11 An electric oven is connected to a 230 V root mean square (rms) mains supply using a cable of negligible resistance.

(a) (i) Calculate the peak-to-peak voltage of the mains supply.

$230 \times \sqrt{2} = 325.26\ldots$

peak-to-peak voltage = 650 V (2sf)

(2)

(ii) The resistance of the heating element in the oven at its working temperature is 12 Ω.

Calculate the power dissipated by the heating element in the oven.
Give your answer to an appropriate number of significant figures.

$P = \frac{V^2}{R} = \frac{230^2}{12} =$

power = 4.4×10^3 W

(3)

(b) In practice the resistance of the cable connecting the oven to the mains supply is not negligible. Each of the **two** wires connecting the heating element to the mains electricity supply has a length of 3.15 m. Each metre of wire has a resistance of 0.0150 Ω.

(i) Explain why the rms voltage across the heating element in the oven will be less than 230 V.

you have connected in two lengths of of 3.15m = 6.3m in series.

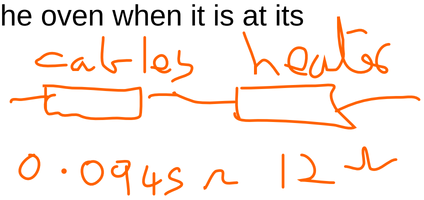
This has a resistatnce of 6.3x0.15=0.0945ohms Some voltage is dropped across these wires

Or you could talk about a bigger an increased resistance leading to a smaller current.

(2)

(ii) Calculate the rms voltage across the heating element in the oven when it is at its working temperature.

see last past. so we have a potential divider:



$$\therefore \frac{230 \times 12}{12+0\,0945}$$

rms voltage = 228 V

(3)

(iii) Calculate the average power wasted in the cable due to the heating effect of the electric current.

$$P = \frac{V^2}{R} = \frac{(230-228)^2}{0.0945}$$

$$I = \frac{V}{R} = \frac{230}{12+0.0945}$$

$$\underline{I} = 19A \therefore$$

$$P = I^2R$$

$$= \boxed{34\ W}$$

$P = VI$

$P = I^2R$

So bit of a range

average power = $\boxed{42.3}$ W

(2)

(iv) State **two** reasons why it is important that the cable has a low resistance.

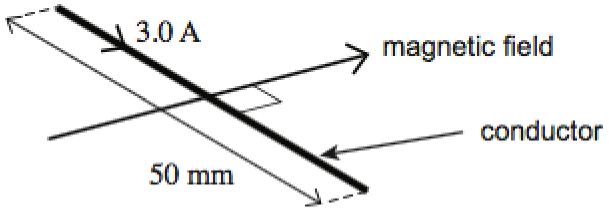
1. maximise efficiency by reducing power loss in cables

2. avoid cables getting hot and so melting/burning

(2)

(Total 14 marks)

12 The diagram shows a horizontal conductor of length 50 mm carrying a current of 3.0 A at right angles to a uniform horizontal magnetic field of flux density 0.50 T.



FLHR says up

$F = BIL$

$F = 0.5 \times 3 \times 50 \times 10^{-3}$

$= 0.075 N$

What is the magnitude and direction of the magnetic force on the conductor ?

[✓ **A**] 0.075 N vertically upwards

B 0.075 N vertically downwards

C 75 N vertically upwards

D 75 N vertically downwards

(Total 1 mark)

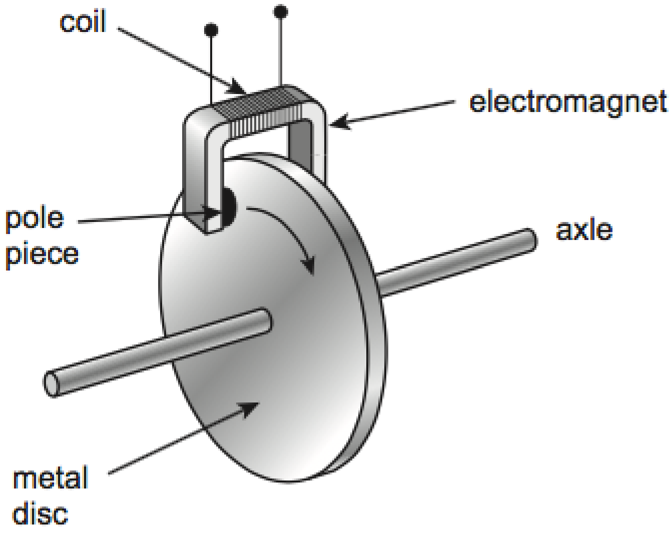
13 (a) State, in words, the two laws of electromagnetic induction.

Law 1 faraday's law - the emf induced is proportional to the rate of change of flux linkage

Law 2 direction of the induced emf acts to oppose the change that created it

(3)

(b) The diagram below illustrates the main components of one type of electromagnetic braking system. A metal disc is attached to the rotating axle of a vehicle. An electromagnet is mounted with its pole pieces placed either side of the rotating disc, but not touching it. When the brakes are applied, a direct current is passed through the coil of the electromagnet and the disc slows down.



(i) Explain, using the laws of electromagnetic induction, how the device in the diagram acts as an electromagnetic brake.

when current flows through the coil a (probably large) magnetic field is created which passes at 90 degrees through the disc

since the disc is rotating the flux linkage is changing through a small section of the disc as it moves through the flux.

This induced an emf in that small section of the disc which is in the direction that opposes the orrigianal rotation of the disc thereby providig a breaking force as it creates currents (eddy) in the disc which in turn interact with the magnetic field in such as way as to slow the disc down.

As one little area of the disc passes through the B-field so a new one enters it and so the breaking force continues, though reduces as the wheel slows down and the induced emf therefore decreases

(3)

(ii) A conventional braking system has friction pads that are brought into contact with a moving metal surface when the vehicle is to be slowed down.
State **one** advantage and **one** disadvantage of an electromagnetic brake compared to a conventional brake.

Advantage there are parts that get worn down and need to be replaced

Disadvantage you cannot work the magnetic breaks when the train is stationary like when you are doing a hill start.....

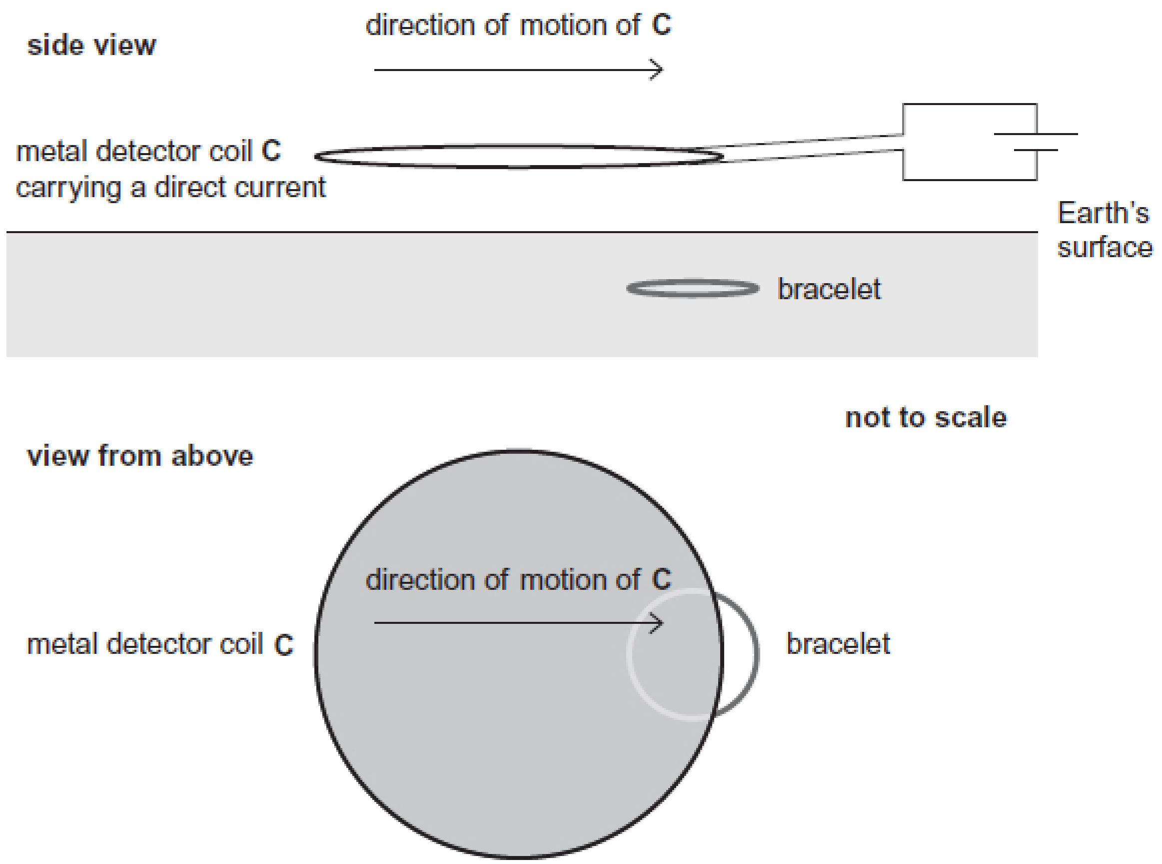
(2)

(Total 8 marks)

14 A metal detector is moved horizontally at a constant speed just above the Earth's surface to search for buried metal objects

Figure 1 shows the coil **C** of a metal detector moving over a circular bracelet made from a single band of metal. The planes of the coil and the bracelet are both horizontal.

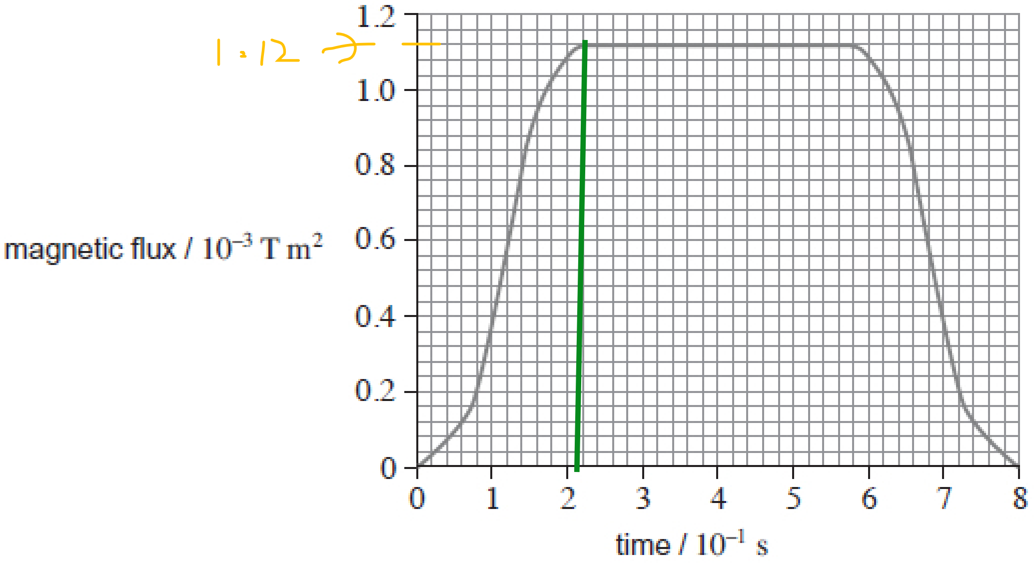
Figure 1



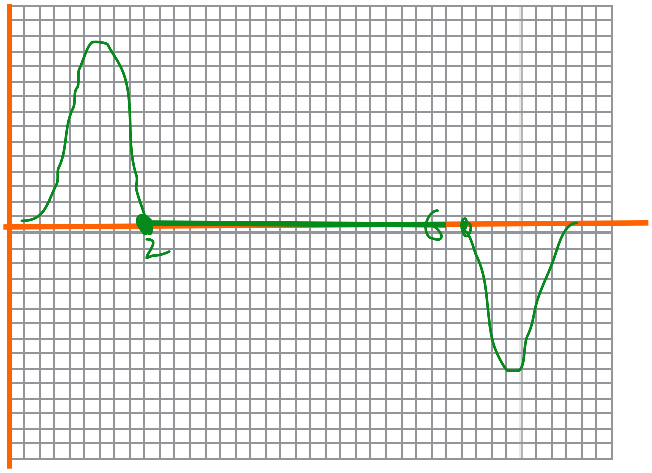
In this metal detector, **C** carries a direct current so that the magnetic flux produced by **C** does not vary. The bracelet is just below the surface, so the flux is perpendicular to the plane of the bracelet. The field is negligible outside the shaded region of **C**.

Figure 2 shows how the magnetic flux through the bracelet varies with time when **C** is moving at a constant velocity.

Figure 2



(a) (i) Sketch a graph on the grid to show how the emf induced in the bracelet varies with time as **C** moves across the bracelet. Use the same scale on the time axis as in **Figure 2**.



(3)

(ii) Use the laws of Faraday and Lenz to explain the shape of your graph.

faraday's law - the emf induced is proportional to the rate of change of flux linkage

so the emf graph is related to the gradient of the flux graph

Thus when the gradient is zero then there is no emf. When the gradient is max there is max emf.

The two gradients in the flux lines are of opposite gradient, so the emf graph has to be too

(4)

(b) The velocity at which **C** is moved is 0.28 m s^{-1}.

Show that the diameter of the bracelet is about 6 cm.

time of pulse from graphs is $\simeq 0.22$ s

$s \times t = d \Rightarrow d = 0.28 \times 0.22 = 6.16$ cm.

(1)

(c) Determine the magnetic flux density of the field produced by **C** at the position of the bracelet.

$N = 1$

$\Phi = BA$

Area of bracelet $= \pi \times \left(\frac{6.2\times10^{-2}}{2}\right)^2 = 3.0\times10^{-2-}\ m^{2}$

$B = \frac{\Phi}{A} = \frac{1.12\times10^{-3}}{9.8\times10^{-4}}$

magnetic flux density 0.37 T

(2)

(d) Determine the maximum emf induced in the bracelet.

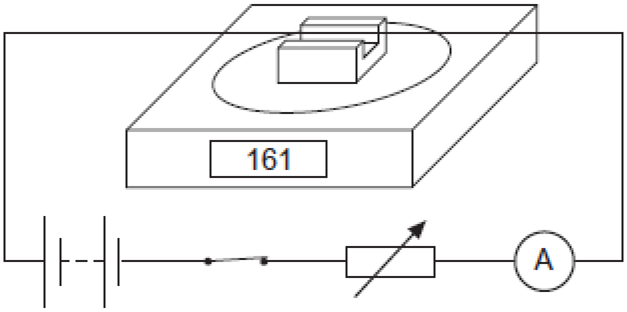
Gradient at steepest point

maximum emf 10 – 11 mV V

(3)

(Total 13 marks)

15 The diagram shows a rigidly-clamped straight horizontal current-carrying wire held mid-way between the poles of a magnet on a top-pan balance. The wire is perpendicular to the magnetic field direction.



The balance, which was zeroed before the switch was closed, read 161 g after the switch was closed. When the current is reversed and doubled, what would be the new reading on the balance?

[✓ **A**] −322 g

B −161 g

C zero

D 322 g

$F = B\underline{I}L$ so

force doubled

& in opposite

direction

(Total 1 mark)