GCSE

WJEC GCSE
The Sciences (Double Award)

Approved by Qualifications Wales

Sample Assessment Materials

Unit 3: Physics - Forces, Motion and the Universe
Foundation Tier

Teaching from 2026
For award from 2028

This Qualifications Wales regulated qualification is not available to centres in England.

Made for Wales.
Ready for the world.

WJEC would like to thank the students and teachers of Fitzalan High School, Cardiff and Llanwern High School, Newport for their participation in the creation of these covers.

Contents

Surname	Centre number	Candidate number
First name(s)		0

GCSE

3455U3

The Sciences (Double Award) – Unit 3 Physics: Forces, Motion and the Universe

FOUNDATION TIER
1 hour 15 minutes
SAMPLE ASSESSMENT MATERIALS

Additional materials

A calculator and ruler are permitted.

Instructions to candidates

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

You may use a pencil for graphs and diagrams only.

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

Answer **all** questions.

For examiner's use only		
Question	**Maximum mark**	**Mark awarded**
1.	**10**	
2.	**7**	
3.	**5**	
4.	**12**	
5.	**8**	
6.	**14**	
Total	**56**	

Write your answers in the spaces in this booklet. If you need more space, use the additional page(s) at the back of this booklet. 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 total number of marks available is **56.**

You should think carefully about how you use your time.

Your responses must be clear, accurate and well presented.

Equations

Speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in speed}}{\text{time}}$	
weight = mass × gravitational field strength	W = mg
efficiency = $\frac{\text{useful energy transferred}}{\text{input energy}}$ x 100 OR efficiency = $\frac{\text{useful power output}}{\text{input power}}$ x 100	
power = $\frac{\text{energy transfer}}{\text{time}}$	$P = \frac{E}{T}$
units used (kWh) = power (kW) × time (hours) cost = units used × cost per unit	
frequency = $\frac{1}{\text{period}}$	$f = \frac{1}{T}$
wave speed = frequency × wavelength	$v = f\lambda$
force = mass × acceleration	F = ma

SI multipliers

Prefix	Symbol	Conversion factor	Multiplier
milli	m	divide by 1000	1×10^{-3}
centi	c	divide by 100	1×10^{-2}
kilo	k	multiply by 1000	1×10^{3}
mega	M	multiply by 1 000 000	1×10^{6}

Answer **all** questions.

Examiner only

1. A council collects food waste from homes to use to generate power for homes in the county.

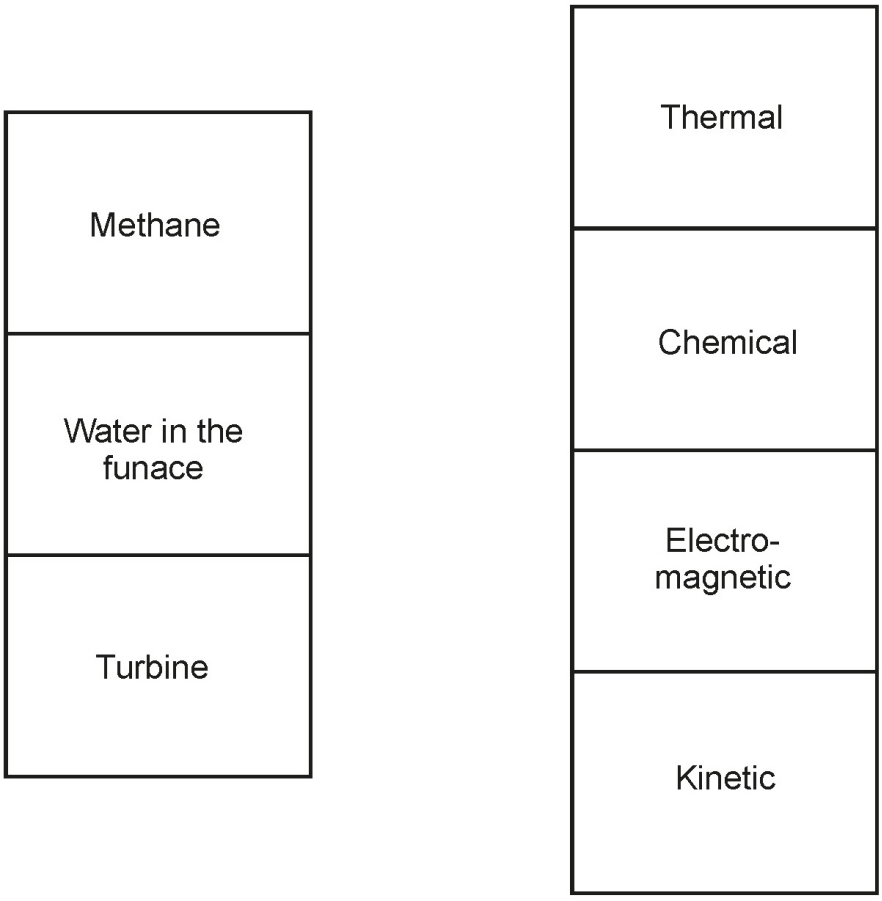
The food waste is converted to methane.

The methane is burnt in a furnace.

This heats water in a boiler.

The steam then turns a turbine which drives a generator and is used to generate electricity.

(a) **Draw 3 lines** to connect the part to the corresponding energy store. [3]



Examiner only

(b) Use the words in the box below to complete the sentences to describe the advantages of using methane as an alternative fuel. [3]

renewable	non-renewable	reproducible
hydrocarbon	nitrogen	carbon dioxide
acid rain	global warming	radioactive waste

Methane is a …….. resource.

Using methane is better for the environment than using fossil fuels because it does not cause an increase in the …….. levels in the atmosphere.

This will reduce the rate of ……...

(c) The council collects an average of 23 000 tonnes of food waste per year.

They state that the processing plant can produce enough power for 1500 homes.

One tonne of food waste can produce 65 kg of methane.

One kg of methane releases 56 MJ of energy when burnt.

(i) Calculate how much methane can be produced in the county per year. [1]

methane produced = ... kg

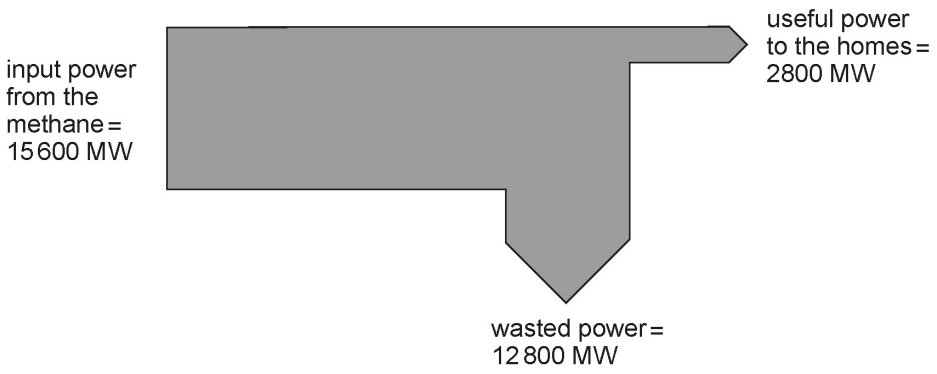
(ii) Calculate the energy produced by the methane when burnt in the furnace. [1]

energy released = ... MJ

Examiner only

(iii) On average the power station supplies 2800MW of power.

The diagram below shows the power transferred in this power station.



Use information from the diagram and the equation below:

$$\text{efficiency} = \frac{\text{useful power output}}{\text{input power}} \times 100$$

to calculate the efficiency of the power station.

[2]

efficiency = ... %

10

Examiner only

2. Astronomers use both space-based telescopes and ground-based telescopes to collect information about stars and planets.

(a) Tick (✓) the **one** correct statement below that describe an advantage of ground-based telescopes. [1]

Not affected by light pollution	
Must be placed at low altitudes	
Only some wavelengths can penetrate the atmosphere	
Cheaper	

The table below shows information about the Sun and some other stars that have been discovered with six or more exoplanets in orbit around them.

Name of star	Distance of star from Earth (units)	Mass of star (compared to the Sun)	Temperature of star (K)	Number of planets in orbit
Sun	0.00002	1.0	5 770	8
HR 8832	21	0.8	4 700	7
HD 10180	127	1.1	5 910	7
Kepler 90	2 500	1.1	5 930	7
HD 40307	42	752.0	4 980	6
HD 127	206	0.7	870	6
Kepler 20	950	0.9	5470	6
Kepler 11	2 000	1.0	5 680	6

Examiner only

(b) Use information from the table to complete the following questions.

(i) Tick (✓) the **two** correct statements below. [2]

Four stars have the same mass. ☐

Light travelling from Kepler 90 takes the longest time to reach Earth. ☐

The star temperatures range from 870 K to 5930 K. ☐

The star furthest from Earth has the lowest temperature. ☐

Star HR8832 is double the distance of star HD 40307 away from Earth. ☐

(ii) Emrys states that Kepler 11 is the star most likely to have a Solar System similar to ours.

Explain whether you agree. [2]

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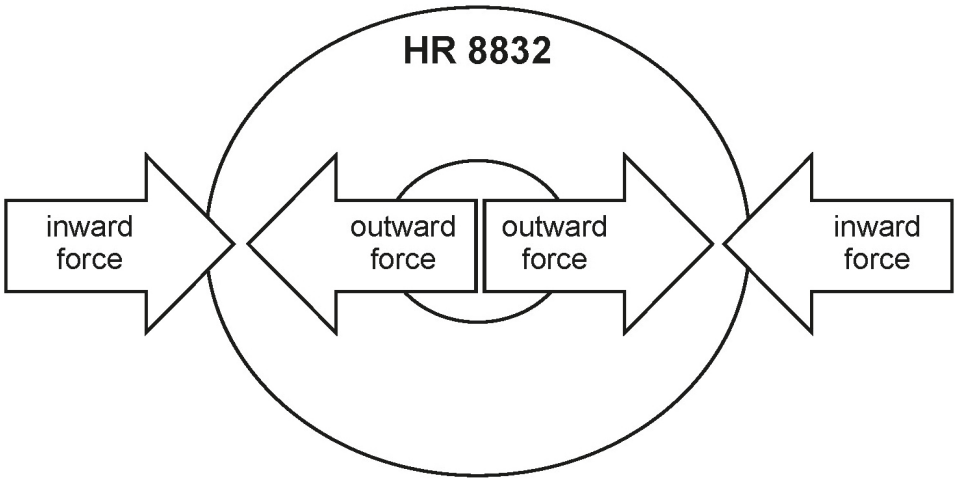
……

Examiner only

(c) The diagram below shows that the forces acting on the star HR 8832 are balanced.



(i) Underline the name of the inward force acting on HR 8832. [1]

gravitational force **force due to radiation pressure**

electromagnetic force

(ii) Underline the life cycle stage of HR 8832 shown in the diagram. [1]

protostar **main sequence** **red giant** **white dwarf**

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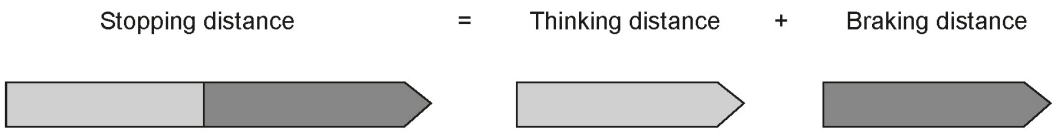
Examiner only

3. Students are investigating the factors that affect the stopping distances of cars.



(a) State **one** factor that increases braking distance. [1]

……

The students predict that tiredness will increase thinking distance and design an experiment in which they measure their reaction times at different times of the day.

(b) State **one** other factor that increases thinking distance. [1]

……

(c) The students use an online game where they must click on the screen when they see an object move.

They use this to measure their reaction time at 9.00 am, 12.00 pm, 4.00 pm and 8.00 pm.

They calculate a mean reaction time at each time of day for the class. The results are shown in the table below.

Time of day	Mean reaction time (s)
9.00 am	0.65
12.00 pm	0.55
4.00 pm	0.60
8.00 pm	0.78

(i) Underline the dependent variable in this experiment. [1]

reaction time **time of day** **the students**

(ii) The students state that they felt most tired at 9.00 am.
Explain whether the results agree with the statement. [2]

……

……

……

……

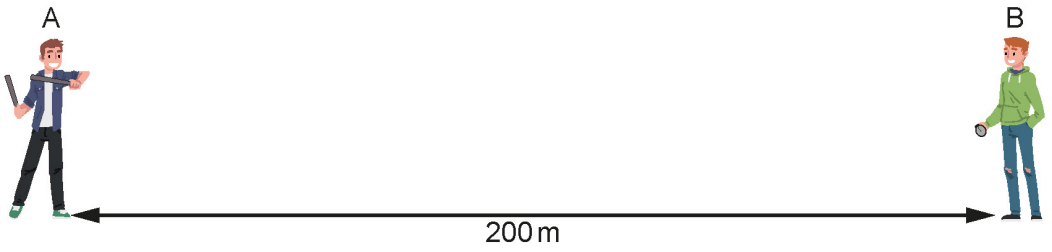
5

Examiner only

4. A teacher demonstrates how to measure the speed of sound waves.
She demonstrates two different methods.

Method 1

The teacher has one student stand at one end of the school field and another at the other end, 200 m away.



Student A knocks 2 blocks of wood together to make a loud sound.

When student B sees the blocks hit each other they start a stopwatch. They stop the stopwatch when they hear the sound.

They repeat the experiment 5 times.

Their results are shown in the table below.

Time taken for the sound to move from A to B (s)				
Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
0.67	0.72	0.63	0.72	0.66

(a) The teacher states that the results are repeatable because the range in the values is less than 0.1 s.

Use data from the table to explain whether you agree. [2]

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Examiner only

(b) They use this time to calculate speed of the sound wave.

(i) Calculate the mean time for the sound to travel from A to B. [2]

mean time = ... s

(ii) Use the equation:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

to calculate the speed of the sound waves. [2]

speed =..... m/s

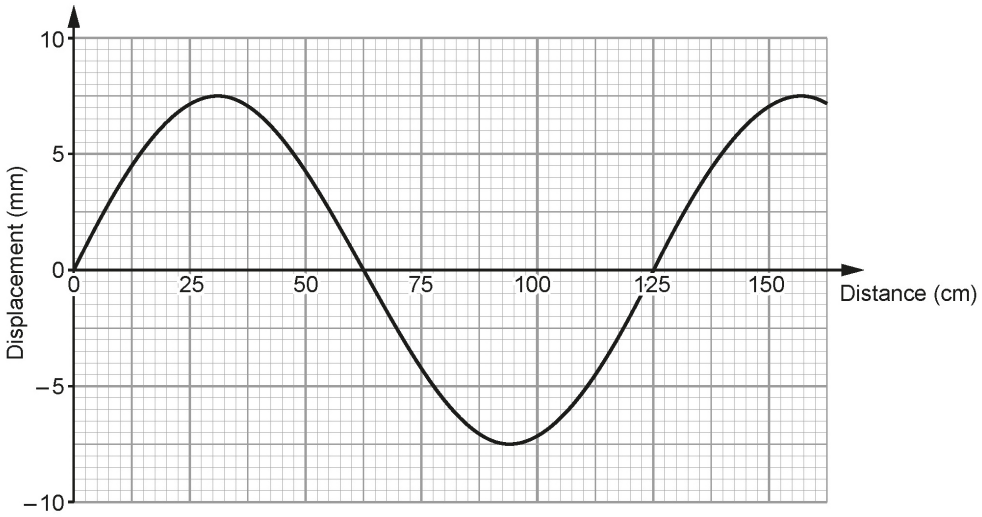
Examiner only

Method 2

(c) The teacher demonstrates another method using a tuning fork.

She uses a tuning fork with a frequency of 256 Hz to create a sound wave. She uses a microphone and a computer program to draw the wave on a screen.

The wave produced is shown opposite.



(i) Use the graph to state the wavelength of the sound wave **in metres**. [2]

wavelength = ... m

(ii) Use an equation from page 2 to calculate the speed of this sound wave. [2]

wave speed = ... m/s

Examiner only

(d) The true value for the speed of sound in the air is 343 m/s.

(i) Explain which method is least accurate. [1]

……

……

(ii) Explain a possible cause for this inaccuracy. [1]

……

……

12

5. A dishwasher has the following four programs.

Program	Time to complete program (hours)	Mean power used (W)	Water temperature (°C)	Units used (kWh)
Intensive	3.2	540	65	1.7
Mixed	3.0	400	55	1.2
Sanitizing	2.2	830	65	1.8
Eco	3.5	220	50	

(a) Part of the table showing the units used by the Eco program is missing.

(i) Use the equation:

units used (kWh) = power (kW) × time (hours)

to calculate the units used by the dishwasher when using the Eco program. [2]

units used = ……. kWh

Examiner only

(ii) The cost per unit is 30 p.
Use the equation:

cost = units used × cost per unit

to calculate the cost of using the Eco program once. [2]

cost = ……. p

(b) The Eco program uses less energy than the other programs.
Explain why.

Use information from the table in your answer. [2]

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……

……

……

(c) 'The Sanitizing program is the cheapest because it takes the least time to complete.'

Use data from the table to explain if you agree or disagree. [2]

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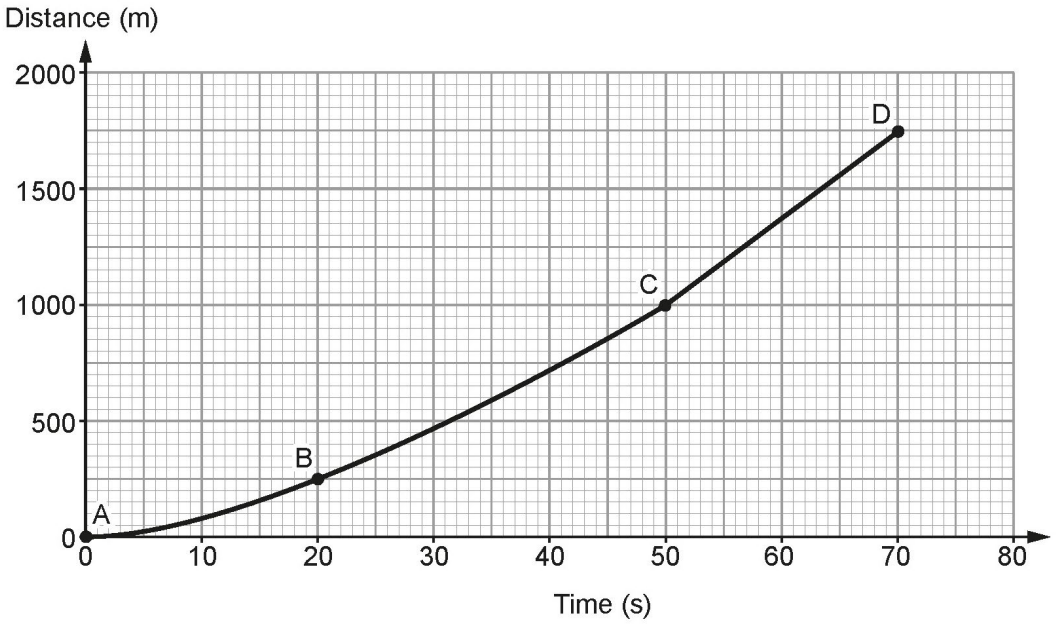
8

Examiner only

6. In January 2024 Welsh duo Adele Nicoll and Kya Placide won gold in the women's bobsleigh at the Europe Cup in Switzerland.

The graph below shows their journey from the start at A to the finish line, D.



(a) Use information from the graph to calculate the distance from B to C. [2]

distance = ... m

(b) A spectator stated that the bobsleigh had the highest speed between B and C.

Use information from the graph to explain whether you agree. [2]

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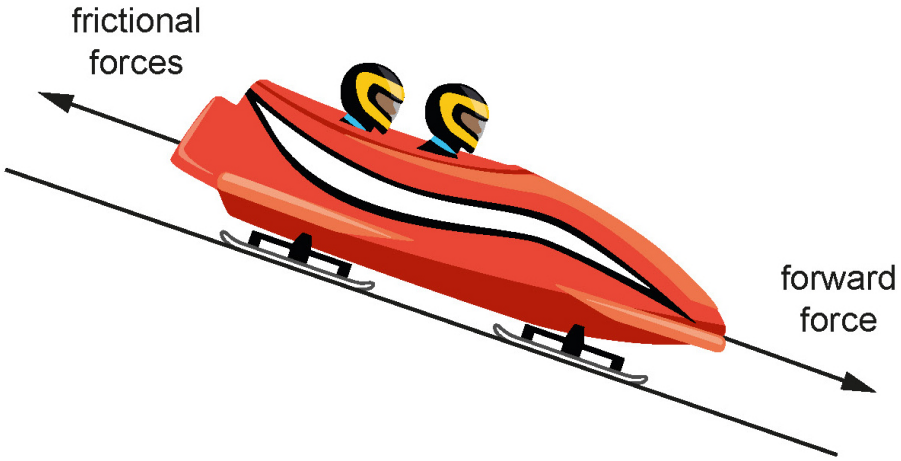
Examiner only

(c) They achieved a maximum terminal speed of 38 m/s.



(i) Explain, in terms of forces, why the bobsleigh reaches its terminal speed. [2]

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.....

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.....

To reach their highest speed the crew crouch as low as possible in the bobsleigh with only the driver sitting upright to see the track.

Examiner only

(ii) Explain how crouching down as low as possible improves the maximum terminal speed the bobsleigh can achieve. [2]

……..

……..

……..

……..

(d) At the start of the course, they accelerated from rest to 13 m/s in 5.6 s.

(i) Use the equation:

$$\text{acceleration} = \frac{\text{change in speed}}{\text{time}}$$

to calculate their mean acceleration at the start. [2]

acceleration = ……. m/s^2

(ii) The mass of the bobsleigh and crew is 330 kg.

Use an equation from page 2 to calculate the resultant force at the start. [2]

resultant force = ……. N

(e) The maximum allowed mass for the bobsleigh is 330 kg.

Delyth states that having more mass means that the bobsleigh will accelerate faster during the push start.

Explain whether she is correct. [2]

……

……

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……

Examiner only

14

END OF PAPER

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

Examiner only

THE SCIENCES (DOUBLE AWARD)
UNIT 3

Physics: Forces, Motion and the Universe

FOUNDATION TIER

MARK SCHEME

Guidance for examiners

Generic marking principles

- Marks awarded are always whole marks (not half marks, or other fractions).
- Answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
- Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
- Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Positive marking

It should be remembered that candidates are writing under examination conditions and credit should be given for what the candidate writes, rather than adopting the approach of penalising candidates for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based, the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

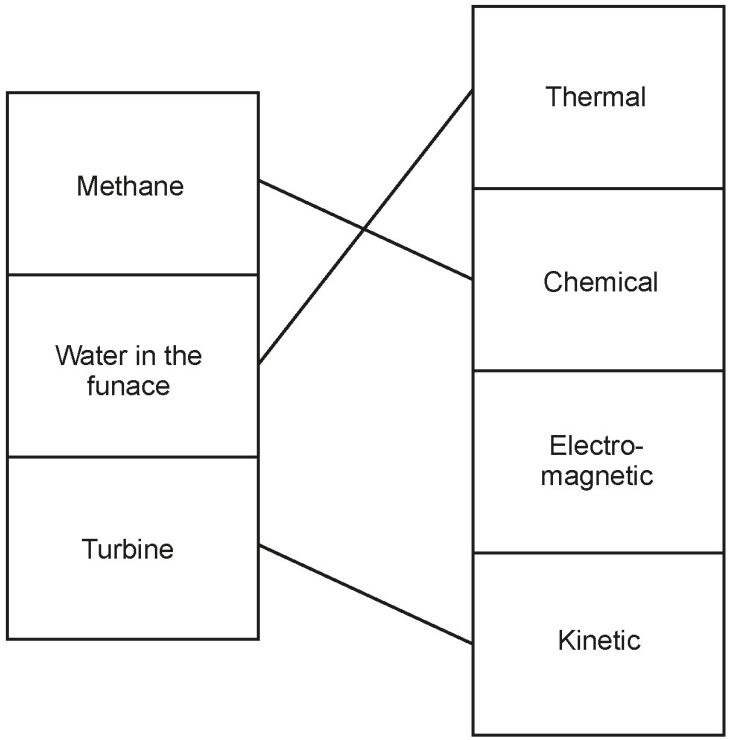
Mark schemes often list points which may be included in candidates' answers. The list is not exhaustive. The inclusion of *'Credit any other valid response.*' (or similar instruction) within mark schemes allows for the possible variation in candidates' responses. Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme. Credit should be given according to the accuracy and relevance of candidates' answers.

Appropriate terminology is reflected in exemplar responses in mark schemes. However, unless there is a specific requirement within a question, candidates may be awarded marks where the answer is accurate but expressed in their own words.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

ecf = error carried forward
bod = benefit of doubt

Question		Marking details	Marks available					
			AO1	AO2	AO3	Total	Maths	Enquiry Skills
1.	(a)			3		3		
	(b)	Renewable Carbon dioxide Global warming	3			3		

	(c)	(i)		23 000 × 65 = 1 495 000 [kg]		1		1	1	
		(ii)		1 495 000 **ecf** × 56 = 83 720 000 [MJ]		1		1	1	
		(iii)		$\frac{2\ 800}{15\ 600}$ × 100% (1) =17.9[%] (1)	1	1		2	2	
				Question 1 total	**4**	**6**	**0**	**10**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
2.	(a)		Cheaper (1) For each extra tick subtract 1 mark – no negative mark	1			1		
	(b)	(i)	Light travelling from Kepler 90 takes the longest time to reach Earth (1) The star temperatures range from 870 K to 5930 K (1) For each extra tick subtract 1 mark – no negative mark		2		2		
		(ii)	Kepler 11 has the <u>same mass</u> as our Sun (1) has the [most] <u>similar</u> temperature to our Sun (1) [so agree]			2	2		
	(c)	(i)	<u>gravitational force</u>	1			1		
		(ii)	<u>Main sequence</u>		1		1		
			Question 2 total	**2**	**3**	**2**	**7**	**0**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Enquiry Skills
3.	(a)			Speed / mass of car / worn tyres or brakes	1			1		
	(b)			Speed / alcohol / drugs	1			1		
	(c)	(i)		Reaction time		1		1		1
		(ii)		Most tired should have the longest reaction time (1) Longest reaction time is at 8pm so disagree (1)			2	2		2
				Question 3 total	**2**	**1**	**2**	**5**	**0**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
4.	(a)		Range = 0.72 - 0.63 = 0.09 (1) Which is less than 0.1 so agree (1)			2	2		2
	(b)	(i)	0.67 + 0.72 + 0.63 + 0.72 + 0.66 (1) $\frac{3.4}{5}$ = 0.68 [s] (1)		2		2	2	2
		(ii)	$\frac{200}{0.68\ ecf}$ (1) = 294 [m/s] (1)	1	1		2	2	2
	(c)	(i)	$\frac{125\ \text{cm}\ (1)}{100}$ = 1.25 [m] (1)		2		2		2
		(ii)	256 × 1.25 **ecf** (1) = 320 [m/s] (1)	1	1		2	2	2
	(d)	(i)	Method 1 because 294 is further from 343 m/s (1)			1	1		1
		(ii)	Reaction time / difficult to hear the sound (1)			1	1		1
			Question 4 total	**2**	**6**	**4**	**12**	**6**	**12**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
5.	(a)	(i)	0.22 (1 – conversion) × 3.5 = 0.77 [kWh] (1)		2		2	2	
		(ii)	0.77 **ecf** × 30 (1) 23.1 [p] (1)	1	1		2	2	
	(b)		Eco program uses the {lowest temperature / lowest power} (1) Less energy is used to keep the water hot (1)		2		2		
	(c)		Sanitizing uses more energy (1) So the cost is higher so disagree (1)			2	2		
			Question 5 total	**1**	**5**	**2**	**8**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Enquiry Skills
6.	(a)		1000 – 250 (1) = 750 [m] (1)		2		2	1	2
	(b)		The bobsleigh travels further in less time between C and D (1) So faster between C and D so disagree (1) **OR** The line is steepest between C and D (1) So faster between C and D so disagree (1)			2	2		2
	(c)	(i)	Air resistance / friction increases as the speed increases (1) Until they balance the forward force pulling the bobsleigh down the hill (1)	2			2		
		(ii)	[Crouching lower] reduces air resistance (1) Which means that the bobsleigh will travel faster before the forces balance (1)		2		2		
	(d)	(i)	Acceleration = $\frac{13}{5.6}$ (1) = 2.3 [m/s^2] (1)		2		2	2	
		(ii)	Force = 330 × 2.3 **ecf** (1) = 759 [N] (1)	1	1		2	2	
	(e)		The same force from the athletes pushing (1) On a greater mass means a smaller acceleration so Delyth is incorrect (1)			2	2		2
			Question 6 total	**3**	**7**	**4**	**14**	**5**	**6**

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	Enquiry Skills
1	4	6	0	10	4	0
2	2	3	2	7	0	0
3	2	1	2	5	0	3
4	2	6	4	12	6	12
5	1	5	2	8	4	0
6	3	7	4	14	5	6
TOTAL	**14**	**28**	**14**	**56**	**19**	**21**