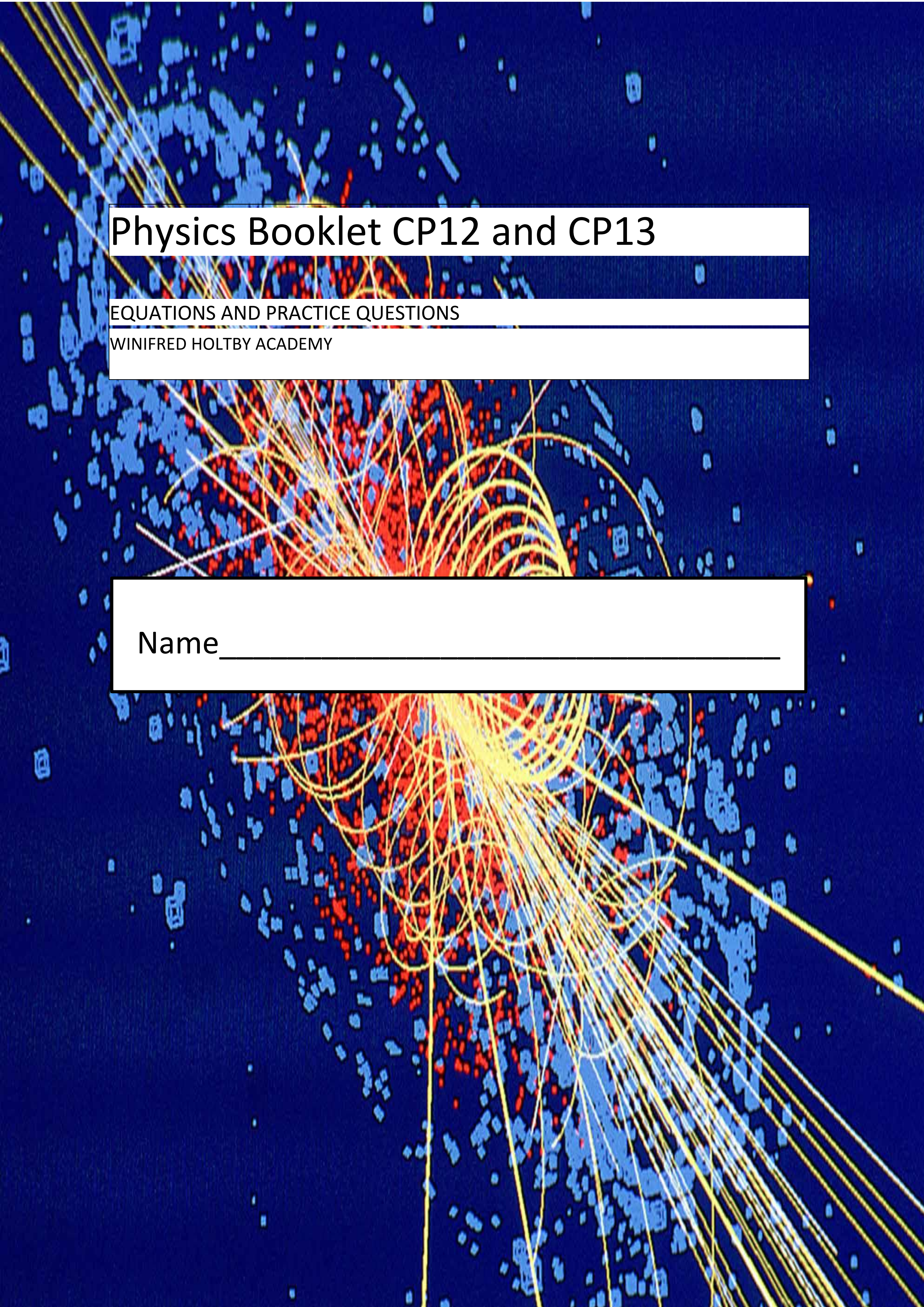


Physics Booklet CP12 and CP13

EQUATIONS AND PRACTICE QUESTIONS

WINIFRED HOLTBY ACADEMY

Name_________________________________

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

CP12a.3

You will be expected to recall the equation for calculating **density** in your exam. You should also be able to change the subject of the equation and to use the correct units. Give your answers to an appropriate number of significant figures.

1 Calculate the missing numbers in the table on the right.

2 Aluminium is chosen for some uses because of its low density.

An aluminium block has a mass of 200 kg and a volume of 0.074 m^3. Calculate the density of aluminium.

3 Lead is often used as radiation shielding because of its high density.

A 50 kg block of lead has a volume of 0.0044 m^3. Calculate the density of lead.

4 A standard gold ingot has a mass of 12.4 kg. The density of gold is 19 320 kg/m^3. Calculate the volume of gold in an ingot.

5 A litre of milk has a volume of 1000 cm^3. Its mass is 1030 g. Calculate the density of milk, in g/cm^3.

6 **a** A piece of sycamore wood has a volume of 0.05 m^3 and a mass of 30 g. Calculate its density in kg/m^3.

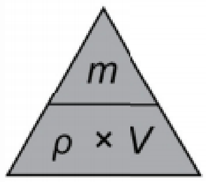
	Mass (kg)	Volume (m^3)	Density (kg/m^3)
a	50	5	
b	125	2.5	
c	0.8	4	
d		3	0.8
e		1.5	70
f	20		25
g	0.6		0.02
h		0.4	15
i		7.5	6
j	0.8		0.04

b A piece of oak has a mass of 60 g and a density of 0.8 kg/m^3. Calculate its volume in m^3.

7 Some salad dressing is made by adding 30 cm^3 of olive oil (density = 0.85 g/cm^3) to 10 cm^3 of vinegar (1.05 g/cm^3). Calculate the mass of salad dressing.

8 The density of hydrogen at room temperature and pressure is approximately 0.08 kg/m^3. The density of air is 1.205 kg/m^3. What is the difference in volume between 0.2 kg of hydrogen and 0.2 kg of air?

$$\text{density} = \frac{\text{mass}}{\text{volume}} \qquad \rho = \frac{m}{V}$$



Units:

For mass in kg and volume in m^3, the density is in kg/m^3.

For mass in g and volume in cm^3, the density is in g/cm^3.

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

CP12c.3

You will need to use these equations to help answer the questions.

change in thermal energy (J) = mass (kg) × specific heat capacity (J/kg °C) × change in temperature (°C)

thermal energy needed for a change of state (J) = mass (kg) × specific latent heat (J/kg)

You will not be expected to recall these equations in your exam. You will, however, be expected to choose the correct equation, change the subject of the equations and use the correct units.

1 The table shows information about heating different substances. Calculate the missing values, giving your answers to an appropriate number of significant figures.

	Material	Energy (J)	Mass (kg)	Specific heat capacity (J/kg °C)	Temperature change (°C)
a	air		2	1005	10
b	brick		5	840	20
c	concrete	5000	3	880	
d	ice	62 790	20		15
e	dry soil	10 000		800	5
f	wet soil	3000	10	1480	
g	liquid water	2500		4182	20
h	iron	673 500	50		30

2 A scientist is heating soil to kill bacteria in it. Her soil samples are at a temperature of 10 °C and she needs to heat them to 90 °C. Calculate the energy needed to heat 10 kg of:

a wet soil

b dry soil.

c What mass of dry soil can the scientist heat by supplying 20 kJ of energy?

3 The table shows information about evaporating different substances. Calculate the missing values, giving your answers to an appropriate number of significant figures.

	Material	Energy (J)	Mass (kg)	Specific latent heat of evaporation (J/kg)
a	ethanol		0.5	846 000
b	ethanol	5000		846 000
c	octane	5960	0.02	
d	octane	20 860 000	70	
e	water		25	2 257 000
f	water	950 000		2 257 000
g	acetic acid	321 600		402 000
h	acetic acid		0.2	402 000

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

CP12c.3

4 Calculate the energy needed to evaporate:

- **a** 3 kg of petrol (octane)
- **b** 500 g of ethanol
- **c** 20 g of vinegar (acetic acid).

5 What mass of ethanol can you evaporate by supplying 80 kJ of energy?

Substance	Specific latent heat of evaporation (J/kg)
ethanol	846 000
octane	298 000
water	2 257 000
acetic acid	402 000

6 20 kg of aluminium is heated to its melting point. A further 6420 kJ of energy is transferred to the aluminium and all of it melts. Calculate the specific latent heat of melting of aluminium.

7 A metalworker is working with copper, silver and gold. The table shows some of the properties of these metals.

Substance	Specific heat capacity (solid) (J/kg °C)	Specific heat capacity (liquid) (J/kg °C)	Specific latent heat of melting (J/kg)	Melting point (°C)
copper	390	490	207 000	1495
silver	230	280	88 000	9
gold	130	150	67 000	1063

The metalworker has 500 g of each metal, at a temperature of 20 °C.

- **a** Calculate how much energy is needed to heat each sample to its melting point.
- **b** The metalworker heats 0.5 g of copper from a starting temperature of 20 °C. Heating transfers 300 kJ of energy. Calculate how much of the copper melts.

Extra challenge

8 Use the values in the table above to help you answer these questions.

- **a** A metalworker heats 0.5 kg of silver from a starting temperature of 20 °C. Heating transfers 60 kJ of energy. Calculate the final temperature of the liquid silver. Give your answer to 3 significant figures.
- **b** The metalworker heats 50 g of gold from a starting temperature of 20 °C. How much energy does he need to supply to obtain 50 g of liquid gold at a temperature of 1200 °C? Give your answer in standard form.

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

CP12c.6

Use these equations to help you answer the questions.

change in thermal energy (J) = mass (kg) × specific heat capacity (J/kg °C) × change in temperature (°C)

thermal energy needed for a change of state (J) = mass (kg) × specific latent heat (J/kg)

change in gravitational potential energy (J) = mass (kg) × *g* × change in vertical height (m) (*g* = 10 N/kg)

1 Some students are investigating the specific heat capacity of lead shot. They put 0.5 kg of lead shot into a tube and seal the ends with rubber bungs. When the tube is sealed, the distance between the inner sides of the bungs is 1.2 m.

The students hold the tube vertically and then turn it upside down so that the lead shot falls down the tube. As the lead shot falls, its gravitational potential energy (GPE) is transferred to thermal energy.

a Calculate the amount of energy transferred to thermal energy in the lead shot as it falls down the tube.

b The students invert the tube 20 times. Calculate the total amount of GPE transferred to thermal energy.

c The temperature of the lead shot increased by 1.5 °C. Calculate the specific heat capacity of lead.

d Reference books give the specific heat capacity of lead as 130 J/kg °C. Explain why your answer to part **c** is not the same as this value.

2 Land and sea breezes occur when the sea and the land warm up at different rates during the day. Heating occurs because the Sun transfers 1400 W of power to each square metre on a sunny day. (1 W = 1 J/s)

Material	Specific heat capacity
sand	835 J/kg °C
water	4182 J/kg °C

a Calculate the temperature change of a square metre of sand and a square metre of water over an hour on a sunny day. Assume the mass of the substance is 100 kg in each case.

b State any assumptions you made in your calculation in part **a**.

3 A saucepan contains 1.5 litres of water (mass = 1.5 kg).

a Calculate the energy required to raise the temperature of the water from 10 °C to boiling point.

b If this same amount of energy was transferred to boiling water, how much water would evaporate? The specific latent heat of evaporation of water is 2 257 000 kJ/kg.

4 Three ice cubes, each with a mass of 5 g, are added to an insulated cup containing 150 g of water at a temperature of 20 °C.

a Calculate the energy stored in the water compared with that in the same mass of water at 0 °C.

b Calculate the energy that must be transferred to the ice to make all of it melt. The specific latent heat of melting of ice is 334 kJ/kg.

c When all the ice has melted, 165 g of water is in the cup. The water stores the original energy (from part **a**) minus the amount of energy used to melt the ice. Calculate the final temperature of the water in the cup.

Extra challenge

5 Look at question **1**. Explain why you could have carried out your calculations without measuring the mass of lead shot used.

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

CP13b.2

You will be expected to recall the equation relating force, extension and **spring constant** in your exam. You may be given the equation for calculating the energy transferred in stretching. You should also be able to change the subject of the equations and to use the correct units.

energy transferred in stretching (J) = ½ × spring constant (N/m) × $(\text{extension})^2$ $(\text{m})^2$

1 Calculate the missing values in the table on the right.

2 A student stretches a spring by pulling on it with a force of 20 N. The extension of the spring is 2 cm. Calculate the spring constant.

3 The unstretched length of a spring is 10 cm. A force of 30 N stretches the spring to 13 cm long. Calculate the spring constant.

4 A force of 10 kN is applied to a spring. It extends by 5 cm. Calculate the spring constant.

5 A compression spring has an original length of 50 cm. A force of 1000 N shortens the spring by 5 cm. Calculate its spring constant.

6 A piece of copper wire is stretched using a force of 120 N. The extension is 3 mm. Calculate the spring constant.

	Force (N)	Spring constant (N/m)	Extension (m)
a		2	0.2
b		15	0.6
c	6		2
d	5	50	
e	16	800	
f	37.5		0.5
g		28	0.03
h	0.005	0.01	

7 Calculate the missing numbers in the table on the right.

8 A spring is extended by 20 cm. Its spring constant is 50 N/m. Calculate the energy transferred in stretching it.

9 A spring has a spring constant of 20 N/m. Calculate the extension when the following amounts of energy are used to stretch it. (*Hint:* remember to take the square root once you have calculated x^2.)

a 200 J **b** 15 J **c** 50 J

10 A length of iron wire has a spring constant of 30 000 N/m. Calculate the energy required to produce an extension of 10 cm.

11 A spring is extended by 0.5 m using a force of 20 N. Calculate the energy transferred in stretching the spring. (*Hint:* you need to use both equations to answer this question.)

	Energy (J)	Spring constant (N/m)	Extension (m)
a		4	0.3
b		16	0.5
c		6	3
d	0.8		0.2
e	0.48		0.04
f	9		0.6
g		14	0.04
h	0.0064		0.8

12 Energy of 50 J is transferred when a spring is stretched. The spring's original length was 0.02 m and its final length is 0.03 m. Calculate the force used.

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

CP13b.4

You need to use this equation to answer some of the questions.

energy transferred in stretching = ½ × spring constant × (extension)^2

1 What does the **spring constant** of a spring tell you about the spring? Tick one box.

☐ the force needed to stretch it by a metre ☐ the energy needed to stretch it by a metre ☐ the force needed to stretch it by a centimetre

2 Write down the equation that shows the relationship between the spring constant, force and extension.

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3 A spring has a spring constant of 80 N/m and a length of 0.1 m.

a Calculate the force needed to give the spring an extension of 0.2 m.

force = _______________ N

b Calculate the extension of the spring with a force of 2 N on it.

extension = _______________ m

4 Calculate the energy transferred when the spring in question **3** is stretched by 0.4 m.

energy = _______________ N

5 A spring is stretched using 300 J of energy. The extension is 0.2 m. Calculate the spring constant.

spring constant = _______________ N

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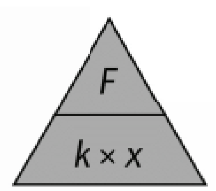
force (N) = spring constant (N/m) × extension (m)

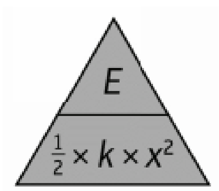
F = force

k = spring constant

x = extension

E = energy





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