

Topic C.8 Solar Energy

Past Exam Questions (Paper 3)

A fuel cell is an energy conversion device that generates electricity from a spontaneous redox reaction.

Dye-sensitized solar cells (DSSC) convert solar energy into electrical energy.

(i) Describe how a DSSC converts sunlight into electrical energy.

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(ii) Explain the role of the electrolyte solution containing iodide ions, I^- , and triiodide ions, I_3^- , in the DSSC.

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2. [3 marks]

The natural absorption of light by chlorophyll has been copied by those developing dye-sensitized solar cells (DSSCs). Outline how a DSSC works.

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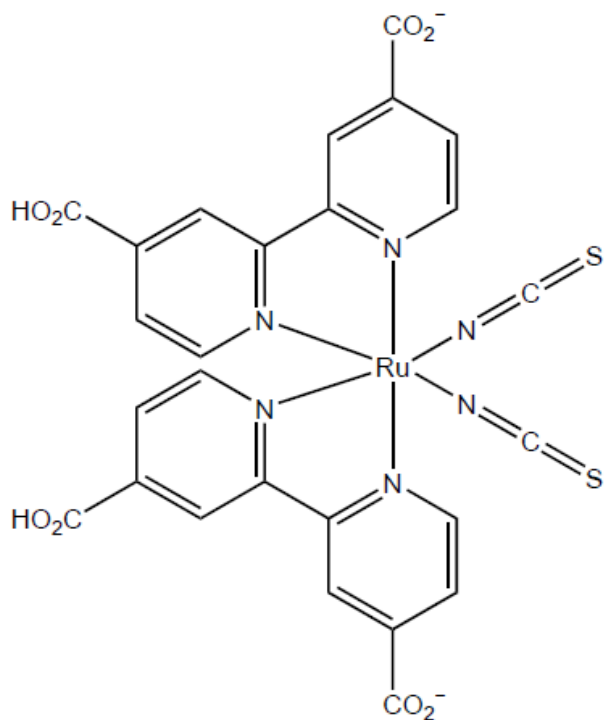
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3a. [2 marks]

Dye-Sensitized Solar Cells (DSSCs) use organic dyes. Their interaction with light has some similarities to photosynthesis.



[Source: www.google.com/patents]

Identify **two** ways in which the structure of the dye shown resembles the chlorophyll molecule. Use section 35 of the data booklet.

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3b. [1 mark]

Both photosynthesis and the Grätzel cell use energy from sunlight to bring about reduction. Deduce an equation for the reduction reaction in the electrolyte of a Grätzel cell.

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4a. [4 marks]

A Grätzel dye-sensitized solar cell (DSSC) and a silicon based photovoltaic cell both convert solar energy into electrical energy by producing a charge separation.

Contrast how absorption of photons and charge separation occur in each device.

Type of solar cell	Absorption of photons	Charge separation
Silicon based		
DSSC		

4b. [1 mark]

Suggest one advantage a DSSC has over a silicon based photovoltaic cell.

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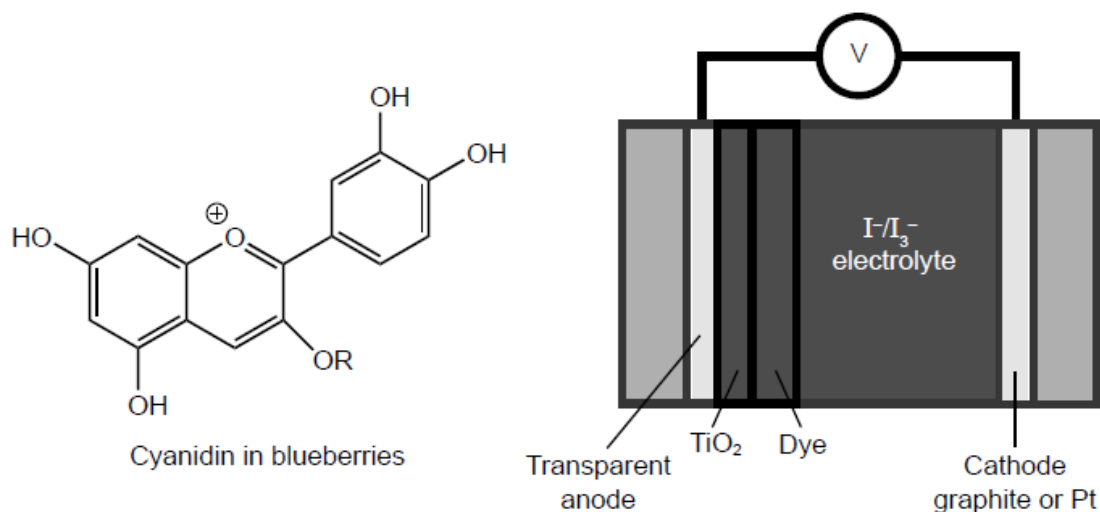
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5a. [1 mark]

Chemical energy from redox reactions can be used as a source of electrical energy.

The chemical structure of a photosensitive dye found in blueberries and a schematic diagram of a solar cell are shown.



Identify the structural feature of the dye that allows the conversion of solar energy into electrical energy.

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5b. [1 mark]

Outline the effect of sunlight on the dye in the solar cell.

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5c. [1 mark]

State the purpose of TiO_2 .

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5d. [1 mark]

Deduce the reduction half-equation at the cathode.

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6a. [1 mark]

Photovoltaic cells are much less hazardous than nuclear fission.

Early photovoltaic cells were based on silicon containing traces of other elements. State the type of semiconductor produced by doping silicon with indium, In, giving a reason that refers to its electronic structure.

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6b. [2 marks]

Dye-sensitized solar cells, DSSCs, use a dye to absorb the sunlight. State **two** advantages that DSSCs have over traditional silicon based photovoltaic cells.

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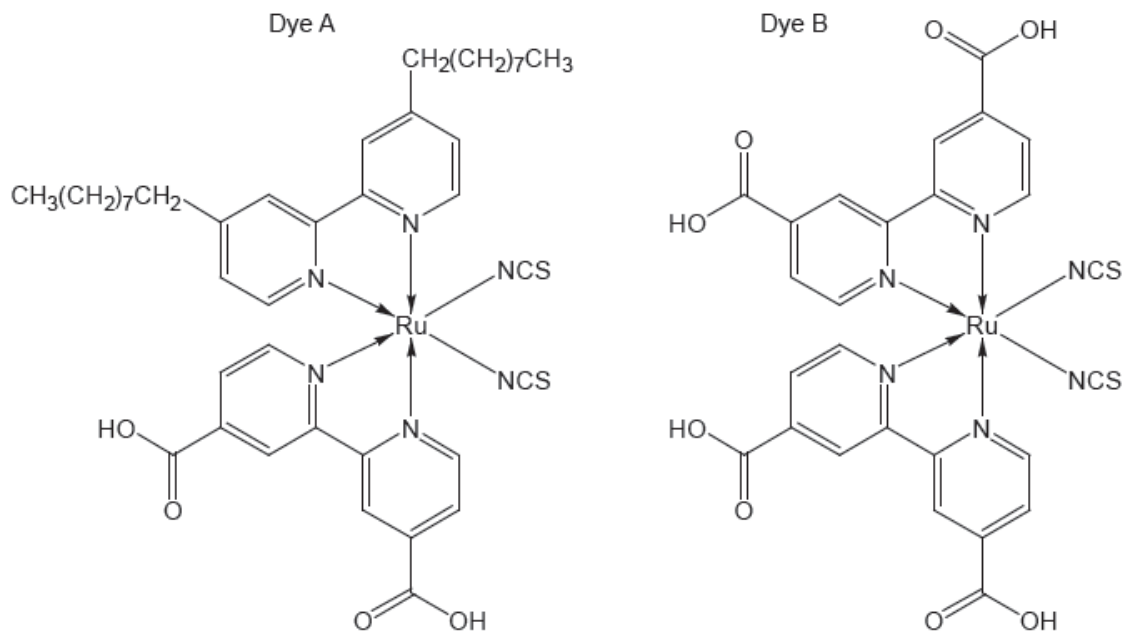
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6c. [1 mark]

The structure of two dyes used in DSSCs are shown.



Predict, giving a reason, which dye will absorb light of longer wavelength.

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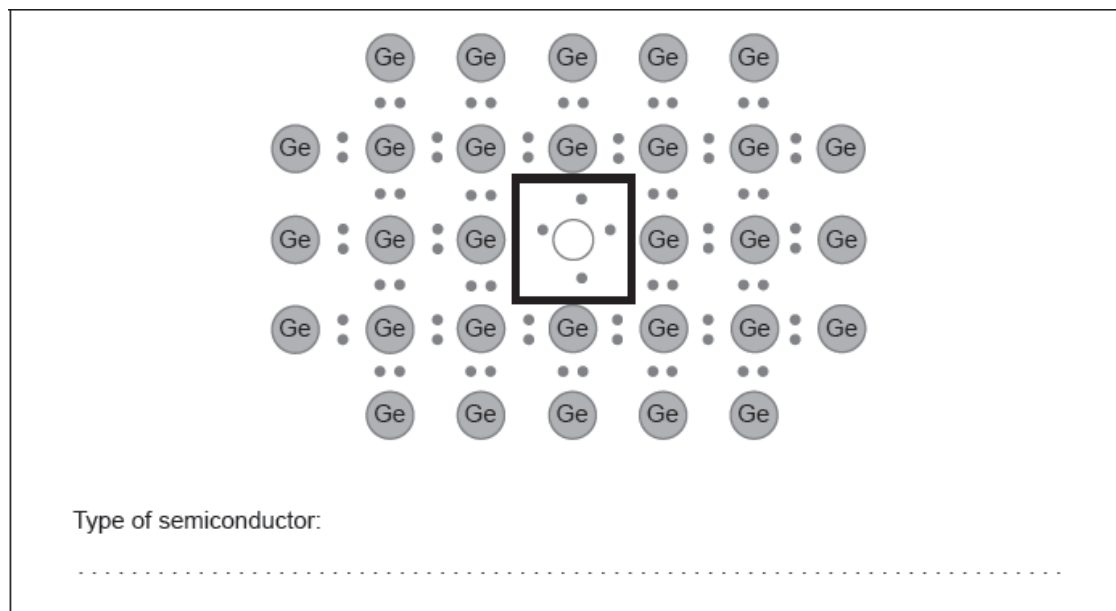
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7a. [2 marks]

The conductivity of a germanium semiconductor can be increased by doping.

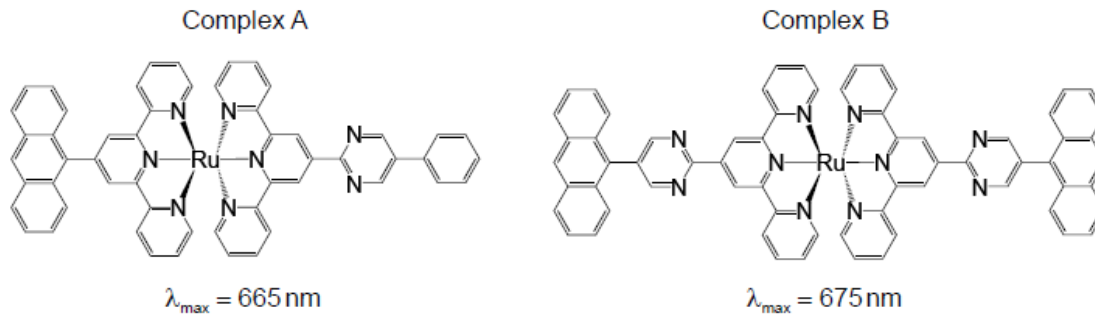
Draw the Lewis (electron dot) structure for an appropriate doping element in the box in the centre identifying the type of semiconductor formed.



[Source: <http://www.radartutorial.eu/21.semiconductors/hl07.tr.html> by Christian Wolff]

7b. [1 mark]

A dye-sensitized solar cell uses a ruthenium(II)–polypyridine complex as the dye. Two ruthenium(II) complexes, A and B, absorb light of wavelengths 665 nm and 675 nm respectively.



State the feature of the molecules responsible for the absorption of light.

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7c. [1 mark]

Outline why complex B absorbs light of longer wavelength than complex A.

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8a. [3 marks]

A dye-sensitized solar cell (DSSC) uses light energy to produce electricity.

Outline the functions of the dye, TiO_2 and the electrolyte in the operation of the DSSC.

Dye:

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TiO_2 :

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Electrolyte:

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8b. [1 mark]

Suggest an advantage of the DSSC over silicon-based photovoltaic cells.

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9a. [3 marks]

This question is about solar cells.

Some solar cells use photovoltaic semi-conductors. Compare, giving reasons, the electrical conductivity of metals and semi-conductors as temperature increases.

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9b. [1 mark]

Suggest **one** advantage of a dye-sensitized solar cell (DSSC) over a silicon based photovoltaic cell.

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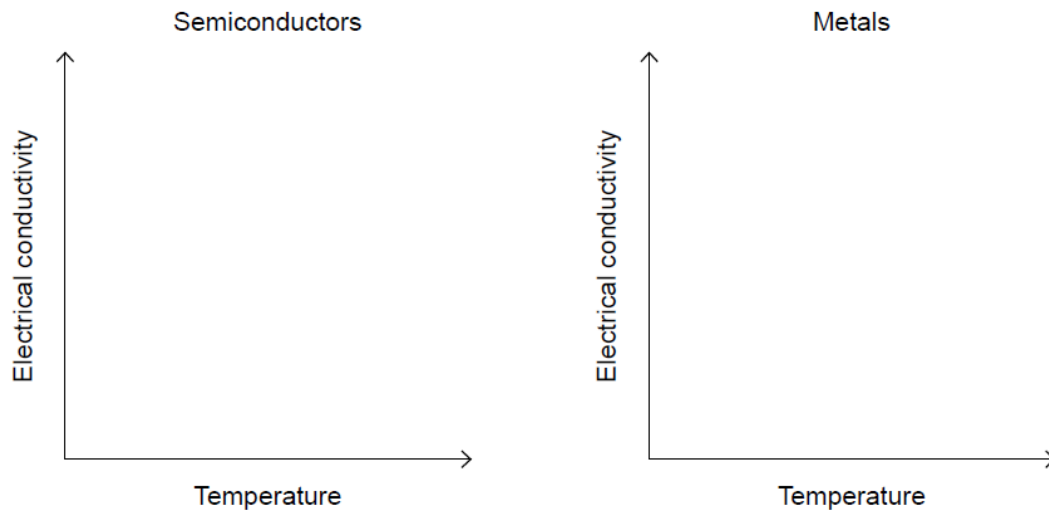
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10a. [2 marks]

Semiconductors and light-sensitive dyes are used in photovoltaic cells.

Sketch graphs to show the general effect of increasing temperature on the electrical conductivity of semiconductors and metals on the axes below.



10b. [2 marks]

Explain the function of dyes in a dye-sensitized solar cell (DSSC).

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