Checkpoints Chapter 11
Magnetic and Electric basics

Question 435

The direction of the field due to the coil is given by the right hand grip rule. If the thumb of your right hand is pointing in the direction of the arrow on the left hand end of the coil, then your fingers will tend to coil and point to the left. This is when your fingers are where the maximum field is, and this is inside the coil.
So the field produced by the coil is to the left.
The force on the wire is given by the right hand rule.
So the current is the direction of the thumb, the field the direction of the fingers. This means that your palm will be pointing out of the page.
Your thumb is up, fingers to the left. ∴The force is given by the direction your palm is facing.

∴ B (ANS)

Question 436

The electron will experience a force in the same direction as the current experiences a force, because it is the same force acting.

With the right hand thumb pointing to the right (in the direction of the current) the fingers point into the page (the direction of the field), then the force is projecting upwards from the palm of your hand.

∴ A (ANS)

Question 437

The flow of electrons is down the conductor, so the conventional current is 'up'. The direction of the field is to the North. If your right hand thumb points up, your fingers are in the direction of the field, (North), then the force must be in a "Westerly" direction, coming straight out of your palm. Refer back to the notes on Magnetic Fields, if you need further clarification.

∴ D (ANS)

Question 438

This question is unusual, it relies on you having an appreciation of the strength of the Earth's magnetic field. From your notes it is 5×10^{-5}T. It might be useful to put this fact on to your cheat sheet.

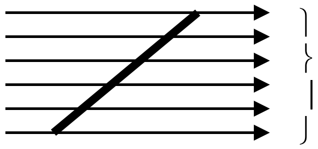
The lightning conductor is going to be reasonably long, because it needs to be high to attract the lightning, because it wants to be the easiest path for the charge to reach ground. This also means that the old saying that 'Lightning never strikes the same place twice" is quite incorrect.

$F = nBIL$
$= 1 \times 5 \times 10^{-5} \times 10^{4} \times 10$
$= 5$ N

The answer in the book uses $B = 2 \times 10^{-5}$T.
Just make sure that you show your working out and thinking very clearly.
The second sentence “During a severe storm ....” is the stem to the NEXT question.

Question 439

Because the conductor is now bent over at an angle of 30^0, the effective length of the conductor perpendicular to the field is less.



this is now the effective length.

So the new force will be less than before, but not zero.

∴ C (ANS)

Question 440

The heat energy produced each second by the heater is given by $P = VI = I^2R = V^2/R$.
Using either supply, the resistance will remain constant, so the energy is proportional to V^2.

For a 180 V (peak) AC supply
$V_{RMS} = 180/\sqrt{2} = 127$V.
∴ the **150 V DC** supply will provide more energy, therefore more infra-red radiation.

Question 441

$F = nBIL$, where F is the force (in Newton), n is the number of turns or number of wires, B is the strength of the magnetic field (in Tesla), I is the current (in amp) and L is the length of the wire (in metres).

Substituting
F = 3N, n = 1, B = 0.15T, and L = 2m,
$3 = 1 \times 0.15 \times I \times 2$

∴ I = 10 amp. (ANS)

Question 442

The current flowing in coil 2 is creating the force acting on coil 1.
In coil 2 the current is flowing from the right hand side of the cell (battery). This is produces a field directed to the left.
The current in coil 1 is in the opposite direction, this produces a field to the right. These fields are in the opposite directions, like two North poles, so they will repel each other.
So the force on coil 1 (from coil 2) is a repulsive force, acting to the left.

Question 443

The expression *one or more* means exactly that, there may be 1, 2, 3 or 4 correct answers. If it does not say *one or more* then there is only one 'best' answer.
If the wire is being pushed then F = nBIL, implies that n, B, I, L are all non-zero, ∴ they exist.
Answer C is correct because it is actually the definition, the force acts on the moving charges, which in this case are the electrons that are constrained to move inside the wire.

∴ **A C (ANS)**

Question 444

Magnetic fields are vectors, so the two fields due to the individual bar magnets will cancel each other out. There is still the magnetic field due to the Earth at this point, so the best answer is D. C is also correct but D is much better.

∴ **D (ANS)**

Question 445

If the wire is parallel to the field, then the force on the current carrying wire is zero.

Question 446

Power: $P = VI = I^2R = \frac{V^2}{R}$

$P = I^2R$

$\therefore 16\,000 = I^2 \times 11$

$\therefore I^2 = 16\,000/ 11$

$\therefore$ **I = 38 A (ANS)**

This answer is already RMS, because we always assume values are RMS unless otherwise stated.

Question 447

Power: $P = VI = I^2R = \frac{V^2}{R}$

$P = VI$

$\therefore 16\,000 = V \times 38.1385$

(don't use rounded off values, use your calculator)

$\therefore V = 16\,000 / 38.1385$

$\therefore$ **V = 420 V (ANS)**

If you didn't know the value for I, you could have just as easily used the formula

Power: $P = \frac{V^2}{R}$

$\therefore 16\,000 \times 11 = V^2$

$\therefore$ **V = 420 V (ANS)**

(make sure that you always round off properly).

Question 448

The peak value of the current is the RMS × √2

$\therefore I = 38.\ 1385 \times 1.4.14$

$\therefore$ **I = 54 A. (ANS)**

Question 449

The peak value of the voltage is the RMS × √2

$\therefore V = 420 \times \sqrt{2}$

$\therefore$ **V = 593 V. (ANS)**

Question 450

Power is VI. You are given RMS values, so

$\therefore P = 240 \times 150 \times 10^{-3}$

(always be careful with the units)

$\therefore$ **P = 36 W. (ANS)**

Question 451

Power is the rate at which energy is being used, i.e. in joules per second.
Power = VI, assuming both V and I are measured in RMS

$$\therefore P = \frac{V_{peak}}{\sqrt{2}} \times \frac{I_{peak}}{\sqrt{2}}$$

$$\therefore P = \frac{400}{\sqrt{2}} \times \frac{10}{\sqrt{2}}$$

$$\therefore P = \frac{4000}{2}$$

$\therefore P = 2000$ Watt

$\therefore$ **2.0×10^3 J** of energy every second.

Question 452

Power = VI, assuming both V and I are measured in RMS

$\therefore$ 40 = 80 × I

$\therefore$ **I = 0.5 A** **(ANS)**

Question 453

If the EMF of the supply is 240 Volt, then the total potential differences around the circuit must also be 240 V. This means that the PD across the resistor must be 240 - 80 = 160 V. As the two elements are in series the current must be the same in both.

$\therefore I_{resistor}$ = 0.5 amp.

Using V = IR

160 = 0.5 R

$\therefore$ **R = 320 Ω** **(ANS)**

Question 454

P = VI

= 240 × 0.5

(because the current is the same in both elements and the total PD = 240 V)

$\therefore$ **120 W** **(ANS)**

Question 455

The power of the resistor is given by $P = i^2R$

Where I = 0.5 A, and R = 320Ω

$\therefore P = 0.5^2 \times 320$

= 80 W **(ANS)**

Question 456

The distance between A and B represents half a period.

$\therefore$ Period = 7.2ms

$$\therefore f = \frac{1}{T} = \frac{1}{7.2 \times 10^{-3}}$$

$\therefore$ **139 Hz** **(ANS)**

Question 457

$$\text{The RMS voltage} = \frac{V_{peak}}{\sqrt{2}} = \frac{1.2}{\sqrt{2}}$$

$\therefore$ **0.85 V** **(ANS)**

Question 456

Each vertical division = 0.4V.

$\therefore$ The DC voltage = **1.2 V.** **(ANS)**

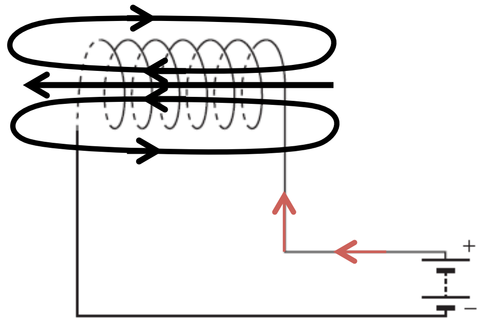
Question 459

This signal shows an AC voltage with a DC voltage of 0.8V (1 division). The magnitude of the AC voltage is 2 divisions,

$\therefore$ 1.6 V_{peak}.

$\therefore$ **C** **(ANS)**

Question 460 **(2010 Q1, 2m, 65%)**



The conventional current from the +ve terminal to the –ve terminal, so it is going up the front of the coil. This leads to the field inside the solenoid pointing to the left, and pointing to the right outside the coil.

Make sure that you draw three lines, and that they are both inside and outside the solenoid.

Question 461 **(2010 Q12, 2m, 85%)**

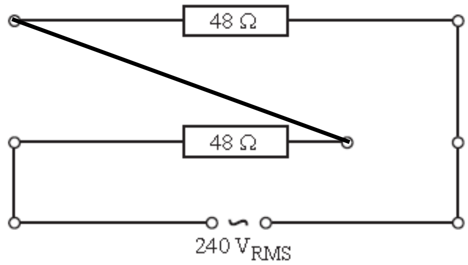
With only one element connected the voltage across it must be 240 V.

$$\text{Using } P = \frac{V^2}{R} \text{ gives}$$

$$P = \frac{240^2}{48}$$

= 1200 W **(ANS)**

Question 462 **(2010 Q13, 2m, 60%)**



Using P = VI, where V = 240, and I is unknown, then to get the lowest power output, you need a circuit that gives you the lowest current.

From V = IR, this means that you need the circuit with the greatest resistance. Therefore the elements need to be connected in series.

The other way to think about this is to rearrange the formula, $P = \frac{V^2}{R}$ to get

$$R = \frac{V^2}{P}$$
$$\therefore R = \frac{240^2}{600}$$
$$\therefore R = 96\ \Omega$$

The only way to arrange two 48 Ω resistors to get a total of 96 Ω is to combine them in series.

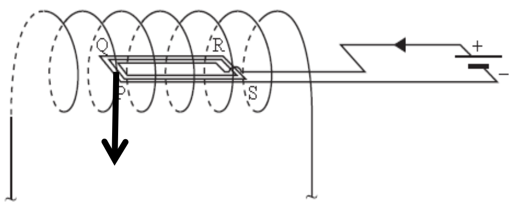
Therefore draw the line as shown.

Question 463 (2010 Q2, 2m, 45%)

Inside the loop the magnetic field is parallel to the loop. Therefore there is not any flux threading the loop.

Question 464 (2010 Q3, 1m, 70%)

The field is acting to the left the current is going from Q to P.
Using the right hand rule, the force will be downwards.



Question 465 (2010 Q4, 2m, 70%)

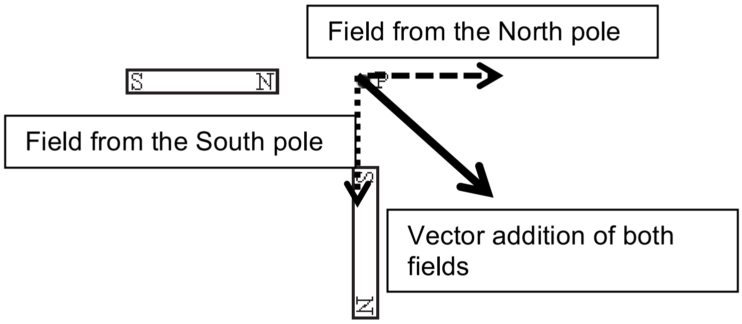
Using $F = nBiL$ gives
$$F = 3 \times 5.0 \times 10^{-2} \times 4.0 \times 4.0 \times 10^{-2}$$
$$\therefore F = 240 \times 10^{-4}$$
$$\therefore F = 0.024\ \text{N}$$

Question 466 (2010 Q5, 2m, 70%)

The current in QR is parallel to the field of the solenoid, therefore the force will be zero.

$\therefore$ **0 N (ANS)**

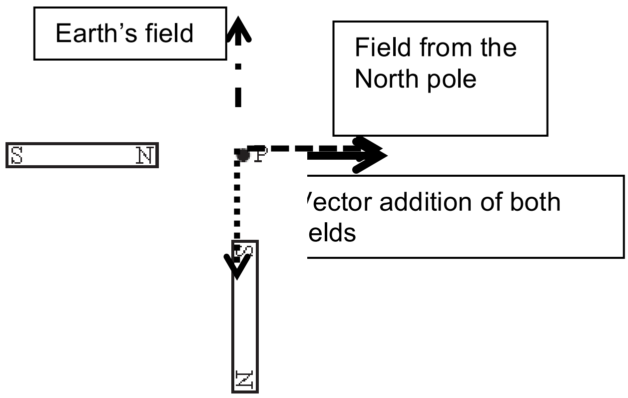
Question 467 (2011 Q1, 2m, 44%)



The vector addition will give the combined effect of these two fields. This is a magnetic field down to the right at 45^0. (Angles close to 45^0 were accepted).
The arrow should start at the point P.

Question 468 (2011 Q2, 2m, 37%)

The Earth's field will be cancelled by the field from the South Pole of the magnet.
$\therefore$ the combined field will be the field created by the North pole of the other magnet.



Question 469 (2011 Q18, 3m, 70%)

The power being supplied by the battery is given by P = VI.
In the series circuit (A), the battery is 12V supplying 2A for the circuit. (Since the globes are in series, they both have the same current flowing through them.)

$$\therefore P = 12 \times 2$$
$$= 24\ \text{W}$$

In circuit B, the three globes are in parallel, therefore each have 12 V across them and each draw 1A from the battery. Therefore the total current being drawn is 3 A

$$\therefore P = 12 \times 3$$
$$= 36\ \text{W}$$

$\therefore$ **B uses more power. (ANS)**

Question 470 (2011 Q17, 2m, 20%)

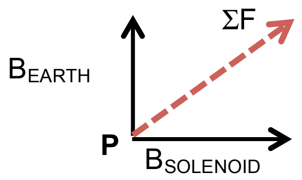
The current in the transmission line is 30 A_{RMS}, this means that it is $30\sqrt{2}$ A_{Peak}.
Since the current varies sinusoidally, so will the force.

F = nBIL
$= 1 \times 1.0 \times 10^{-4} \times 30\sqrt{2} \times 1$
$= 4.2 \times 10^{-3}$ Peak.

∴ Graph B (ANS)

Remember that the question specifically said "Show a numerical calculation to justify your answer". You did not get full marks without the correct calculation.

Question 471 (2012 Q17, 1m, 40%)



The arrow had to **originate at P**, and point approximately 45^0 up to the right.

Question 472 (2012 Q17, 2m, 47%)

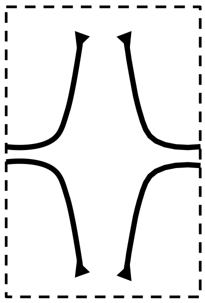
The direction of the field is given by the direction that the North end of the compass will point to.

∴ C (ANS)

As we are told to ignore the Earth's field.

The small magnet free to rotate about its centre is a compass needle. This points in the direction of the magnetic field.

Question 473 (2013 Q14, 2m, 60%)



Question 474 (2014 Q12a, 1m, 50%)

The current is going up the front in the wire at the left hand end. This will give a field to the left.

∴ A (ANS)

Question 475 (2014 Q12b, 1m, 50%)

With the field to the left, the current up the page, then from the right hand slap rule, the force is out of the page.

∴ E (ANS)
