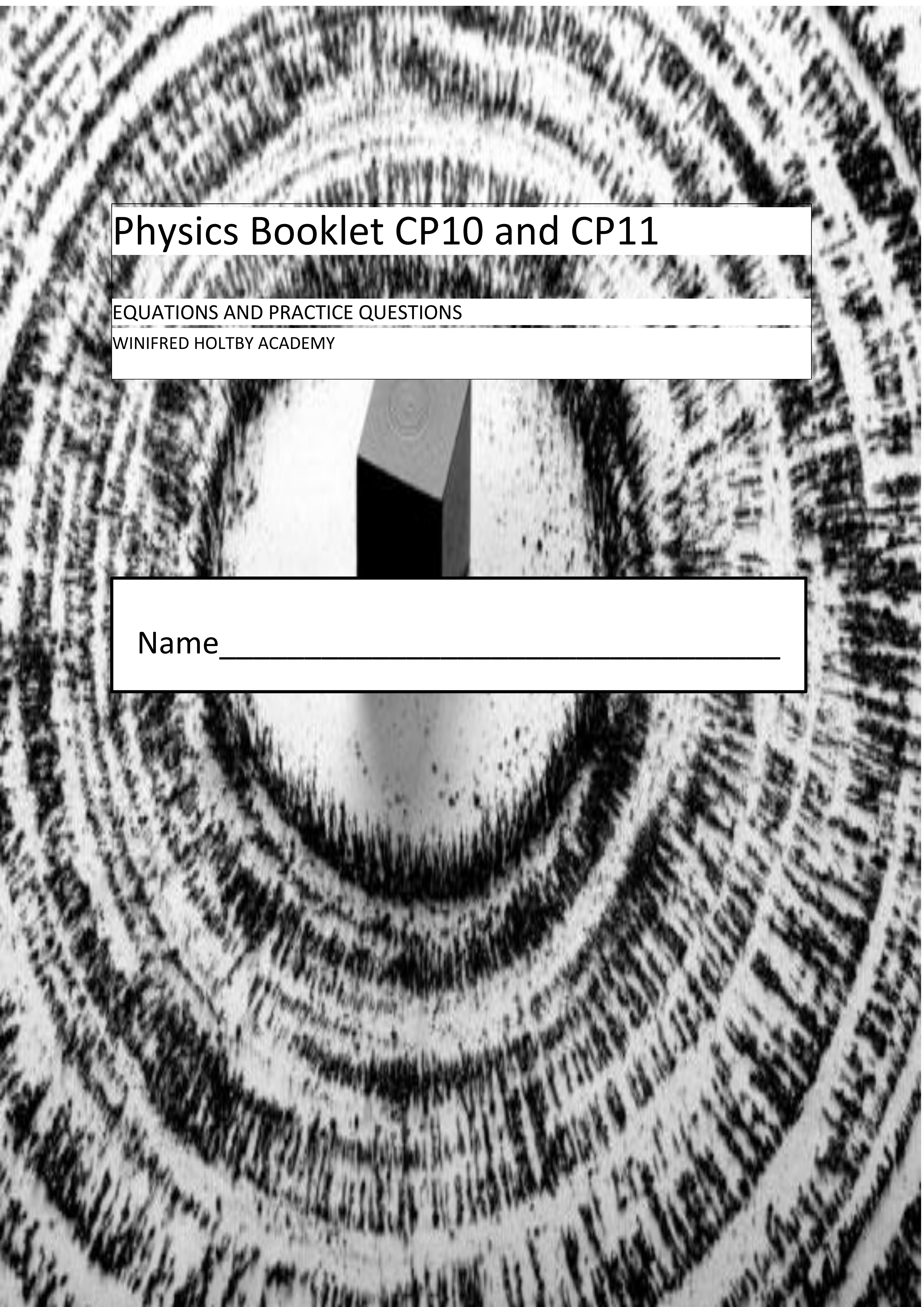


Physics Booklet CP10 and CP11

EQUATIONS AND PRACTICE QUESTIONS

WINIFRED HOLTBY ACADEMY

Name____________________________________

Answer the questions using the F.R.S.A.U format and a calculator.

CP10c.3

The equation $F = B \times I \times l$ links the force on a wire to **magnetic flux density**, current and the length of the wire.

1 State what each symbol in the equation stands for, and the unit used to measure it.

2 You are given a force, current and length of wire. Write out the equation in the form you would need to use to calculate the magnetic flux density.

3 Calculate the missing numbers in the table.

4 A 50 cm wire experiences a force of 0.02 N when a current of 5 A flows through it. Calculate the strength of the magnetic field near the wire.

5 A current of 4 mA flows in a wire 10 cm long. The wire is at right angles to a magnetic field with a flux density of 2 mT. Calculate the force on the wire.

6 Calculate the current needed to produce a force of 3×10^{-4} N on the wire in question **5**.

7 A wire is held 3 cm from a magnet, where the magnetic flux density is 2×10^{-3} T. There is a 5 cm length of wire in the field. The voltage across the wire is 2 V and the current is 0.5 A. Calculate the force on the wire. Give your answer in standard form.

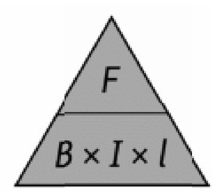
	Force (N)	**Magnetic flux density (N/A m)**	**Current (A)**	**Length (m)**
a		0.2	1.2	0.5
b	0.06		0.01	1.2
c	0.02		10	20
d	0.1	0.01		2
e	0.016	0.02	2	
f		4	0.001	0.2
g	0.6	2		0.1
h	0.003	0.005	2	

F = force on a conductor carrying a current at right angles to a magnetic field (N)

B = magnetic flux density (N/A m or **tesla**, T)

I = current (A)

l = length of wire (m)



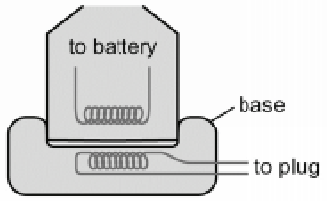
Answer the questions using the F.R.S.A.U format and a calculator.

CP11a.2

You do not need to recall the information on this sheet, but in an exam you may be asked to apply your knowledge to new situations.

A **transformer** works because an alternating current in the primary coil produces a continually changing magnetic field. The iron core concentrates this field. The changing magnetic field **induces** an alternating **potential difference** in the secondary coil. The iron core is not essential – if the two coils are close enough together the secondary coil will still be affected by the magnetic field from the primary coil. However, the transformer is not as efficient without the iron core.

This idea is used in inductive charging, which is often used for small items such as electric toothbrushes. Instead of the battery in the toothbrush being charged by a current flowing into it from a base containing a transformer, half of the transformer is placed in the toothbrush itself. This means that there does not have to be an electrical contact between the toothbrush and the holder. This method works best when the two coils are within a centimetre of each other.



inductive charging

1 Explain why an electric toothbrush with an inductive charger may be safer than one using normal electrical contacts.

This idea can be taken even further. Some companies are working on ways of powering all items in a room by induction. Induction coils in the walls could power TVs, laptops and other items, without the need for power cables. Recent developments in technology mean that this can be done with 70% efficiency at a distance of 0.5 metres and 40% efficiency at distances up to 2 metres.

2 A large plasma TV screen needs 500 W to run. How much extra energy per second would need to be supplied to the induction coil in the wall to power the TV if it were:

   a 0.5 m from the coil

   b 2 m from the coil?

3 A mobile phone charger uses 0.5 W when it is plugged in but not charging the phone. When the phone is being charged it uses 2 W.

   a How much energy needs to be supplied each second to the induction coil in the wall for a charger that is not charging a phone? Assume the charger is within 0.5 m of the coil.

   b If the charger is not used to charge a phone, how much energy (in joules) is wasted in 24 hours?

   c How much energy would be wasted in 24 hours if the charger were plugged directly into a wall socket?

4 Do you think that new homes should be fitted with induction coils for powering electrical equipment? Explain your answer.

Extra challenge

5 How much energy is wasted in a year if the phone charger in question **3** is used to charge a phone for 1 hour per day? The charger is left plugged in and switched on all the time, and is powered by an induction coil.

$$\text{efficiency} = \frac{\text{(useful energy transferred by the device)}}{\text{(total energy supplied to the device)}}$$

You can use power in the equation instead of energy if you are given values of power. In this case, you are thinking about the energy transferred each second.

Answer the questions using the F.R.S.A.U format and a calculator.

CP11a.3

The equation linking the currents and voltages in a **transformer** is:

$$V_P \times I_P = V_S \times I_S$$

where: V_P represents the **potential difference** across the primary coil

I_P represents the current in the primary coil

V_S represents the potential difference across the secondary coil

I_S represents the current in the secondary coil.

1 The table shows the potential differences and currents in a transformer. Calculate the missing values, assuming the transformer is 100% efficient.

2 Calculate the **electrical power** transferred by the transformer in cases **a–h** in question **1**.

3 Mains power in the UK is at 230 V. Some of the electricity is transferred around the country at a potential difference of 33 kV.

An electric shower uses a current of 20 A. What current flows in the 33 kV line to provide the power for the shower?

	V_P (V)	I_P (A)	V_S (V)	I_S (A)
a	12	3		0.75
b	12	4	6	
c	120		60	4
d		5	20	30
e	50		200	0.75
f	60	8		32
g	80	20		5
h	4000	5	200	

Answer the questions using the F.R.S.A.U format and a calculator.

CP11a.6

1 a What do **transformers** do?

b Describe the structure of a transformer. Include the following words in your description: primary coil, secondary coil, core.

c Name the effect that allows transformers to work.

2 a Describe the difference between energy and power.

b What two measurements would you need to make in order to work out the power being transferred by an electrical appliance?

c Write down the equation used to calculate the power of an electrical appliance, including the units for the different quantities.

3 A charger for a digital camera contains a transformer. It uses the mains voltage at 230 V and a current of 0.04 A.

a Calculate its **electrical power**.

b Calculate the current it would use with a 100 V supply if its power were the same.

The equation linking the currents and voltages in a transformer is:

$V_P \times I_P = V_S \times I_S$

4 a What do the terms in the equation in question **3b** represent?

b This equation only works if we make an assumption about the efficiency of the transformer. What is this assumption?

5 a Calculate I_P when V_P = 200 V, V_S = 10 V and I_S = 80 A.

b Calculate V_S when V_P = 100 V, I_P = 2 A and I_S = 20 A.

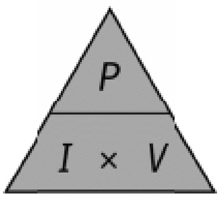
c Calculate I_S when V_P = 10 V, I_P = 3 A and V_S = 200 V.

Extra challenge

6 a The charger in question **3** has an output voltage of 4 V. Calculate the current in its secondary coil.

b The charger gets warm while it is being used. Explain what this tells you about its efficiency.

c If you measured the current produced by the charger, would it be more or less than the value you calculated in part **a**? Explain your answer.



Answer the questions using the F.R.S.A.U format and a calculator.

CP11b.4

1 Electricity from power stations is transmitted around the country at a very high voltage. Why is this done? Tick *one* box.

☐ It is safer. ☐ It is more dangerous.

☐ It wastes less energy. ☐ It wastes more energy.

2 Wasted energy is transferred from electricity lines by which of the following? Tick *one* box.

☐ light ☐ heating

☐ sound ☐ forces

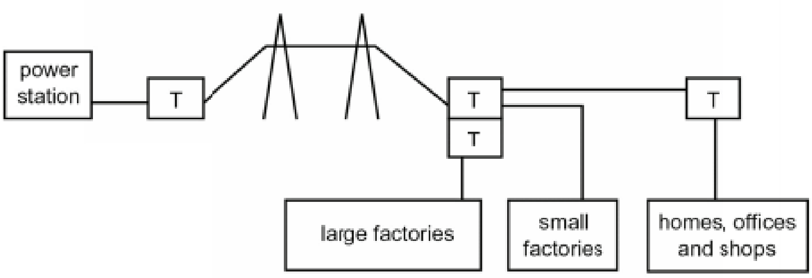
3 Tick the correct boxes to show which kind of transformer is needed for each of these situations.

Starting voltage	Final voltage	Step-up transformer	Step-down transformer
25 kV	400 kV		
400 kV	33 kV		
33 kV	230 V		

4 Draw lines to match up the voltages with the descriptions.

230 V	voltage generated in power stations
11 kV	voltage in **transmission lines**
25 kV	voltage used by small factories
33 kV	voltage used by large factories
400 kV	voltage used in homes, shops and schools

5 This diagram represents the **national grid**.



a Each box labelled T represents a transformer. Next to each box, write SU or SD to show whether it is a **step-up transformer** (SU) or a **step-down transformer** (SD).

b The voltages in the boxes in question **4** are the voltages in different parts of the national grid. Write the voltages in the correct places on the diagram above.

	distance travelled = average speed × time	
	acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{(v - u)}{t}$
	force = mass × acceleration	$F = m \times a$
	weight = mass × gravitational field strength	$W = m \times g$
	efficiency = $\frac{\text{(useful energy transferred by the device)}}{\text{(total energy supplied to the device)}}$	
HT	**momentum = mass × velocity**	$p = m \times v$
	wave speed = frequency × wavelength	$v = f \times \lambda$
	wave speed = distance ÷ time	$v = \frac{x}{t}$
	density = mass ÷ volume	$\rho = \frac{m}{V}$
	work done = force × distance moved in direction of force	$E = F \times d$
	change in gravitational potential energy = mass × gravitational field strength × change in vertical height	$\Delta GPE = m \times g \times \Delta h$
	kinetic energy = ½ × mass × (speed)^2	$KE = \frac{1}{2} \times m \times v^2$
	power = work done ÷ time taken	$P = \frac{E}{t}$
	energy transferred = charge moved × potential difference	$E = Q \times V$
	charge = current × time	$Q = I \times t$
	potential difference = current × resistance	$V = I \times R$
	power = energy transferred ÷ time taken	$P = \frac{E}{t}$
	electrical power = current × potential difference	$P = I \times V$
	electrical power = current squared × resistance	$P = I^2 \times R$
	force exerted on a spring = spring constant × extension	$F = k \times x$

GCSE (9–1) Physics, you also need to learn these extra equations:

moment of a force = force × distance normal to the direction of the force	
pressure = force normal to surface ÷ area of that surface	$P = \frac{F}{A}$