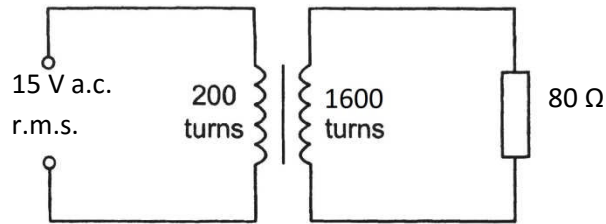# ALTERNATING CURRENT

Challenging **MCQ** questions by The Physics Cafe

Compiled and selected by The Physics Cafe

1   The primary of an ideal transformer has 200 turns and is connected to a 15 V root-mean-square (r.m.s.) supply. The secondary 1600 turns and is connected to a resistor of resistance 80 Ω, as shown in the diagram.

What are possible values of the secondary voltage, the secondary current and the mean power dissipated in the resistor?

	secondary voltage / V r.m.s.	secondary current / A r.m.s.	mean power in resistor / W
A	1.9	0.02	0.38
B	1.9	42	80
C	120	0.67	80
D	120	1.5	180

2   When a resistor is connected across an sinusoidal A.C. source of peak voltage 170 V, the average power dissipated is 40 W. Two such identical resistors are now connected in series to the electrical mains of 220 V r.m.s.

What would be the total power dissipated?

A   33.5 W

B   67.0 W

C   80.0 W

D   134 W

3   An alternating current with potential difference V / V varies with time t / ms across a resistive load as shown below.
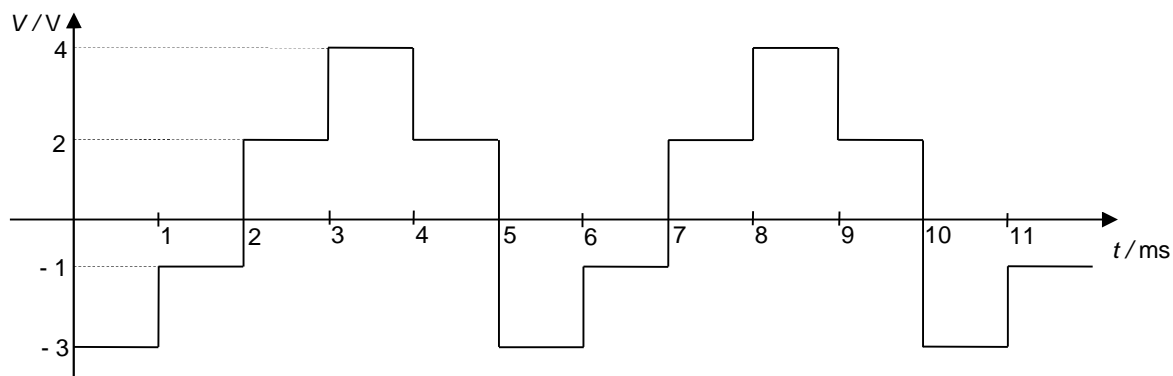
What is the mean power dissipated in the resistive load if its resistance is 20 Ω?

A 0.340 W   **B** 0.375 W   **C** 0.450 W   **D** 0.800 W

4   The diagram below shows a transformer which allows perfect magnetic flux linkage between the primary and secondary coil. The primary coil is supplied with an a.c. supply of power P.
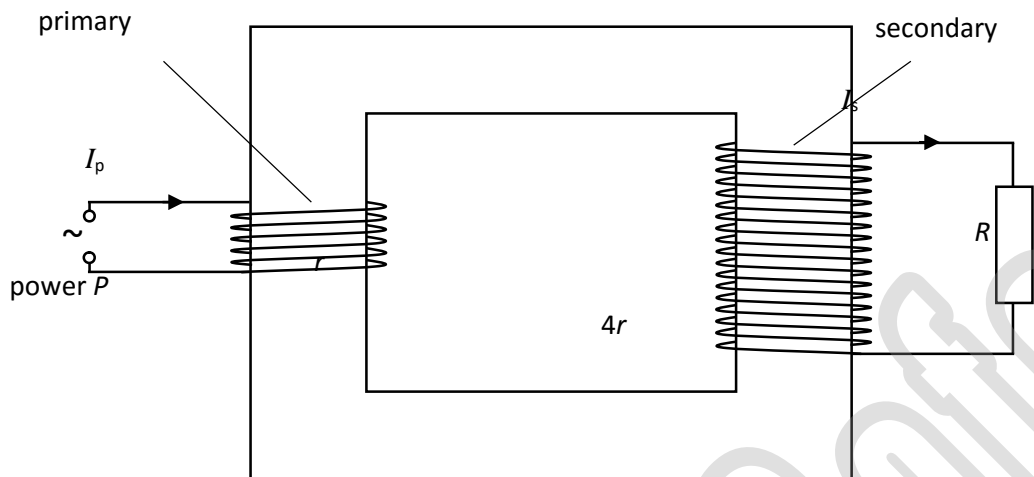

There are 4 times as many turns in the secondary coil as in the primary coil. The wires making up the primary coil are the same type as the secondary coil, and have a total resistance of r, and the load resistor across the secondary coil has a resistance of R. The r.m.s. current in the primary and secondary circuits are denoted I_p and I_s, respectively.

What is the power dissipated in the load resistor?

A $P - I_p^2 r$ **B** $P - (I_p^2 + 4I_s^2)r$ **C** P **D** $\left(\dfrac{4P}{I_p}\right)^2 \dfrac{1}{R}$

5   A signal generator can produce a variety of voltage waveforms. The diagram below shows 2 possible cases, (*a*) and (*b*).
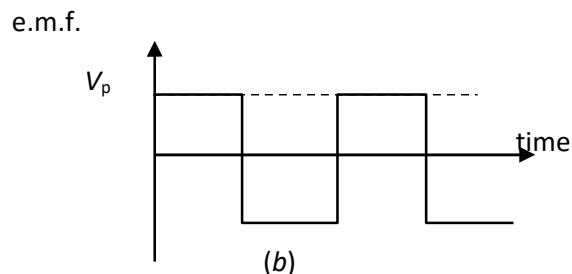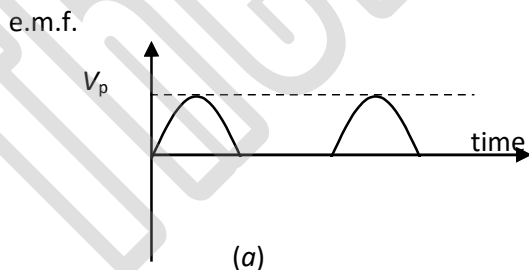
What is the ratio $\dfrac{\text{mean power in case } (a)}{\text{mean power in case } (b)}$ for a pure resistive load?

**A**   0.250   **B** 0.354   **C** 0.500   **D** 0.707

6   An ideal transformer is used to step down the a.c. voltage supply to a resistive load R. If the number of turns in the primary coil is doubled, what is the new current in the primary coil?
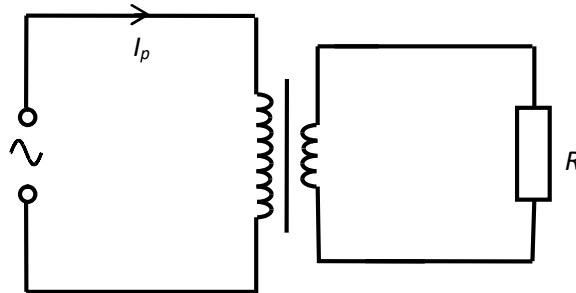
   A   Twice the original current in the primary coil

   B   Same as the original current in the primary coil

   C   Half the original current in the primary coil

   D   One quarter of the original current in the primary coil

7   Two resistors are connected in series to an alternating voltage source. There are 7.5 V r.m.s. across one resistor and 4.2 V r.m.s. across the other. What is the peak source voltage?

   A   3.30 V   **B**   1.65 V   **C**   11.7 V   **D**   16.5 V

8   The figure below shows an alternating current with a period of 1.0 s.
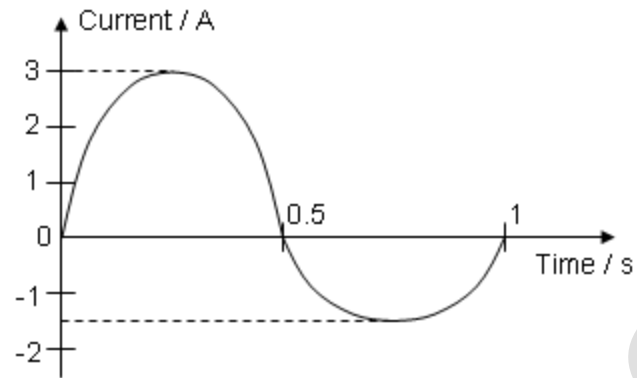
For the first half of the period, the current is sinusoidal with peak current 3.00 A. For the second half, it is sinusoidal with peak current 1.50 A.

What is the root-mean-square current of this alternating current?

A   1.59 A   **B**   1.67 A   **C**   2.25 A   **D**   2.78 A

9

In a laboratory experiment to test a transformer, a student obtains the following readings:

V_p / V	I_p / mA	N_p turns	V_s / V	I_s / mA	N_s turns
240	2.0	?	?	50	50

Assuming the transformer is 100% efficient, what are the missing readings?

	N_p turns	V_s / V
A	2	6000
B	50	9.6
C	480	1.0
D	1250	9.6

10 An electric kettle has the following label:

Power : 2000 to 2400 W

Voltage : 220 to 240V

Frequency : 50 to 60 Hz

Which of the following is a probable expression of the current that passes through the kettle when used in Singapore?

A $I = 8.33 \sin (315t)$

B $I = 10.9 \sin (315t)$

C $I = 14.1 \sin (375t)$

D $I = 16.0 \sin (375t)$

11 A direct current of 10 A flowing through a heating coil produces a certain power P.

What is the new power produced in the same heating coil by a sinusoidal alternating current of 10 A peak value?

A P 　　　　　 B $2P$ 　　　　　 C $\dfrac{1}{4}P$ 　　　　　 D $\dfrac{1}{2}P$

12 An alternating voltage V varies with time t according to the equation given below

$$V = 12\cos(50\pi t)$$

What is the mean power dissipated in a resistive load of 10 Ω ?

A 7.20 W 　　　　 B 12.0 W 　　　　 C 14.4 W 　　　　 D 28.8 W

13 A steady current I dissipates a certain power in a variable resistor. The resistance has to be halved to obtain the same power when a sinusoidal alternating current is used.

What is the peak value of the alternating current?

A $\frac{1}{2}I$ B $\sqrt{2}\,I$ C I D $2I$

14 Which of the following supplies delivers the largest power to a 2.0 Ω resistive load?

A   3.0 V DC

B   4.5 V rms 50 Hz Sinusoidal AC

C   6.0 V peak 60 Hz Sinusoidal AC

D   6.0 V DC with 1.0 Ω internal resistance.

15 A transformer with 3000 turns in its primary coil is used to change an alternating pd from ac rms value of 240 V to ac rms value 12 V. When a 60 W, 12 V lamp is connected to the secondary coil, the lamp lights at normal brightness and a rms current of 0.26 A passes through the primary coil.
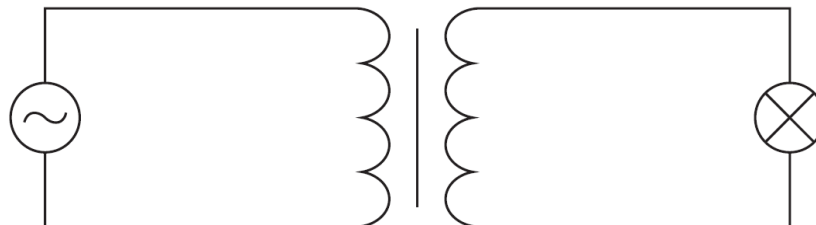
What are the correct values for the number of turns on the secondary coil and for the transformer efficiency?

	Number of turns on the secondary coil	efficiency
A	150	96%
B	60000	96%
C	150	90%
D	60000	90%

ALTERNATING CURRENT WORKED SOLUTIONS

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1   Ans: **D**
$V_s/V_p = N_s/N_p$
$V = IR$
$P_{mean} = I_{rms}V_{rms}$

2   Ans: **B**
Let peak voltage of 1 resistor be V_o.
$$<P> = \frac{1}{2}\frac{V_o^2}{R}$$
Given $<P> = 40$ W,
$40 = ½ (170)^2/R$
$R = (170)^2/80$
$P_{total} = 220^2 / [2x(170)^2/80] = 67$ W

3   Ans: **A**
$$\langle V^2 \rangle = \frac{(-3)^2+(-1)^2+2^2+4^2+2^2}{5}$$
$\langle V^2 \rangle = 6.80$
$V_{rms} = 2.61$ V
$$\langle P \rangle = \frac{V_{rms}^2}{R} = \frac{2.61^2}{20} = 0.340 \text{ W}$$

4   Ans: **B**

5   Ans: **A**

6   Ans: **D**

7   Ans: **D**

Since the resistors are connected in series, the combined p.d. is 7.5 + 4.2 = 11.7 V r.m.s

Peak $V = V_{rms} \times \sqrt{2}$

$= 11.7 \times \sqrt{2} = 16.5$ V

8   Ans: **B**

Let the alternating current flow through a 1 Ω resistor and determine the energy dissipated in 1 s.

$$\left(\frac{3}{\sqrt{2}}\right)^2 (1)(0.5) + \left(\frac{1.5}{\sqrt{2}}\right)^2 (1)(0.5) = I_{rms}^2 (1)(1)$$

$I_{rms} = 1.67$A

9   Ans: **D**

Transformer equation: $\dfrac{N_s}{N_p} = \dfrac{V_s}{V_p} = \dfrac{I_p}{I_s}$

$\dfrac{50}{N_p} = \dfrac{V_s}{240} = \dfrac{2}{50} \Rightarrow N_p = 1250$ turns and $V_s = 9.6$ V

10   Ans: **C**

Range of I_{rms} = P/V = 8.333 A to 10.9 A

Range of corresponding I_0 = 11.79 A to 15.4 A

Expression for $I = I_0 \sin\omega t$

11   Ans: **D**

For D.C,   P = I^2R = $(10)^2$R

For A.C,   power produced $<P>$ = ½ P_o = ½ I_o^2R = ½ $(10)^2$R = ½ P

12   Ans: **A**

$$\text{Vrms} = \frac{\text{Vo}}{\sqrt{2}} = \frac{12}{\sqrt{2}} = 8.48$$

Mean Power = $(V_{rms})^2$/R = $\dfrac{8.48^2}{10} = 7.20\text{W}$

13   Ans: **D**

Average power in DC = Average power in AC
I^2 R = I_{rms}^2 (R/2)
I_{rms}^2 = 2 I^2
I_{rms} = $\sqrt{2}$ I

Hence I_o = I_{rms} ($\sqrt{2}$) = $\sqrt{2}$ I ($\sqrt{2}$) = 2 I

14   Ans: **B**

15   Ans: **A**