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Professor of Chemistry
Hiram College



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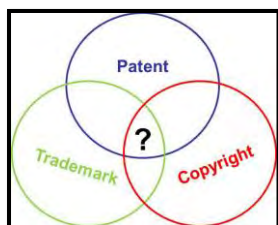
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Thursday, August 8, 2013

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Alternative Careers: Chemistry and Art Detective

*Suzanne Quillen Lomax
National Gallery of Art*



Art Conservation at the National Gallery of Art

Conservation scientists work with curators and conservators to answer questions about works of art.

- Painting Conservation
- Paper Conservation
- Photograph Conservation
- Objects Conservation
- Loans and Exhibitions Conservation
- Textile Conservation
- Scientific Research Department



Museums and Institutions in the US with Conservation Science Departments

- National Gallery of Art, Washington DC
- Smithsonian Institution, Washington DC
- National Archives and Records Administration, College Park, MD
- Library of Congress, Washington DC
- Walters Art Museum, Baltimore MD
- Philadelphia Museum of Art
- Art Institute of Chicago (also NU-ACCESS)
- Metropolitan Museum of Art, New York
- Museum of Modern Art, New York
- Getty Conservation Institute, Los Angeles
- Los Angeles County Museum of Art
- Indianapolis Museum of Art
- Museum of Fine Arts, Houston
- Art Conservation Research Center, Yale University
- The Strauss Center, Harvard University

Careers in Conservation Science

- No training program exists in the US for conservation scientists. There are three training programs in the US for conservators.
 - Buffalo State College
 - New York University (Conservation Center of the Institute of Fine Arts)
 - Winterthur/University of Delaware
- General educational characteristics of conservation scientists:
 - A graduate degree in chemistry, physics or materials science
 - Often courses in studio art and art history
 - work in a museum or with a private conservator

Scientific Research Department



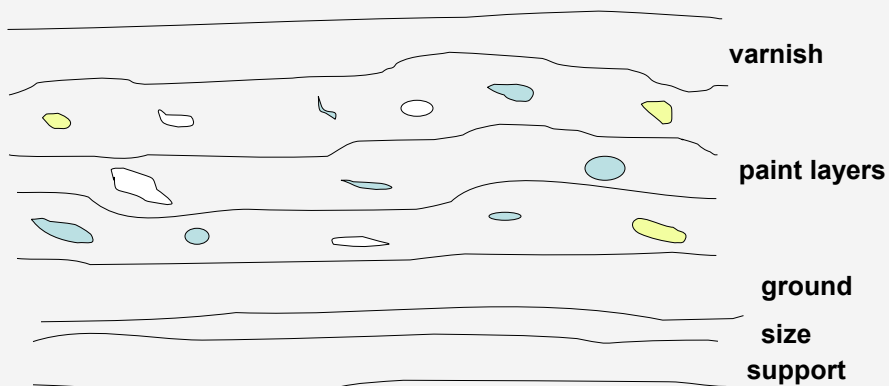
Instrumentation

- Infrared microspectroscopy
- Gas and liquid chromatography/mass spectrometry
- Pyrolysis gas chromatography/mass spectrometry

- X-ray fluorescence spectrometry
- X-ray powder diffraction
- Optical Microscopy/Fluorescence Microscopy
- Scanning Electron Microscopy/Energy Dispersive Spectrometry
- FORS (fiber optic reflectance spectroscopy)

- Weatherometer (accelerated aging)
- Color Measuring equipment
- UV/Vis spectroscopy
- Size exclusion chromatography

Cross Section of a Painting



Painting reconstruction



canvas

lower ground of chalk
and lead white in animal glue

upper ground of lead white in
linseed oil

red brown underdrawing

paint layers

resin varnish in turpentine

1968.1.1
John Singleton Copley
Mrs. Metcalfe Bowler
Gift of Louise Alida Livingston

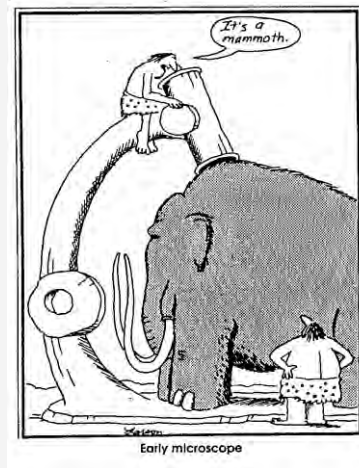
Poll Question 1

Which of the following is **not** a paint binder commonly found in Western Art?

1. Linseed oil
2. Olive oil
3. Egg yolk
4. Gum Arabic

Analysis Problems in Art Conservation

- Often requires destructive analysis
- Small samples
- Inhomogeneous samples
- Contamination of samples from previous restoration treatments
- Few original components left in samples (organic analysis, in the case of oils and natural resins)



Analysis of Drying Oils

- Linseed, walnut and poppy oil are common
- Composed of triglycerides of:
 - Palmitic acid
 - Stearic acid
 - Linoleic acid
 - Linolenic acid
 - Oleic acid
- P/S ratio tells which oil
- Azelaic acid appears over time
- FAME analysis



Pereira, *Transfluent Lines*, 1946

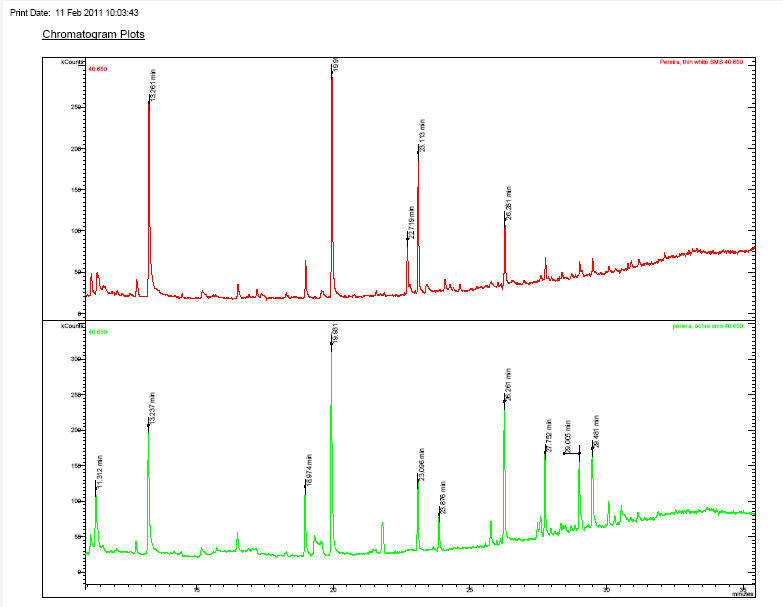


Question:

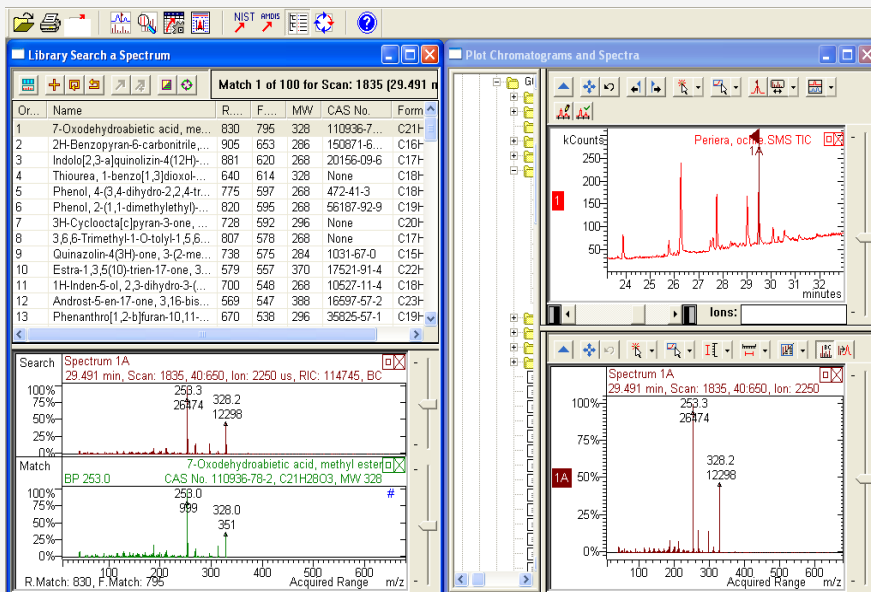
What is the medium of this piece and why do certain colors exhibit flaking?

I Rice Pereira
Transfluent Lines
 1973.71.2
 Gift of Mr. and Mrs. Burton Tremaine

Pereira, *Transfluent Lines*, chromatograms



Pereira, *Transfluent Lines*, chromatogram/ mass spectra



Analysis of Proteinaceous Binders

- Used to distinguish egg, glue or milk protein
- These historically have been commonly used binders
- Via amino acid analysis
- Hydrolyze with 6N HCl, 24 hours under vacuum
- Silylate (derivatization with MTBSTFA/TBDMCS)
- Analysis by GC/MS to match the profile with standards of the binders
- Fatty acids from oil containing sources are silylated along with the amino acids

Ferrarese, 15th C, *Madonna and Child with Angels*

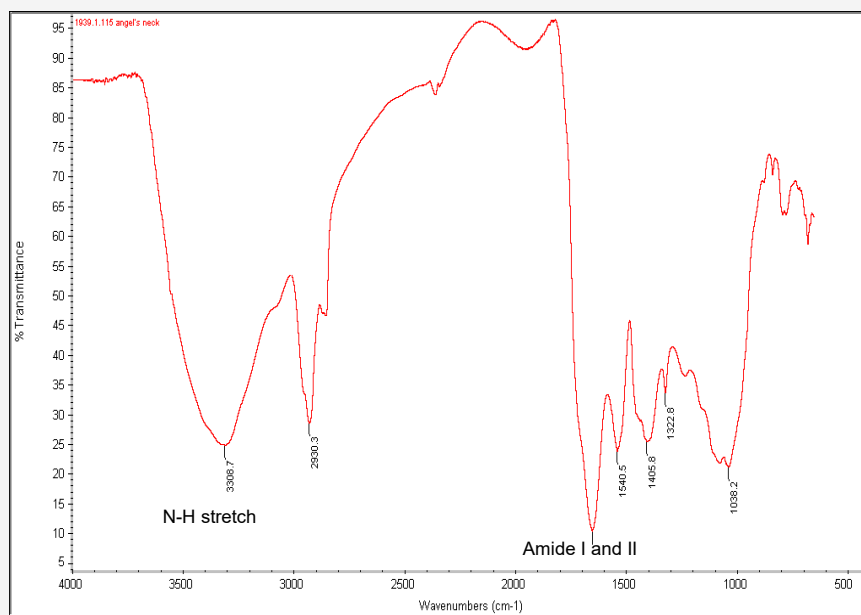


Question:

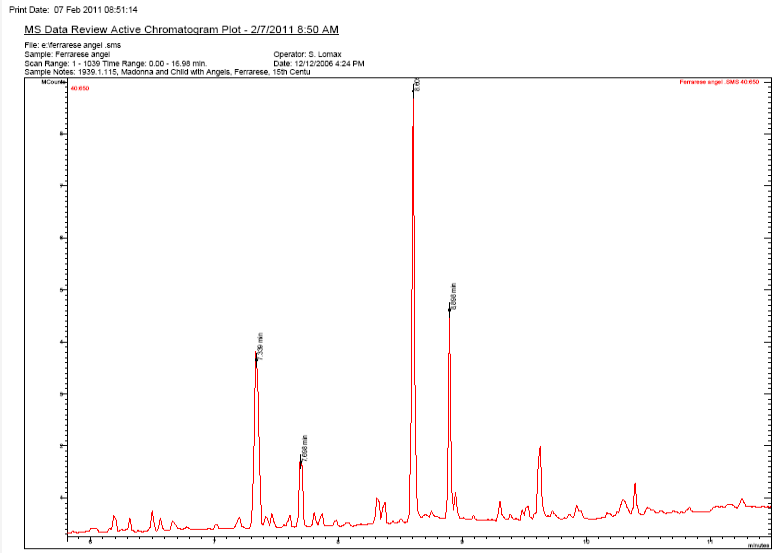
What is the medium of this painting?
Zinc white found in highlights, is it a modern painting or 15thC?

1939.1.115
Madonna and Child with Angels
Samuel H. Kress Collection

Madonna and Child, infrared spectrum white paint



Madonna and Child, chromatogram



Poll Question 2

- Which of these works of art appeals to you more?



1



2

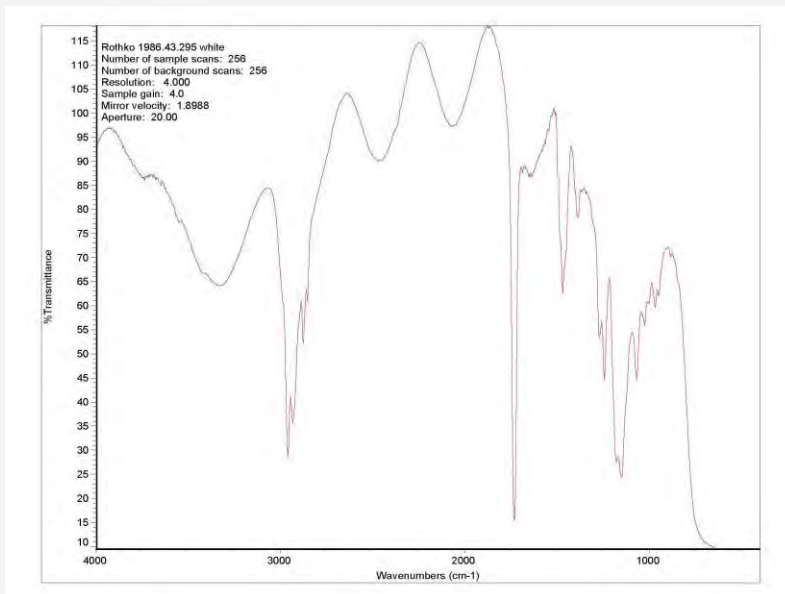
Rothko, works on paper



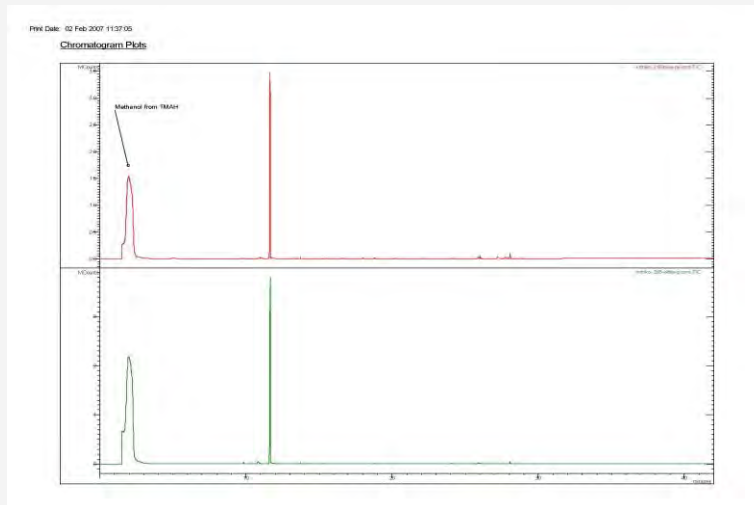
Question:
 What is the medium of
 these paintings on paper?
 The curator wants
 a vocabulary for the
 catalog raisonnée of works
 by Rothko.

Mark Rothko
Untitled
 1986.43.295
 Gift of The Mark Rothko Foundation, Inc

Rothko, works on paper



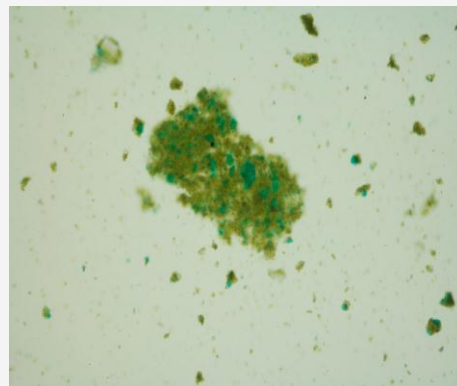
Rothko, *Untitled*, pyrograms of blue and white paint



Magna, a solution paint consisting of poly(n-butyl methacrylate)

Mineral Pigment Analysis

- X-ray fluorescence
- Fiber optic reflectance spectroscopy (FORS)
- Polarized light microscopy
- X-ray diffraction
- Scanning electron microscopy/energy dispersive spectroscopy



Magnified image of green paint from painting by Georgia O'Keeffe

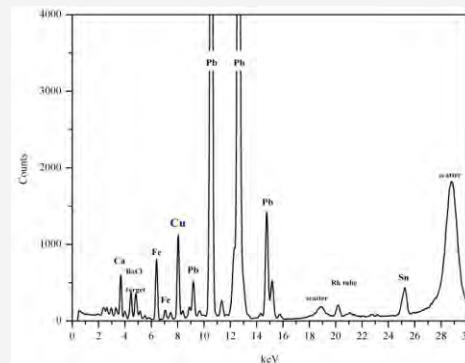
Poll Question 3

- Which of the following pigments does not discolor or fade under normal conditions?
 1. Vermilion (HgS)
 2. Hematite (Fe₂O₃)
 3. Smalt (Co containing potash glass)
 4. Eosin (C₂₀H₆Br₄Na₂O₅⁻ xanthene dye)

Characterization of Artist's Materials using XRF



Bianca Maria Sforza, Ambrogio di Predis, c.1493



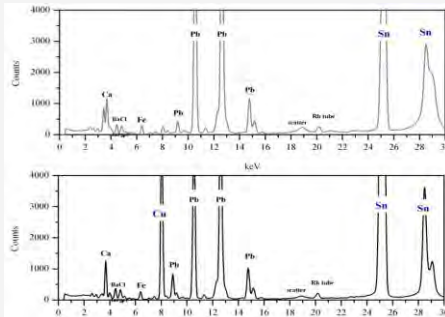
Spectrum of the brown dress

Question: is the original color of the dress brown?

Characterization of Artist's Materials using XRF

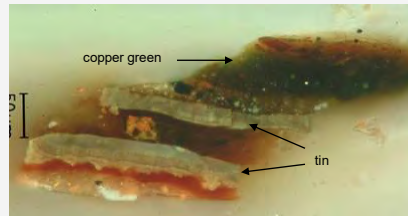


Question: Why are the jewels grey or black?



- The tin is attributable to tin foil.
- The spectrum of the black jewel contains copper. This pigment is possibly a copper green or blue which has turned black over time.
- The grey jewels may have been colored with a fugitive organic pigment, which has gone colorless.

XRF Combined with Other Analysis Methods



- Conclusion: Polarized light microscopy image of a cross section shows two layers of tin. The green paint layer near the top is the likely source of the copper, probably due to a discolored copper resinates

Degas, *Dancer in the Role of Harlequin*



1999.80.25
Collection of Mr. and
Mrs. Paul Mellon

Degas Questions

Questions:

What are the sculptures made of?

Can we distinguish repair from original?

Can we come up with a chronology based on materials?

Why do some of the sculptures have shiny patches on the surface?



The Tub
1985.64.48
Collection of Mr. and Mrs. Paul Mellon

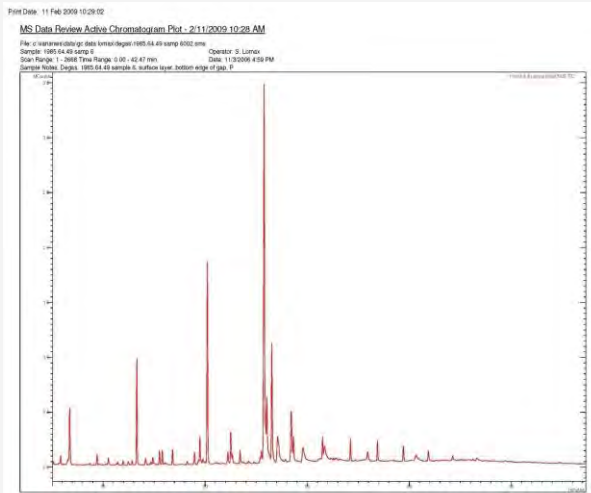
Analysis of Degas samples

- Looked at over 300 samples from 64 sculptures.
 - Wax examined by gas chromatography, polarized light microscopy and SEM/EDS
 - Sculptures examined by XRF
 - Additional samples of shiny exudates analyzed



1999.80.11
Horse Galloping on the right foot
Collection of Mr. and Mrs. Paul Mellon

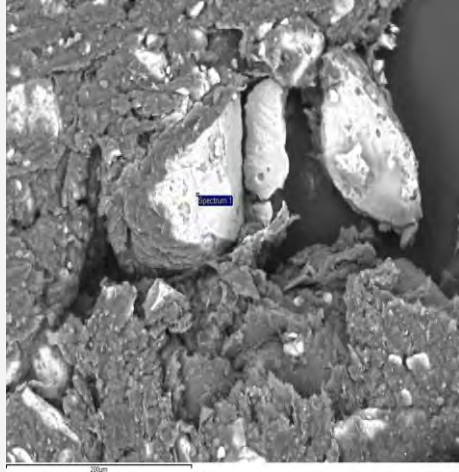
Fourth Position Front, on the Left Leg



1985.64.49
Collection of Mr. and Mrs. Paul Mellon

Question:
What is this sculpture made of?
We don't see any wax.

Degas, *The Schoolgirl*



1999.80.18
Collection of Mr. and Mrs. Paul Mellon

Conclusions:

Most of the sculptures are wax
(beeswax)

Some are all clay

Some are clay core with wax cladding

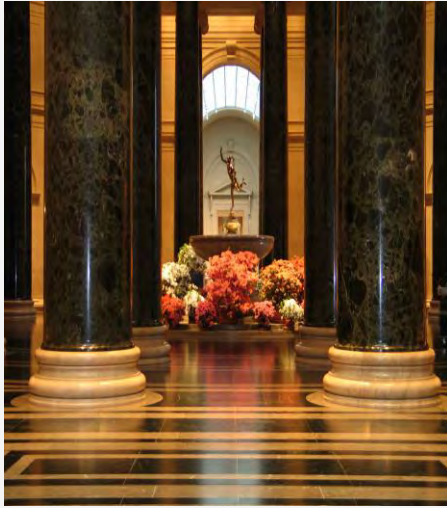
Repairs are usually done in paraffin wax

The modeling clay contains fat which
migrates to the surface of the
sculpture.

Since sculptures are not dated, we
cannot attribute materials to certain
periods in Degas' career.



1985.64.64
Dancer Adjusting the Shoulder Strap
of her Bodice
Collection of Mr. and Mrs. Paul Mellon



With thanks to:

Barbara Berrie
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 Lisha Glinsman
 Melanie Gifford
 Christopher Maines
 Kathryn Morales
 Michael Palmer
 Rebecca Ploeger

Kristin DeGetaldi

Additional Resources

Taft and Mayer, "The Science of Paintings", 2000, Springer-Verlag.

Mills and White, "The Organic Chemistry of Museum Objects", 2nd edition, 1994, Butterworths-Heinemann.

Derrick, Stulik, and Landry, "Infrared Spectroscopy in Conservation Science", 1999, The Getty Conservation Institute.

Artists' Pigments, Volumes 1-4, (Volume 1, Robert Feller editor; Volume 2, Ashok Roy editor; Volume 3, Elisabeth West-Fitzhugh editor; Volume 4, Barbara Berrie, editor) reissued from Archetype, 2012

National Gallery of Art's conservation webpage:

<http://www.nga.gov/content/ngaweb/conservation.html>

The National Gallery, London also has issues of their Technical Bulletin online:

<http://www.nationalgallery.org.uk/technical-bulletin/>

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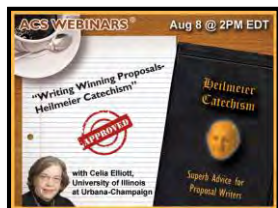


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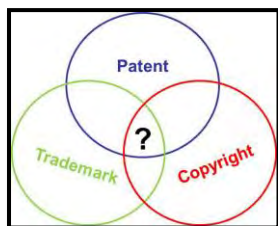
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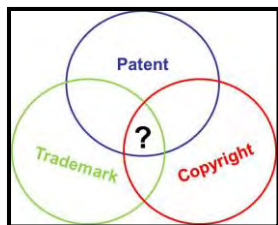
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