11.2 Power Generation & Transmission

Question Paper

Course	DP IB Physics
Section	11. Electromagnetic Induction (HL only)
Topic	11.2 Power Generation & Transmission
Difficulty	Medium

Time allowed: 60

Score: /47

Percentage: /100

Question 1a

A permanent magnet is attached to a vertical spring so that it undergoes simple harmonic motion. A coil of conducting wire is arranged so that when the magnet is displaced vertically it oscillates in and out of the coil, inducing a sinusoidal alternating current (ac) of rms value 1.65 mA.

(a)

(i)
Explain in words how the rms value of the alternating current relates to a direct current of 1.65 mA.

[1]

(ii)
Sketch the graph shape which would be expected from this direct current.

[1]

(iii)
Sketch the graph shape which would be expected from this ac current.

[2]

[4 marks]

Question 1b

The coil which the magnet is oscillating inside has a resistance of 120 kΩ.

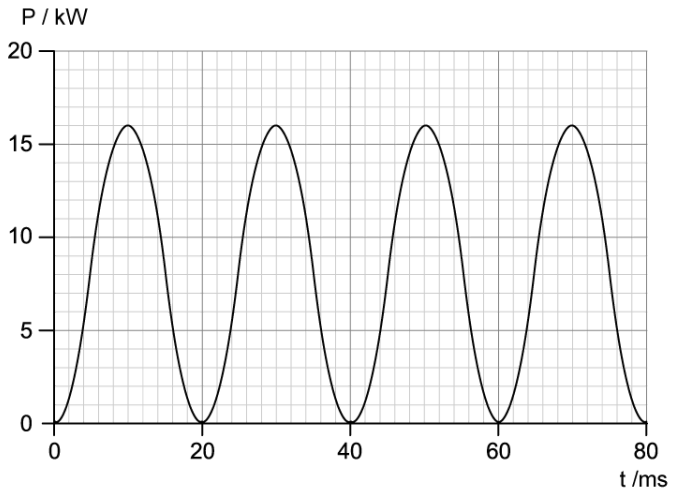
(b)
Calculate the peak voltage induced across the coil.

[2]

[2 marks]

Question 1c

The graph shows the variation with time of the power delivered by an ac generator.



(c)

Determine the frequency of rotation of the generator.

[2]

[2 marks]

Question 1d

(d)

Sketch a graph to show the power delivered when the frequency is halved.

[2]

[2 marks]

Question 2a

A transformer is connected to an alternating power supply.

The transformer has 250 turns in the primary coil and 3500 turns in the secondary coil. The peak value of the voltage of the ac supply is 220 V.

(a)
Determine the root mean square (rms) value of the output voltage.

[3]

[3 marks]

Question 2b

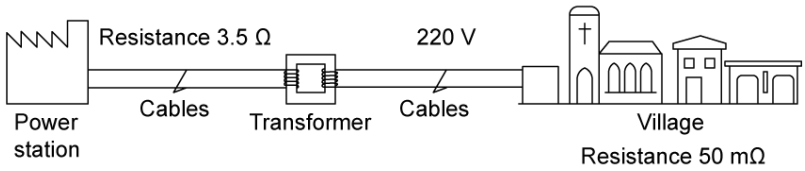
(b)
Describe the use of transformers in electrical power distribution.

[3]

[3 marks]

Question 2c

A different transformer is used to transmit power to a village.



The transmission cables connecting the power station to the transformer have a total resistance of 3.5 Ω. The transformer is 92% efficient and steps down the voltage to 220 V. At the time of maximum power demand the effective combined resistance of the cables to the village and the village is 50 mΩ.

(c)
Calculate the current in the cables connected to the village.

[2]

[2 marks]

Question 2d

(d)
Calculate the power supplied to the transformer.

[2]

[2 marks]

Question 3a

Electrical power is produced for the national electricity grid using a series of alternating current (ac) generators connected to identical transformers.

The following data are available for one transformer. All values are root mean squares (rms).

ac generator output voltage to a transformer	= 35 kV
ac generator output current to a transformer	= 2.8 kA
Transformer output voltage to the grid	= 330 kV
Transformer efficiency	= 96%

(a)
Calculate the current output by this transformer to the grid.

[2]

[2 marks]

Question 3b

Transformers are often used to step up voltage to 330 kV so that energy can be delivered across long distances.

(b)
State and explain the main advantage of using this very high potential difference.

[2]

[2 marks]

Question 3c

(c)
The rms of the transmitted voltage is stepped down from 330 kV to 230 V to be used in the home.

(i)
Determine the ratio of the number of turns on the primary coil compared to the number of turns on the secondary coil of the step-down transformer.

[1]

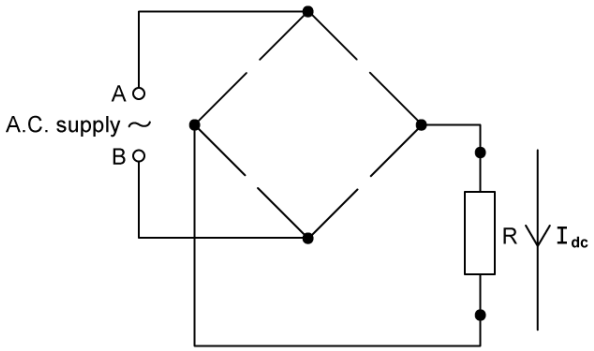
(ii)
Calculate the peak output voltage delivered to the home.

[2]

[3 marks]

Question 3d

Current from ac generators must be converted to dc current for some uses.



(d)

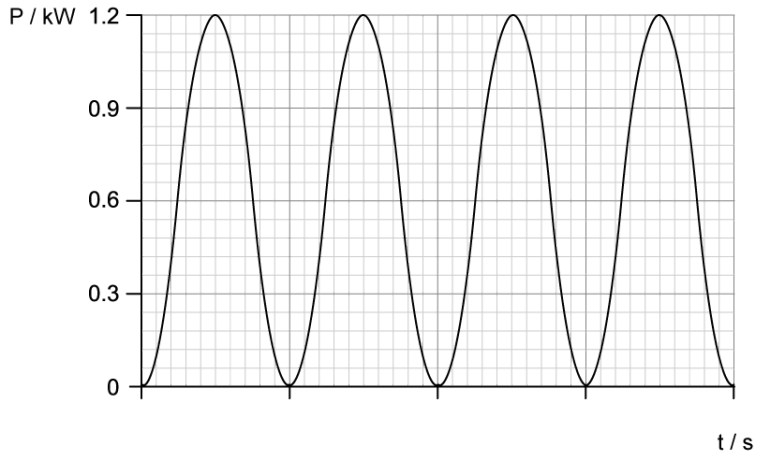
Complete the sketch to show an arrangement of diodes which would achieve full rectification with dc current in the load in the direction shown.

[2]

[2 marks]

Question 4a

An ac voltage is established at the ends of a 75 Ω resistor. The graph shows the variation with time of the power dissipated in the resistor.



(a)
Find the rms value of the current.

[2]

[2 marks]

Question 4b

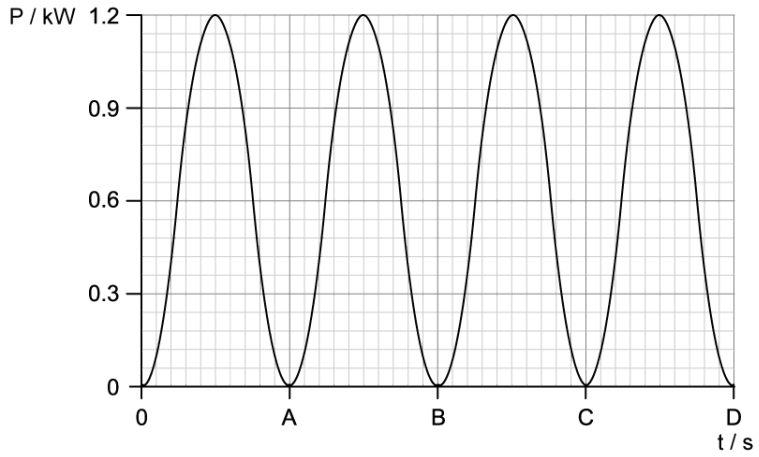
(b)
Calculate the rms value of the voltage.

[2]

[2 marks]

Question 4c

The coil is rotating with a frequency of 50 Hz.



(c)
Determine the times on the graph at points A, B, C and D.

[2]

[2 marks]

Question 4d

A transformer has 700 turns in its primary coil and 300 in the secondary coil. An ac voltage of 220 V and frequency 50 Hz is established in the primary coil.

(d)
For the secondary coil calculate the induced

(i)
Frequency.

[1]

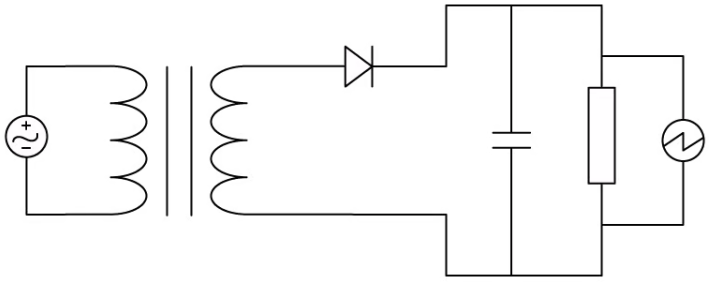
(ii)
Voltage.

[1]

[2 marks]

Question 5a

An investigation into rectification used the circuit shown.



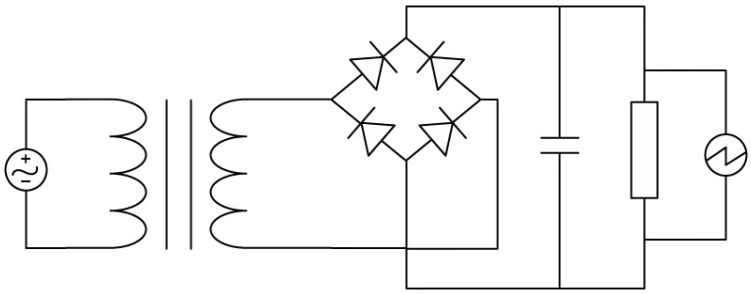
(a)
For this investigation, sketch the resulting graph.

[2]

[2 marks]

Question 5b

The investigation continues, using a second circuit.



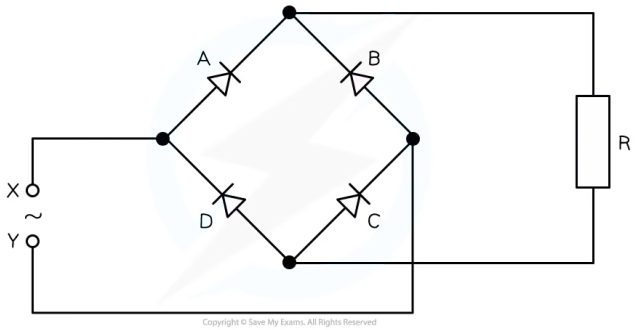
(b)
Sketch the expected graph of the output voltage for this circuit.

[3]

[3 marks]

Question 5c

A bridge rectifier consisting of four ideal diodes is connected to an ac generator with terminals X and Y.



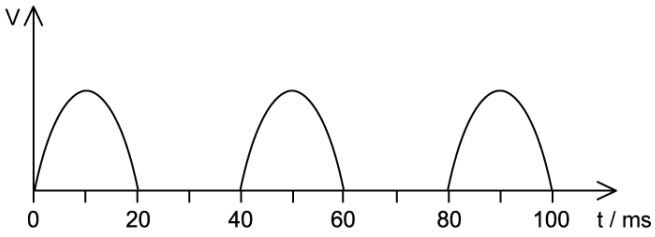
(c)
Identify which diodes are conducting when terminal X of the ac generator is negative.

[2]

[2 marks]

Question 5d

The graph shows the output from an ac generator after undergoing half-wave rectification.



The load resistor has a resistance of 3.6 kΩ. Capacitors of 360 nF and 60 μF are available.

(d)
Select the appropriate capacitor to smooth this output.

[3]

[3 marks]