Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic : 3_ElectricCircuits

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Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

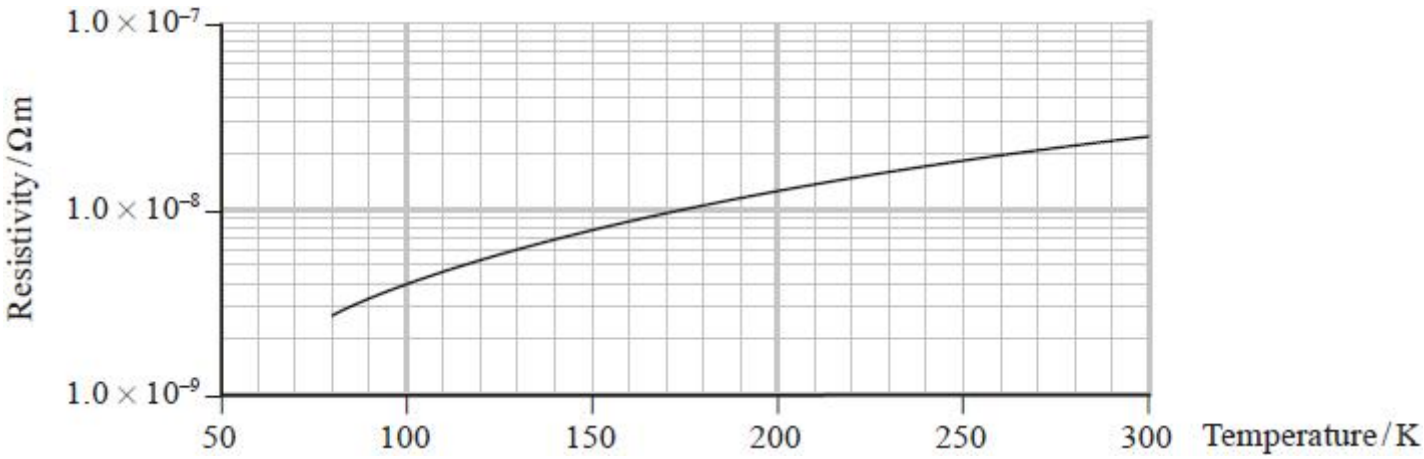
Q1.

Electrical transmission systems are used to transmit electrical power from place to place. Transformers are used to change potential differences (p.d.) and power transmission cables are used to transmit power.

Efficient electrical transmission systems are being developed using superconductors. Superconductors have zero resistance at low temperatures, and therefore no power is wasted by transfer to thermal energy unlike copper cable systems.

In one project a 1.05 km length of copper cable at a temperature of 270 K has been replaced by a superconductor. The superconductor has a cooling system which requires power.

The graph shows the variation of resistivity with temperature for copper.



Deduce whether the power requirement of the superconductor cooling system is less than the power losses in the copper cable.

transmission power = 40 MW

transmission potential difference = 110 kV

cross-sectional area of copper cable = 145 mm^2

power requirement of cooling system for the superconductor = 7 kW

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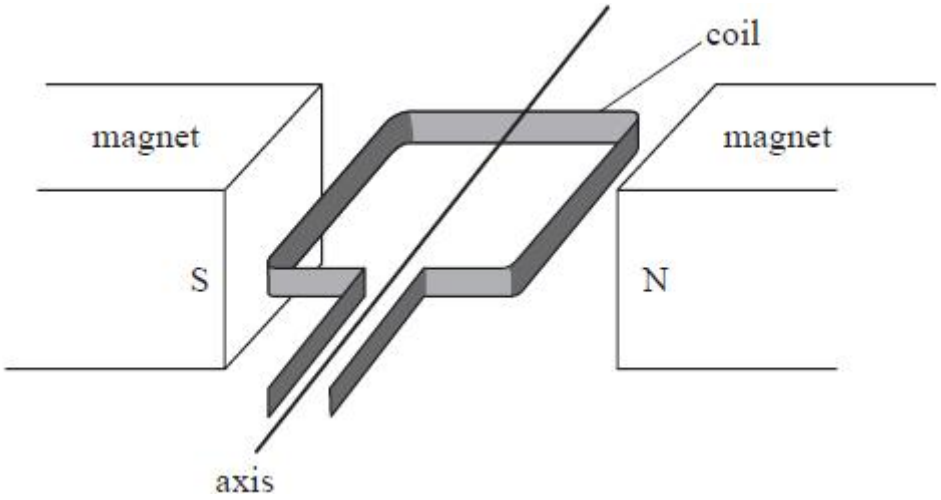
(Total for question = 5 marks)

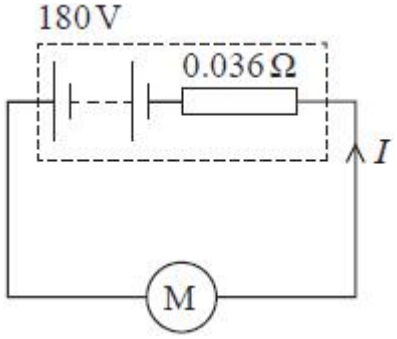
Q2.

Hybrid electric vehicles (HEV) use the same device both as a generator to charge the car battery and as an electric motor to support the propulsion system. A simplified diagram of the device is shown. The coil can rotate freely around the axis.



The circuit diagram shows a car battery connected to an electric motor for a HEV.

The battery has an electromotive force (e.m.f.) 180 V and internal resistance 0.036 Ω.



The motor has a maximum power of 88 kW.

(i) Show that the current *I* drawn by the electric motor when operating at this power would be given by the equation

$$0.036I^2 - 180I + 88\,000 = 0$$

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(ii) Solving the equation above produces an answer of I = 550 A. At maximum power, the car can accelerate from rest to sixty miles per hour in under 7 s.

The maximum charge capacity of the battery within this HEV is 6.1 amp-hour.

Deduce whether the battery could maintain this current for up to 7 s.

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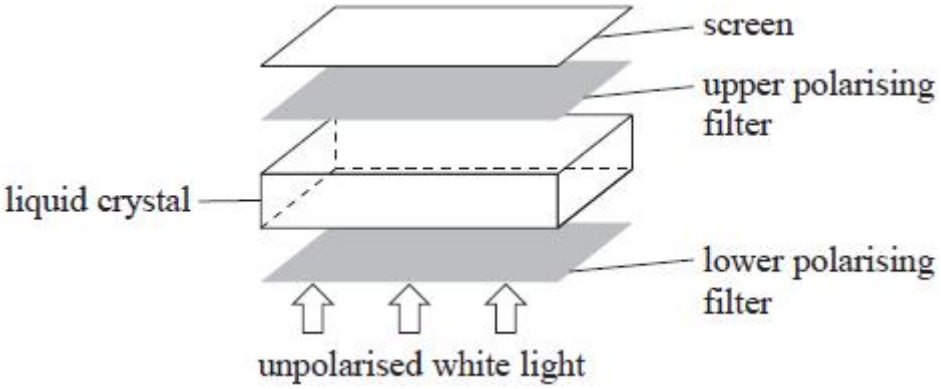
(Total for question = 5 marks)

Q3.

A liquid-crystal display uses a series of segments to form letters and numbers on a screen.

The construction of a display segment is shown.



- Unpolarised white light passes through the lower polarising filter and becomes plane polarised.
- When there is no potential difference (p.d.) across the liquid crystal, the molecules in the liquid crystal rotate the plane of polarisation by 90°.
- Light then passes through the upper polarising filter and appears on the screen.
- When a p.d. is applied across the liquid crystal, the molecules no longer rotate the plane of polarisation. The light will not pass through the upper polarising filter and the screen appears dark.

(i) The intensity of the emitted light at the surface of a display segment is 7.8 W m^{-2}.

The segment has an exposed area of 1.8×10^{-3} m^2.
Calculate the power of the emitted light at the surface of the display segment.

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Power of emitted light = ...

(ii) A light-emitting diode (LED) is used to provide the unpolarised white light for the liquid-crystal display.

Calculate the efficiency of the liquid-crystal display segment.

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current in LED = 20 mA
p.d. across LED = 3.6 V

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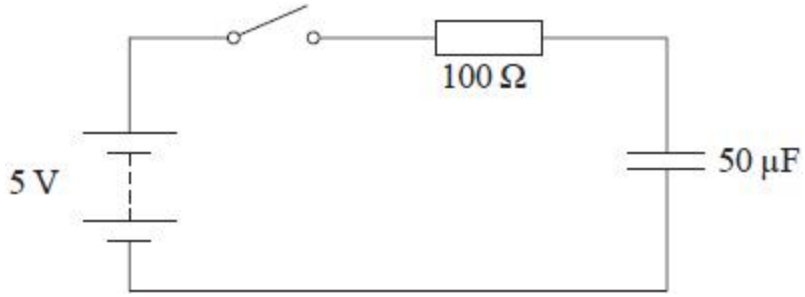
Efficiency of liquid-crystal display segment = ...

(Total for question = 5 marks)

Q4.

A circuit consists of a battery of e.m.f. 5 V and negligible internal resistance, a switch, a 100 Ω resistor and an uncharged 50 μF capacitor.



Describe what happens to the potential difference across the resistor and the potential difference across the capacitor after the switch is closed.

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(Total for question = 4 marks)