rightarrow \delta P \rightarrow \delta V$

Setup:



- element A absorbs radiation, generating pyroelectric voltage measured by amplifier
- element B has reflecting electrode ∴ does not absorb radiation.
- Piezoelectric effect generate equal voltages in A & B that cancel each other across terminals a & b input to amplifier.

∴ Detector only amplifies radiation measured by A.

3) 1. Non-Volatile RAMs: Utilizing Ferroelectric Hysteresis phenomenal by applying Electric Field, Fast-response polarization corresponds to digital 1 while neutral (no E) is digital 0 ∴ used as RAM with very fast-response & is non-volatile if power is removed, Ferroelectric RAM FRAM is faster than flash memory

2. Smart cards; Ferroelectric RAM FRAM is faster than flash memory and use contactless radio freq. input/output. They can carry substantial information with low risk of data corruption.

3. Tuneable microwave Devices/optical waveguides; ∵ Ferromaterials can be tuneable, can be applied in communication applications, tuneability $= \Phi = \dfrac{\Delta E}{\epsilon(E=0)}$ by using integrated microwave components with characteristics tuneable by applied voltage, + is sustainable.

4. Batteries offer superior energy density & higher breakdown voltage. Supercapacitors are lighter, have more robust limits, longer life expectancy, greater power density, but more expensive to develop.

$\boxed{4}$ $xy =$ Area A, $z =$ thickness, $\because \frac{dx}{dT} = \lambda x$, $\frac{dy}{dT} = \lambda y$, $\frac{dz}{dT} = \lambda z$

$\because \varepsilon_r$ is temperature dependant $\therefore \frac{dC}{dT}$ is:-

$$\therefore C = \frac{\varepsilon_0 \varepsilon_r xy}{z}$$

$$\therefore \frac{dC}{dT} = \frac{\left(\varepsilon_0 xy \frac{d\varepsilon_r}{dT} + \varepsilon_0 \varepsilon_r y \frac{dx}{dT} + \varepsilon_0 \varepsilon_r x \frac{dy}{dT}\right) z - \varepsilon_0 \varepsilon_r xy \frac{dz}{dT}}{z^2}$$, using derivatives

$$\therefore \frac{dC}{dT} = \frac{\varepsilon_0 xy \frac{d\varepsilon_r}{dT} + \lambda \varepsilon_0 \varepsilon_r xy}{z}$$, $\because TCC = \frac{1}{C}\frac{dC}{dT}$

$$\therefore TCC = \frac{\varepsilon_0 xy \frac{d\varepsilon_r}{dT} + \lambda \varepsilon_0 \varepsilon_r xy}{Cz} = \frac{\varepsilon_0 xy \frac{d\varepsilon_r}{dT} + \lambda \varepsilon_0 \varepsilon_r xy}{\left(\frac{\varepsilon_0 \varepsilon_r xy}{z}\right) z}$$

$\therefore$ Simplifying:- $\boxed{TCC = \frac{1}{\varepsilon_r}\frac{d\varepsilon_r}{dT} + \lambda}$