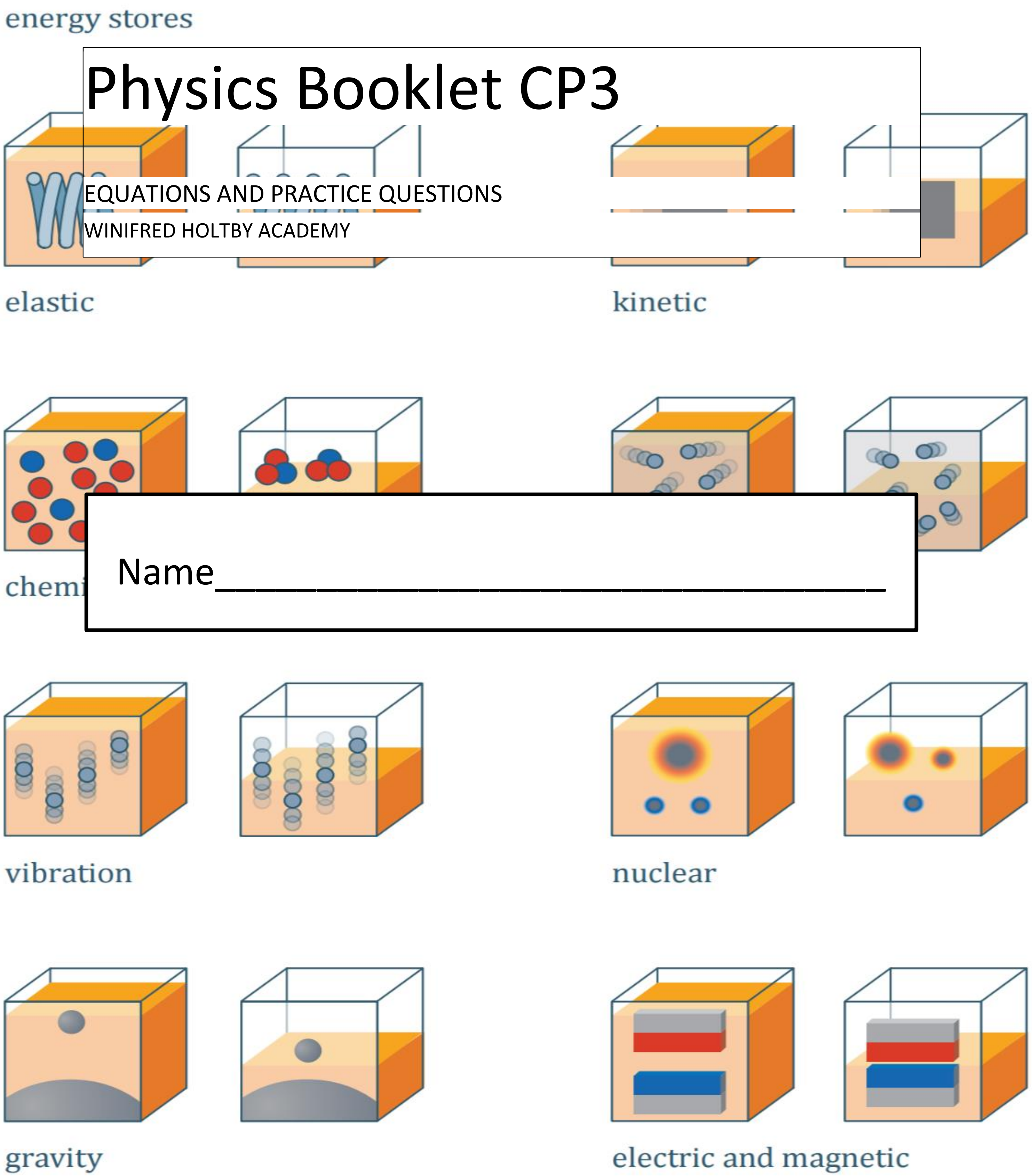
Physics Booklet CP3

EQUATIONS AND PRACTICE QUESTIONS

WINIFRED HOLTBY ACADEMY

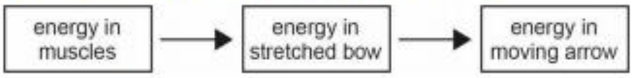
Name_______________________________________



Write as many of the equations as you can remember in this box. Correct them in green pen using the equations sheet on the back.

CP3a.2

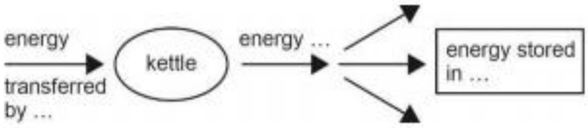
We can represent energy stores and transfers using flow diagrams. The diagram below shows some of the energy stores and transfers when someone shoots an arrow.



1 The boxes show energy stores. What name do we give to each of these energy stores?

2 The arrows show energy transfers. What label should be on the arrows? (*Hint*: it is the same label for both arrows.)

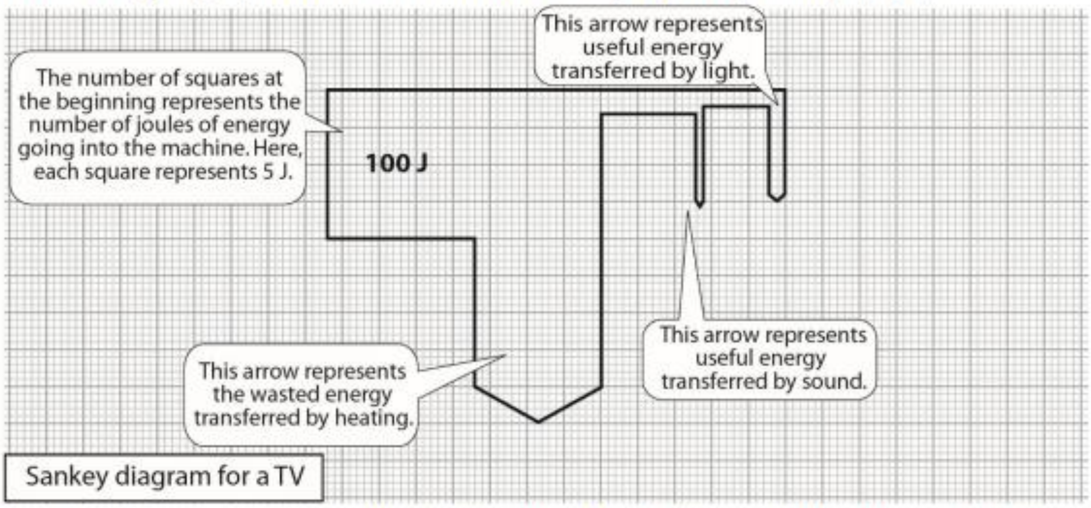
3 When we boil a kettle, energy is transferred to it by electricity. The energy ends up stored as **thermal energy** in the hot water, in the kettle and in the surroundings.



a Copy and complete the diagram on the right to show the different energy stores and transfers.

b Explain which of the final energy stores is useful energy.

A **Sankey diagram** shows energy transfers. The widths of the arrows on the diagram are proportional to the amount of energy they represent. It is easier to draw a Sankey diagram if you use graph paper.



4 Look at the Sankey diagram for a TV. For every 100 J of energy transferred to the TV, how much is transferred to the surroundings by:

a heating b light c sound?

5 A light bulb transfers 60 J of energy every second. It transfers 33 J of useful light energy and the rest is transferred to the surroundings by heating.

a How is energy transferred to the light bulb?

b How much energy is transferred from the light bulb by heating?

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

CP3b.3

1 The table gives information about some different machines. Copy the table and fill in the missing values.

	Total energy supplied per second (J)	Useful energy transferred per second (J)	Wasted energy transferred per second (J)	Efficiency
a	100	80	20	
b	25	6.25	18.75	
c	30	12	18	
d	80	68	12	
e	1200		120	0.9
f	5000		250	0.95
g	750		525	0.3
h		350	150	0.7
i		260	140	0.65
j		10	40	0.2

2 An incandescent bulb is supplied with 100 J of energy every second and transfers 5 J of energy by light. Calculate the **efficiency** of the bulb.

3 A plasma TV transfers 300 J of energy every second. It transfers 5 J by light and 5 J by sound. What is the efficiency of the TV?

4 An ordinary light bulb has an efficiency of 0.05. If 400 J is supplied by electricity, how much energy is transferred from the bulb by light?

5 A low energy light bulb is supplied with 20 J of energy each second and transfers 9 J by light.

a What is its efficiency?

b How much energy must be transferred to a normal incandescent bulb (efficiency 0.05) for it to transfer 9 J of energy by light?

6 It takes 300 kJ of energy to bring a full kettle of water to the boil. How much energy must be supplied to the kettle by electricity if the efficiency of the kettle is:

a 0.95 **b** 0.9?

7 An electric crane lifts a load of bricks up 5 metres and transfers 90 kJ of gravitational potential energy to them. The crane has an efficiency of 0.8. Calculate the amount of energy transferred to the crane by electricity.

8 A TV is supplied with 50 J of energy each second. It transfers 8 J of this by light and also transfers energy by sound and by heating. Its efficiency is 0.24. Calculate the amount of energy transferred by sound each second.

9 A power station has an efficiency of 0.5, the transmission lines that get the electricity to homes have an efficiency of 0.9, and a light bulb has an efficiency of 0.05. How much energy must be input as fuel to the power station for the light bulb to transfer 1 J of energy? (*Hint*: start by working out how much energy must be supplied to the bulb, then how much must be sent down the transmission lines for this amount to arrive)

CP3b.6

Extra challenge

4 A fridge is standing in the middle of an empty room with all the doors and windows closed. The fridge is switched on and its door is opened.

a Will the temperature in the room go down, stay the same or go up?

b Explain your answer to part **a**.

Write as many of the equations as you can remember in this box. Correct them in green pen using the equations sheet on the back.

CP3d.3

You will be expected to recall the equations for change in gravitational potential energy (GPE) and kinetic energy (KE) in your examination. You will need to choose the correct formula to answer the question and you should also be able to change the subject of the equations and to use the correct units.

Use a value of 10 N/kg for the Earth's gravitational field strength for all questions on this sheet.

When we talk about the gravitational potential energy (GPE) stored in an object, we are referring to the change in GPE as the object is raised to that position from the floor or from the ground.

1 Goods in a warehouse are stored on shelves. Table **A** shows the changes in gravitational potential energy as different items are put onto their shelves.

Calculate the missing values in the table.

	Change in GPE	Mass	Change in height
a		4 kg	2 m
b		2.5 kg	3 m
c		500 g	2.5 m
d	800 J		2 m
e	1125 J	75 kg	
f	1.5 kJ	50 kg	
g	50 J		50 cm

A

2 **a** Calculate the change in GPE when an astronaut lifts a 2 kg hammer onto a shelf 1.5 m above the floor in a base on the Moon. The gravitational field strength on the Moon is 1.6 N/kg.

b The same hammer is lifted onto a shelf of the same height on Mars. It gains 11.1 J of GPE.

Calculate the gravitational field strength on Mars.

c A space probe with a mass of 400 kg lands on Titan (one of the moons of Saturn). When it is 500 m above the surface it stores 280 kJ of GPE.

Calculate the gravitational field strength on Titan.

3 Table **B** shows the kinetic energy (KE) stored in moving balls of different kinds. The speeds in the table are the fastest speeds for those balls.

Calculate the missing values in the table.

	Ball	KE	Mass	Speed (m/s)
a	cricket ball		0.16 kg	44
b	football		0.4 kg	30
d	hockey ball		150 g	30
e	ice hockey puck	185 J		48
f	tennis ball	142 J		70
g	table tennis ball		2.7 g	40
h	golf ball	186.3 J		90

4 A car has a mass of 1500 kg. Calculate the KE stored in the car when it is travelling at the following speeds.

a 10 m/s (about 20 mph)

b 20 m/s (about 45 mph)

c 30 m/s (about 70 mph)

CP3d.3

5 A student drops a bouncy ball from a height of 2 m. The mass of the ball is 0.02 kg. She measures the maximum height it reaches on each bounce and calculates the GPE at the top of each bounce. Table **C** shows her results.

Calculate the missing values in the table below.

Bounce	**0**	**1**	**2**	**3**	**4**	**5**
Height (m)	2.0	1.4	1.0			
GPE (J)	0.4			0.14	0.10	0.07

C

6 In the investigation in question **5**, the GPE stored in the ball at the top of each bounce is converted to kinetic energy by the time the ball reaches the ground again. When the ball is first dropped, it has 0.4 J of kinetic energy just before it reaches the ground. Its speed is 6.32 m/s.

Calculate the speed of the ball just before it reaches the ground after bounces 3, 4 and 5. (*Hint*: remember to take the square root once you have calculated v^2).

7 The bob of a large pendulum has mass of 30 kg. The change in height of the pendulum as it swings is 0.5 m.

a Calculate the change in GPE as the bob moves from its highest to its lowest point.

b All the GPE stored in the bob at its highest point is transferred to kinetic energy as the bob reaches its lowest point. Calculate the maximum speed of the bob.

8 A wrecking ball has a mass of 5000 kg. The ball is pulled sideways and rises by 6 m. When it is released it swings and hits the building to be demolished when it is at the lowest point of its swing.

a Calculate the speed of the ball when it hits the building.

b Calculate the maximum speed of the ball if it is only pulled upwards by 3 m before being released.

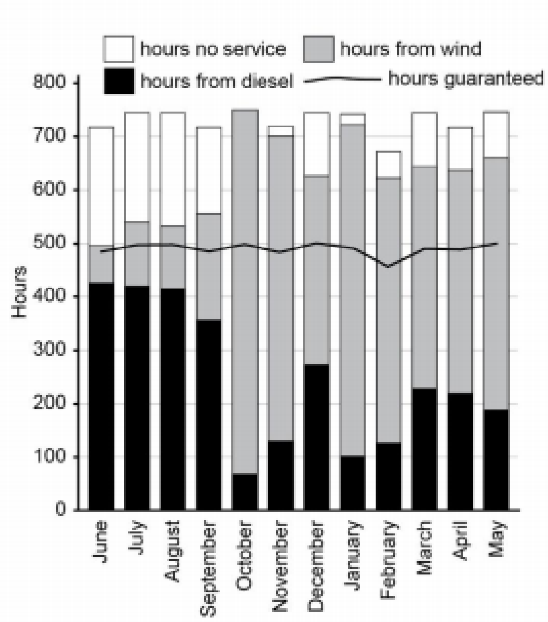
Answer the questions using the F.R.S.A.U format and a calculator.

CP3f.2

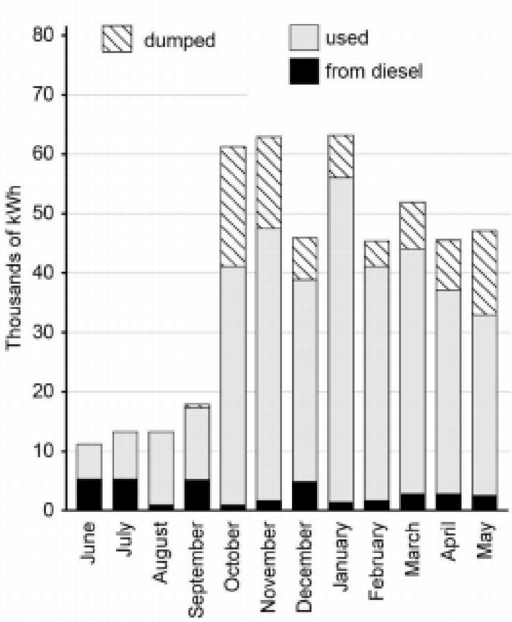
Fair Isle is a small island, about 5 km long and 2 km wide, off the coast of Scotland between the Shetland and Orkney islands. The UK is one of the windiest countries in Europe, and the Scottish islands are the windiest parts of the UK. The island is not connected to the National Grid, so there is no mains electricity.

Until 1982 the inhabitants of the islands got all their electricity from small diesel generators. In 1982 the first **wind turbine** was erected on Fair Isle with the approval of the local residents. Another wind turbine was added later, again with the approval of the island's residents.

A) Hours of electricity supplied on Fair Isle



B) Electricity generated on Fair Isle



1 At the start of the period shown in the graphs, there was only one wind turbine on Fair Isle. When did the second wind turbine start to contribute to the power supply? Explain your answer.

2 The electricity company on Fair Isle only guarantees an electricity supply for a certain number of hours per month.

a For approximately how many hours a day is there a guaranteed supply?

b Why does the number of guaranteed hours per month drop in February?

3 What do the two graphs tell you about:

a the total amount of energy available from the wind each month

b the number of hours each day when there was enough wind to use it to supply electricity?

4 a What further information would you need to give more accurate answers to question 3?

b The wind turbines on Fair Isle produce electricity for around 60 per cent of the time. Explain whether you would expect a wind turbine on the mainland to provide electricity for this proportion of the time.

5 Use graph A to estimate what percentage of electrical energy on Fair Isle is supplied by the wind turbines.

6 Many people would like to see the UK generating a lot more of its electricity from wind power. Describe two of the difficulties that would have to be overcome to make this happen.

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	$P = \frac{F}{A}$