Surname	Centre Number	Candidate Number
Other Names		0

wjec cbac

GCSE – NEW

3430UF0-1

S18-3430UF0-1

SCIENCE (Double Award)

Unit 6 – PHYSICS 2
HIGHER TIER

WEDNESDAY, 23 MAY 2018 – AFTERNOON

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**17**	
3.	**9**	
4.	**9**	
5.	**10**	
Total	**60**	

3430UF01 01

ADDITIONAL MATERIALS

In addition to this examination paper, you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **3*(b)***.

Equations

speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
resultant force = mass × acceleration	$F = ma$
weight = mass × gravitational field strength	$W = mg$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{velocity}^2}{2}$	$\text{KE} = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$\text{PE} = mgh$
force = spring constant × extension	$F = kx$
work done in stretching = area under a force-extension graph	$W = \frac{1}{2}Fx$

SI multipliers

Prefix	Multiplier
p	1×10^{-12}
n	1×10^{-9}
μ	1×10^{-6}
m	1×10^{-3}

Prefix	Multiplier
k	1×10^{3}
M	1×10^{6}
G	1×10^{9}
T	1×10^{12}

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

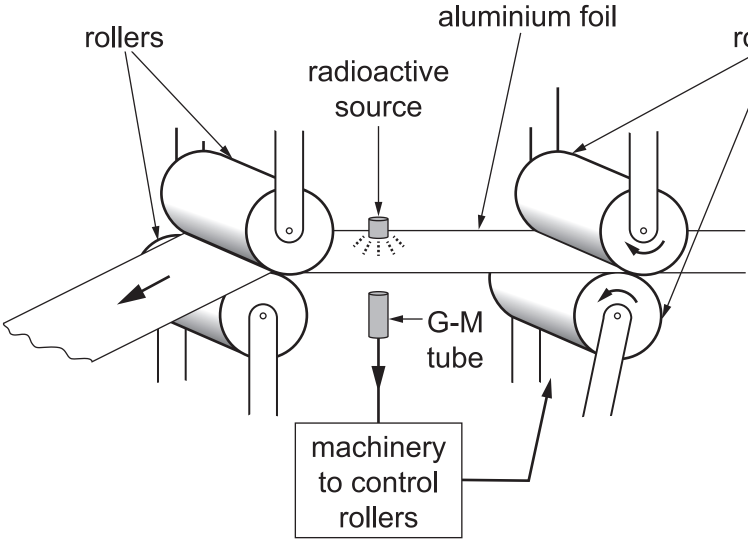
Turn over.

Examiner only

Answer **all** *questions.*

1. A group of students study the uses of radioactivity. They find that radioactive isotopes are widely used in a variety of applications. For example, alpha emitters are used in smoke detectors. Medical diagnosis and cancer treatments use a range of radioisotopes emitting alpha, beta and gamma radiation.

One use they study in detail is monitoring the thickness of aluminium foil when it is manufactured. Radiation passes through the aluminium foil and is detected by a G-M tube. Changes to the thickness cause a difference in the count rate detected and adjustments can then be made to the pressure applied by the rollers.



Different radioisotopes have different half-lives and decay in different ways. The properties of some radioisotopes are given in the table below.

Isotope	Symbol	Half-life	Decay mode
strontium-90	$^{90}_{38}Sr$	29 years	beta
americium-241	$^{241}_{95}Am$	432 years	alpha
caesium-137	$^{137}_{55}Cs$	30 years	gamma
phosphorous-32	$^{32}_{15}P$	14 days	beta
actinium-225	$^{225}_{89}Ac$	10 days	alpha

Examiner only

(a) Tick (✓) the boxes alongside the **three** correct statements below. [3]

Alpha radiation consists of helium nuclei	☐
Alpha radiation is more ionising than gamma	☐
Strontium-90 has 90 nucleons	☐
Gamma radiation consists of low energy waves	☐
Gamma radiation only travels a short range in air	☐
Beta radiation consists of slow moving electrons	☐

(b) One of the students suggests that strontium-90 is the most suitable isotope from the table for monitoring the thickness of aluminium foil. Explain whether or not you agree with this suggestion. [3]

....

....

....

....

....

(c) (i) Explain what is meant by the statement: 'The half-life of strontium-90 is 29 years.' [2]

....

....

....

(ii) Calculate the time taken for the activity of strontium-90 to fall to $\frac{1}{8}$th of its initial value. [3]

Time = ... years

Examiner only

(d) The students' teacher demonstrates experiments with radioactive sources. First she measures the radiation in the laboratory, recording 150 counts in 5 minutes. This allows her to work out the count rate of the background radiation.

(i) Calculate the background radiation count rate in counts per **second** (cps). [2]

Background count rate = ... cps

(ii) Suggest **two** ways in which the teacher could improve the accuracy of her result. [2]

....

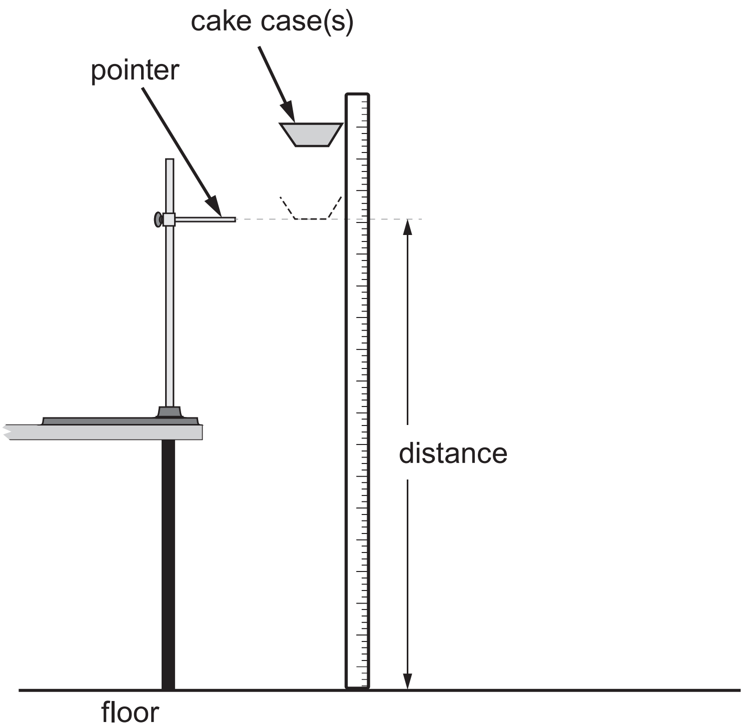
....

....

15

Examiner only

2. A group of students investigate if the terminal speed of falling paper cake cases depends on their mass. They follow the method given below.



1. Set up a pointer in the clamp stand and set it 1.50 m above the ground.
2. Take a single cake case and record its mass using a balance.
3. Drop the cake case from 20 cm above the pointer.
4. Use a stopwatch to record the time it takes to fall from the level of the pointer to the floor.
5. Repeat steps 3 and 4 another four times.
6. Repeat steps 3-5 with extra cake cases in a stack.

(a) (i) Give **one** reason why the students let the cake case fall for 20 cm before starting the stopwatch. [1]

....

(ii) Give **two** reasons why the students take more than one repeat reading. [2]

....

....

Examiner only

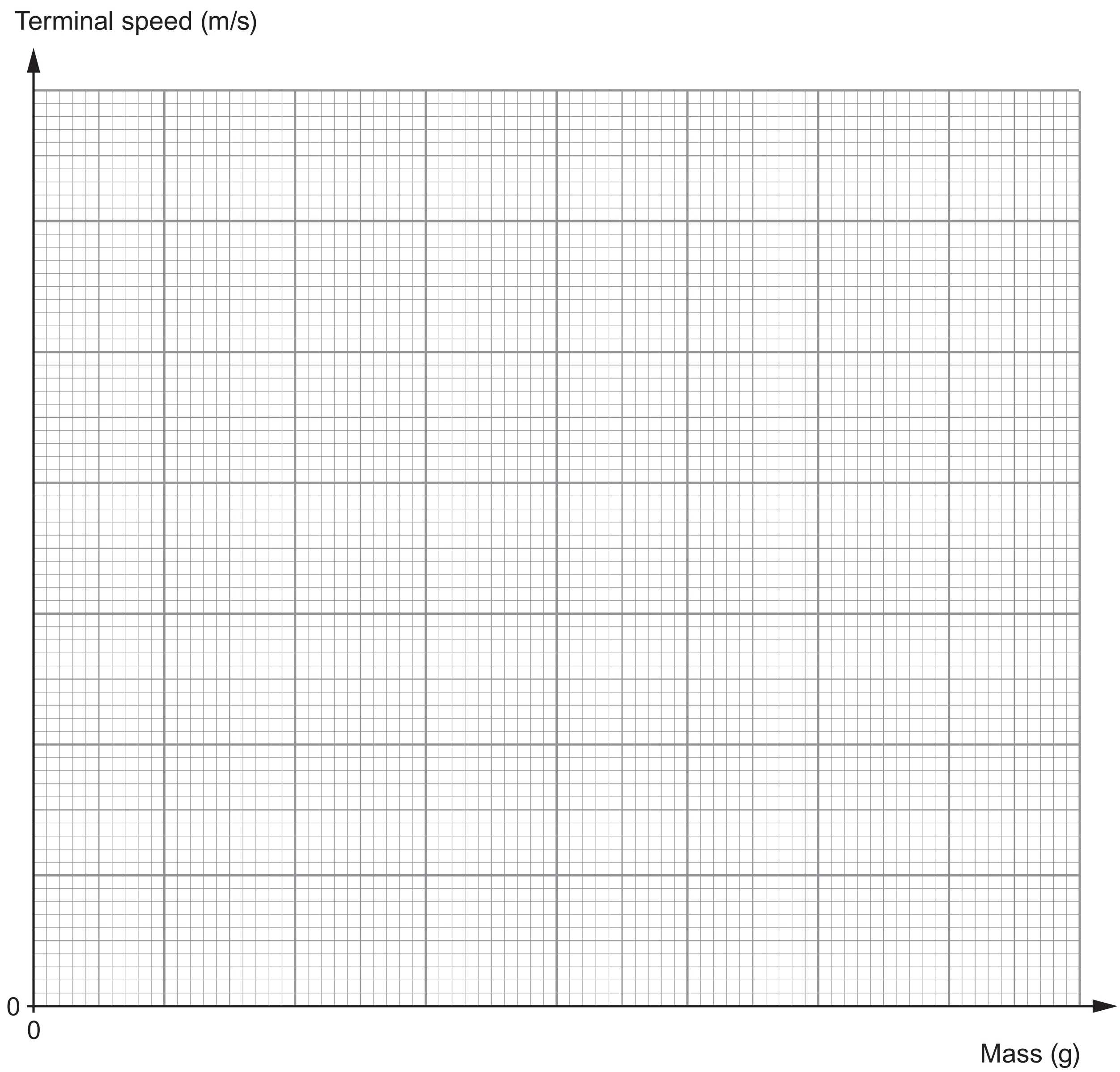
(b) The following data are collected. The students assume that each of the cake cases has a mass of 0.5 g.

Number of cake cases	Mass of cake cases (g)	Mean time taken for cake cases to fall 1.50 m (s)	Terminal speed (m/s)
0	0		0
1	0.5	0.94	1.60
2	1.0	0.67	2.24
3	1.5	0.59	2.54
5	2.5	....	2.88
6	3.0	0.51	2.94

(i) **Complete the table.** Use an equation from page 2 to calculate the missing value of the mean time. *Space for workings.* [2]

Examiner only

(ii) Plot the data on the grid below and draw a suitable line. [4]



(iii) One of the students suggests that the terminal speed will always increase by a factor of 1.4 if the mass is doubled. The student finds that when the mass doubles from 0.5 g to 1.0 g this suggestion is true. Explain if this is true for the other masses. [3]

....

....

....

....

....

Examiner only

(c) Apart from taking more repeat readings, suggest one way in which the method could be improved to collect better quality data **and** explain how the improvement would give better data. [2]

....

....

....

(d) Explaining your reasoning and using an equation from page 2, calculate the size of the air resistance force acting on a stack of 5 cake cases when travelling at terminal speed. (Gravitational field strength, g = 10 N/kg). *Space for workings.* [3]

Air resistance = ... N

....

....

17

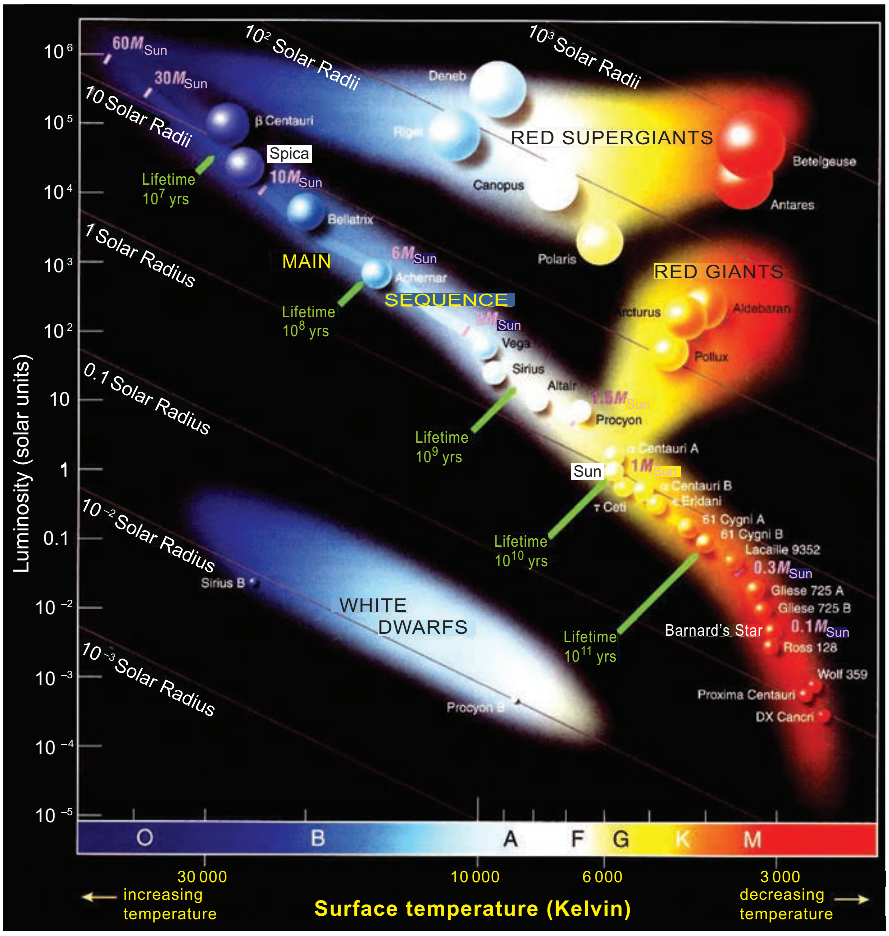
 (3430UF0-1)

BLANK PAGE

PLEASE DO NOT WRITE
ON THIS PAGE

Examiner only

3. One of the most useful diagrams in astrophysics is the Hertzsprung-Russell (HR) diagram. It was developed separately by two astronomers, the Danish astronomer Ejnar Hertzsprung and the American astronomer Henry Norris Russell. Their combined diagram shows that the relationship between the temperature and luminosity of a star is not random and stars fall into distinct groups. These are seen in the Hertzsprung-Russell diagram below which shows the properties of stars.



(a) Spica is a very large blue star on the main sequence, approximately 10 times the mass of the Sun. Spica is 261 light-years from Earth.

(i) Explain, in terms of forces, why Spica is currently stable. [2]

....

....

....

(ii) Spica is 261 light-years from Earth. State what this means. [1]

....

....

Examiner only

(b) The Sun is also on the main sequence. It is a yellow dwarf star. Explain in terms of forces, the reactions within the Sun and the properties shown on the HR diagram how the Sun will change during the remainder of its life cycle. [6 QER]

....

....

....

....

....

....

....

....

....

....

....

....

....

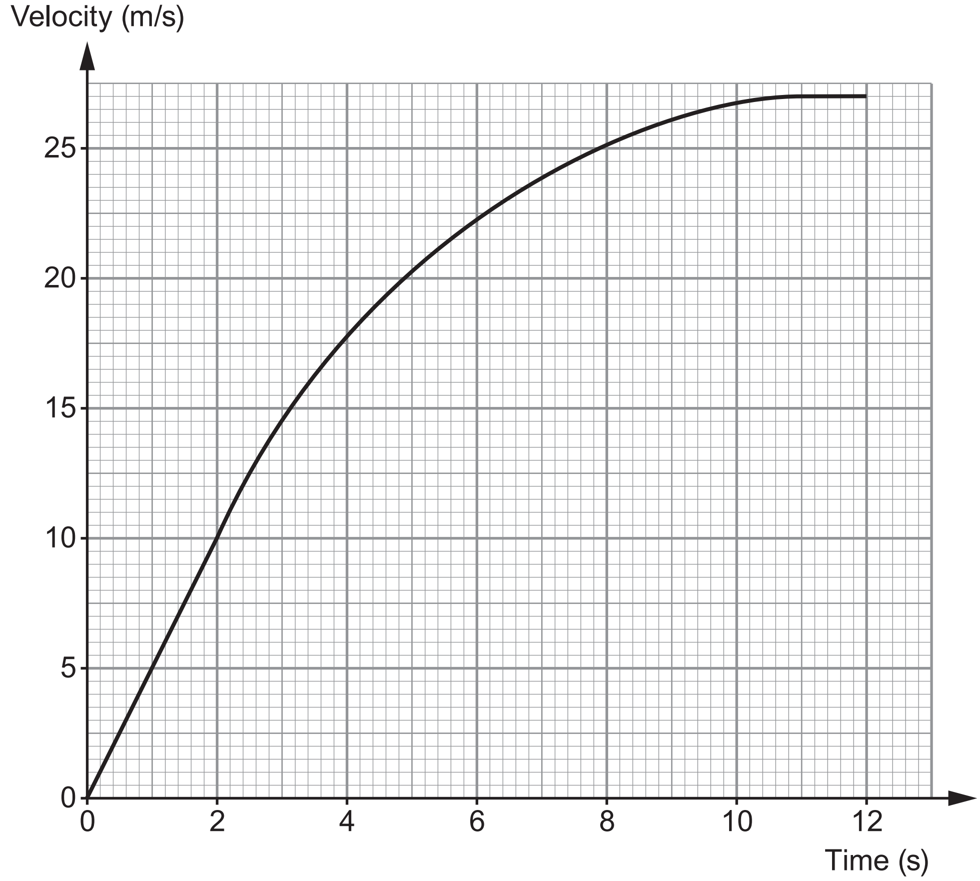
....

....

9

Examiner only

4. Manufacturers test new cars on a level track. In order to find out how long it takes them to accelerate to 27 m/s (60 mph), the cars are driven in a straight line at maximum power and the speed recorded. Data for one car is shown on the graph below.



(a) Describe how the **acceleration** changes during the 12 s shown. [2]

....

....

....

(b) By drawing a suitable tangent and using:

acceleration = gradient of a velocity-time graph

calculate the acceleration of the car at 5 s. Give a unit with your answer. [3]

Acceleration = ... Unit = ...

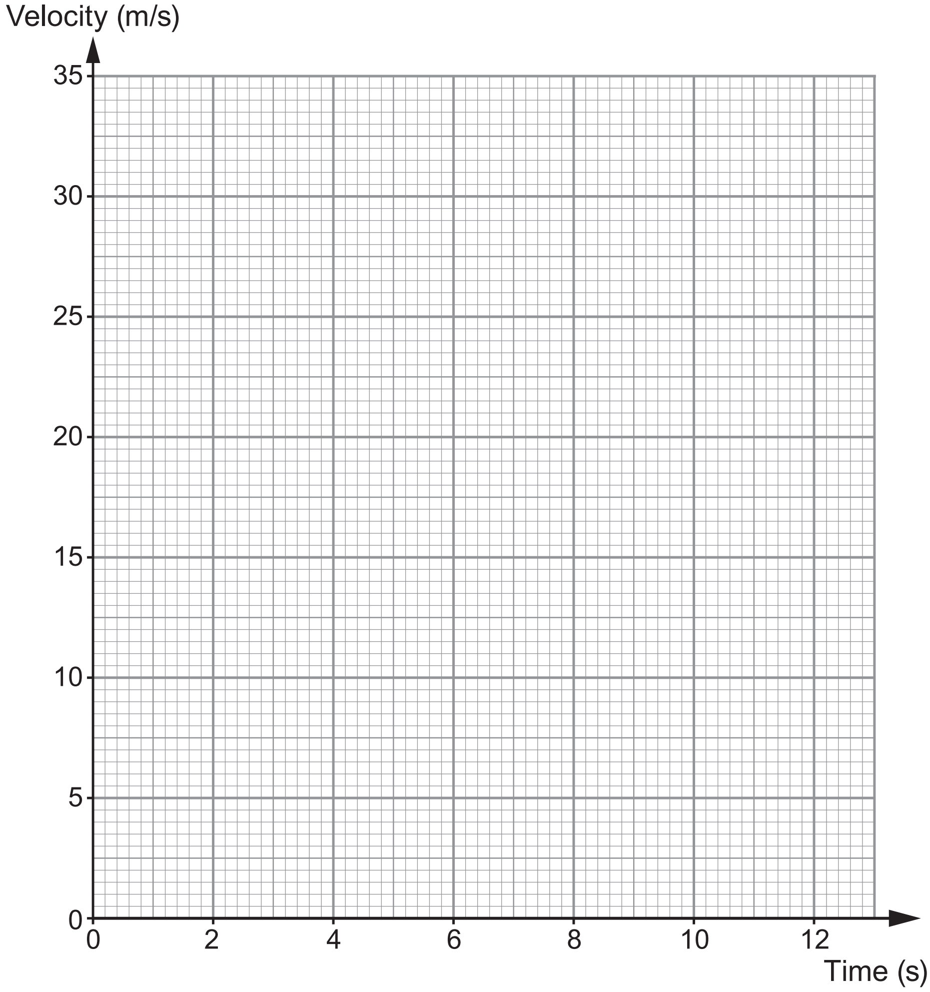
 (3430UF0-1)

Examiner only

(c) Use an equation from page 2 to estimate the distance travelled by the car in the first 3 s. [2]

Distance = ... m

(d) Another car of the same power and mass but with a more streamlined shape is tested. **Sketch on the grid below** the velocity-time graph for this car. [2]



9

Examiner only

5. Almost all cars rely on fossil fuels as their source of energy. However with supplies of fossil fuels decreasing and concerns over climate change increasing, it is important to make cars as energy efficient as possible. One type of car which is very efficient is a hybrid electric vehicle, which has both a conventional engine and an electric motor which runs from batteries. These hybrid vehicles use regenerative braking where some of the kinetic energy transferred when the brakes are applied is used to charge the batteries rather than all being lost as heat. This has a maximum energy transfer of 60%.

Data about a hybrid electric / petrol car is given below.

Time taken to accelerate from 0-100 km/h (0-28 m/s)	11.8 s
Mass of car	1 160 kg
Mean CO_2 emissions	8.9×10^{-2} kg/km
Mean fuel economy	31.6 km/litre

(a) The car uses 10 litres of fuel per week. Calculate the mean mass of CO_2 emitted by the car in a year (52 weeks). [3]

Mean mass of CO_2 = ... kg

(b) Energy can be lost from cars in a variety of ways such as inertial losses, rolling resistance losses and idling losses. State the design features that manufacturers can use to reduce **each** of these energy losses. [3]

....

....

....

....

....

Examiner only

(c) During a journey the car slows down from 30 m/s to 10 m/s.
Use an equation from page 2 to calculate how much electrical energy is transferred to the battery if the regenerative braking process is at its maximum energy transfer. [4]

Energy transferred = ... J

10

END OF PAPER

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

BLANK PAGE

PLEASE DO NOT WRITE
ON THIS PAGE

