

“A PEN WITH REFILL INDICATOR”

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Shaikh Mehboob Nasruddin

Abstract:

Problem:

Many times, a pen runs out of ink during exams or important work. This causes stress and interrupts writing. Students often face this problem in the middle of exams and get disturbed, while teachers may think they are cheating when they ask for another pen. There is no easy way to know when the pen's ink is about to finish.

Solution

The “Smart Pen with Refill Indicator” helps users know when their ink is low. It uses a small electric circuit with an LED light, battery, and two metal pins. When the ink goes below a certain level, the LED glows to show that the refill needs to be replaced. This simple idea can help students and professionals avoid sudden ink problems.

AIM: To develop a pen with refill indicator.

Apparatus: Ball pens for different trials, insulin syringe for using Minimal diameter conductive pins, alpins, button cells , LED bulbs, copper wire, solder iron, solder wire, solder paste, Slime, fine iron powder and fine graphite powder.

For manufacturing machine presentation:

Steel straw, glasses, battery, switch, springs, nuts and bolts of different sizes, wooden board, sun board, chart, colours.

TRIALS:

Different trials have been made to develop a refill indicator pen.

Hypothesis 1:

A small lightweight floating material like slime can show refill levels easily.

Trial1:

To insert a small floating ball inside the refill which can be seen by a transparent line in pen's body.

Procedure:

Trial is attempting using small slime balls used in the top of refill.

Results:

It does not float down along refill sink levels. Fails!

Trial 2:

To insert a small ball made of solder wire which is inserted to float on ink. The floating ball must come in contact with conducting pins (syringe needles) inserted near the bottom line of ink levels. On the top button battery with LED is installed.

Hypothesis 2:

When refill goes down solder made minute ball comes in contact of pins and light the bulbs to indicate ink levels.

Problem faced: Ink filled refills when punctured by pins leaks out ink. Secondly it was difficult to make small balls of solder wire using soldering iron of desired size. Once made, it sinks in ink and ink acts as insulator giving undesired results.

Results: Attempt failed due to ink leakage and ball sinking in ink.

Trial 3:

To insert graphite powder removed from old cell body to replace solder balls in same mechanism.

Hypothesis 3: LED must glow with lower levels of ink.

Problem faced:

Ink filled in refill took long time to get over and hence unable to find results frequently. Graphite powder could not be tightly filled in top of ink to provide good line of conduction to complete circuit.

Result: partial success.

Trial 4:

Replace refill with its simulator (syringe and pen body) and mixing bit iron filling with graphite powder to show quick working mechanism.

Hypothesis 4: The LED will glow in such mechanism.

Problem Faced: when applied pressure ink is mixed with graphite and iron filling. Hence bulb glows even ink is there due to contact with circuit.

Result: Partial success.

Trial 5:

Replace graphite powder and iron filing mixture in the fine mesh of slime + iron filling + graphite powder tightly packed to rest in top of syringe.

Hypothesis 5: when applied pressure, ink (represented by slime) comes out of syringe and slime mesh with graphite and iron filling come in contact with conducting pins to light the LED.

Problem Faced: capillary action and upthrust of air to resist slime filling. However it took time to fill slime, it was a successful attempt and successfully showcased the working mechanism of a pen with refill indicator.

Result: Successful to display.

WORKING MECHANISM.

1. When Ink is Sufficient:

- The two conducting pins are covered by non-conducting ink.
- The circuit is open, so current does not flow.
- The bulb or LED does not glow.

2. When Ink is Low:

- The ink level falls below the pins.
- The graphite and iron powder come in contact with the pins.
- The circuit is closed, and current flows from the battery.
- The bulb or LED glows, showing the ink is low.

KEY POINTS

- Simple and low-cost mechanism.
- LED glows when ink is low.
- Battery-operated (button cell).
- Safe and reusable.
- Can be applied to any **normal ball pen or gel pen.**

PROJECT SYNOPSIS

This project is designed to solve the common problem of pen ink finishing suddenly. It uses basic electrical principles where a closed circuit allows current to flow and light a bulb. Here, the ink level acts as a switch. When ink is full, the circuit stays open; when ink is low, the graphite and iron powder close the circuit and light the LED. This idea is simple, cost-effective, and can be used in schools, offices, and daily life.

CHALLENGES

It is difficult to float a very minute particle of metals in ink.

Trials were made by using solder iron made ball, iron filling and graphite. They all fail to fit in body of refill if hand made.

Secondly, the density of all these materials is more than the density of ink.

Here is a table showing comparison of density of metals with ball pen ink.

Name of conductor	Density
Iron in true form	7.87g/cm ³
Pinch Of iron filling	2-4 g/cm ³
Solder wire balls (60% lead+40% tin)	8.5g/cm ³
Graphite in true form	2.2g/cm ³
Graphite powder	0.4-0.9g/cm ³

So it is found that graphite in true form can sink but it's fine powder form can have lesser density than density of ball pen ink(1- 1.2g/cm³).

Thus, Graphite powder with a little mixture of Iron filling is selected as conducting material to complete the circuit.

RESULTS

The mechanism of a ball pen with refill indicate is successfully shown in the model. The LED glows when ink is low else it remains close.

FUTURE PERSPECTIVE:

1. Pen with automatic system of lights for High quality pen like Parker using mini form of Arduino in detecting level of ink in pen
2. This idea can also be applied to Automation of pen making systems professionally.
3. Professional machines can make the manufacturing process easy.
4. This idea is fruitful for ink and gel pens as well.

5. Work can be done on beautiful for body design and making the pen light weighted.

REFERENCES:

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2. Archimedes principal of floating objects., Textbook of Maharashtra state boards class VIII.
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Additional Critical Questions and Answers

- Q1. What made you think about this idea?
Many times, I saw students whose pen ink finished during exams. When they asked for a pen, teachers warned them thinking it was cheating. This problem gave me the idea of creating a pen that warns before ink finishes.
- Q2. Why didn't you use an actual refill in the demonstration?
Actual pen refills are very thin. If we puncture them to fix the conducting pins, the ink leaks out. To make it successful, we need to insert the pins before filling the ink at the manufacturing stage. Since I don't want to disclose my idea publicly, I didn't approach factories.
- Q3. Why did you use a syringe instead of a real pen?
If we used a real refill, we would have to wait 5–7 days for ink to go down to show how it works. Using a syringe helps us easily show how ink moves and how the pins touch the graphite-iron mixture to complete the circuit. It makes the working clear to viewers.
- Q4. Why did you use iron fillings and graphite powder as conductors?
Iron and graphite are denser than ink but lighter than solid metal pieces. They can float on top of the ink inside the narrow tube of the pen and help complete the circuit properly.
- Q5. Why did you use both graphite and iron together?
Graphite powder is very fine, while iron fillings are slightly bigger. When mixed with a small amount of water, graphite fills the tiny gaps between iron pieces, creating better conduction for electricity.
- Q6. Why did you keep the pen in a glass and rotate it?
Rotating the pen in a glass gives it a centrifugal force, which removes air bubbles from inside. This helps the ink flow smoothly and prevents leaking or spilling.

Critical Questions

- Q7. Why did you show the pen-making mechanism? How is it related to your idea?
I showed it to explain that my circuit can be easily fitted in a normal pen during regular manufacturing. No big changes or expensive machines are needed. It's adaptable and simple to apply in existing pen designs.
- Q8. What can be the cost of such a pen?
LED – ₹2
Button Cells – ₹10
Copper Wire – ₹2

Pen Body – ₹5

Total Cost – Around ₹19–₹20 (can reduce to ₹15 in bulk).

- Q9. If selected, how can you improve your setup?
If selected, I will work on a smaller and more compact design. A company can help make a neat version with an attractive look, suitable for all types of ball and gel pens.
- Q10. What is the scope of your idea?
This pen can be useful in schools, offices, call centres, hotels, and corporate workplaces — basically anywhere pens are used. Since everyone faces the problem of ink finishing suddenly, it will have high demand in the market.