

GCSE Science

Summer Hub meetings

Sample maths questions

Published: Summer 2017

The questions are organised into five main areas of maths skills and then into the individual skills.

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Questions

Arithmetic and numerical computation

Synergy 3F

Skill 1b

Low demand

1 0

This question is about speed.

1 0

.

1

What is a typical value for the speed of sound?

[1 mark]

Tick **one** box.

3.3 m/s

☐

3.3×10^2 m/s

☐

3.3×10^3 m/s

☐

3.3×10^6 m/s

☐

Chemistry 1F

Skill 1c

Low demand

0 5

.

8

A coarse particle has a diameter of 1×10^{-6} m.

A nanoparticle has a diameter of 1.6×10^{-9} m.

Calculate how many times bigger the diameter of the coarse particle is than the diameter of the nanoparticle.

[2 marks]

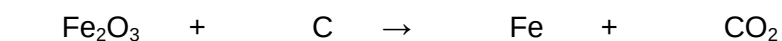
Chemistry 1F
Skill 1c
Low demand

0 2 . 7 Iron is found in the Earth as iron oxide (Fe_2O_3).

Iron oxide is reduced to produce iron.

Balance the equation for the reaction.

[1 mark]



Physics 1F
Skill 1c
Standard demand

Table 1 shows how the count rate from a radioactive source changes with time.

Table 1

Time in seconds	0	40	80	120	160
Count rate in counts/second	400	283	200	141	100

0 7 . 4 Use **Table 1** to calculate the count rate after 200 seconds.

[2 marks]

Trilogy Biology 2H
Skills 1b, 2e
High demand

0	6
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 .

3

 Two alleles control the body colour of carp:
brown (B)
blue (b).

The brown allele is dominant to the blue allele.

Two carp that are heterozygous for colour are crossed and produce 2.6×10^5 offspring.

Approximately how many of the offspring are expected to be blue?

Draw a genetic diagram to explain your answer.

Give your answer in standard form.

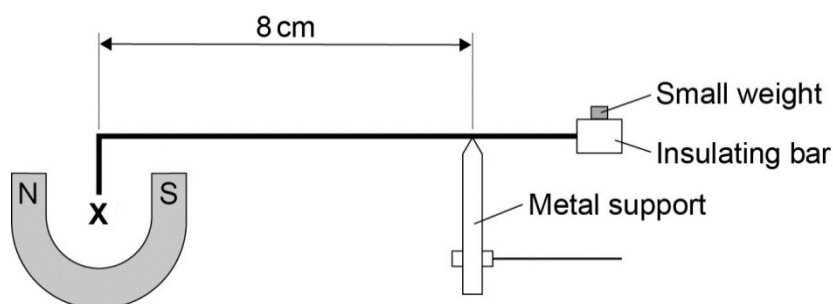
[5 marks]

Number of offspring expected to be blue = _____

Physics 2H
Skills 1c, 3b, 3c, 3d
High demand

Figure 21 shows how a small weight placed on the insulating bar makes the wire **X** go back and balance in its original position.

Figure 21



0 7 . **4** The wire **X** is 5 cm long and carries a current of 1.5 A

The small weight causes a clockwise moment of 4.8×10^{-4} Nm.

Calculate the magnetic flux density where the wire **X** is positioned

Give the unit.

[6 marks]

Magnetic flux density = _____ Unit _____

Trilogy Physics 1F
Skills 1d, 2c
Standard demand

0 **7** . **5** A driver wishes to buy a new car.

Table 2 gives some data about an electric car and one with a petrol engine.

Table 2

	Electric car	Petrol engine car
Cost (£)	27 000	15 000
Running cost per year (£)	250	2 000
Average lifetime (years)	12	12

Which car would be the most economic over its 12 year lifetime?

Use data from **Table 2** to support your answer.

You should include the difference in cost in your answer.

[4 marks]

Physics 2F
Skill 1d
Standard demand

1 **0** . **7** A car driver sees a fallen tree lying across the road ahead and makes an emergency stop.

The braking distance of the car depends on the speed of the car.

For the same braking force, explain what happens to the braking distance if the speed doubles.

You should refer to kinetic energy in your answer.

[4 marks]

Handling data

Trilogy Chemistry 2F

Skills 2a, 2b

Low demand

0 2 . 7

A student measured the melting point of a solid hydrocarbon four times.

The student's results are in **Table 2**.

Table 2

	Trial 1	Trial 2	Trial 3	Trial 4
Melting point in °C	35	48	37	37

Calculate the mean melting point of the hydrocarbon, leaving out any anomalous result.

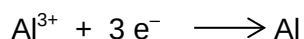
Give your answer to two significant figures.

[2 marks]

Mean melting point = _____ °C

Synergy 3H
Skill 2a
High demand

0 6 . 5 The half equation at the cathode is:



Calculate the number of moles of electrons needed to produce 1 000 kg of aluminium.

Give your answer to three significant figures.

Relative atomic mass (A_r): Al = 27

[3 marks]

Answer = _____ moles

Biology 2F
Skill 2b
Standard demand

Table 2

Test number	Distance ruler dropped in cm	
	Student A	Student B
1	9	12
2	2	13
3	6	13
4	7	9
5	7	8
Mean	7	X

0 7 . 5 Calculate the value of X in Table 2.

[1 mark]

Mean distance ruler dropped = _____ cm

Trilogy Physics 2F
Skill 2c
Low demand

0 **2** . **7** **Table 1** shows some results with a different spring.

Table 1

Force applied in N	Extension in m
0.0	0.000
0.5	0.025
1.0	0.050
1.5	0.075

What would the extension be with a force of 2.0 N?

[1 mark]

Tick **one** box.

- 0.080 m ☐
- 0.090 m ☐
- 0.095 m ☐
- 0.100 m ☐

Chemistry 2F
Skill 2c
Standard demand

0 **6** **Table 2** gives information about four alcohols.

Table 2

Alcohol	Formula	Melting point in °C	Boiling point in °C
Methanol	CH ₃ OH	-94	65
Ethanol	CH ₃ CH ₂ OH	-118	78
Propanol	CH ₃ CH ₂ CH ₂ OH	-129	97
Butanol	CH ₃ CH ₂ CH ₂ CH ₂ OH	-89	118

0 **6** . **1** Which alcohol in **Table 2** is liquid over the greatest temperature range?

[1 mark]

Trilogy Biology 2F**Skill 2e****Low demand**

Two alleles control the body colour of carp:

- brown (**B**)
- blue (**b**).

The brown allele is dominant to the blue allele.

The genetic cross from breeding two carp is shown in **Figure 8**.

Figure 8

	B	b
b	Bb	
b		

0 4 . 4

What is the probability that the offspring from this genetic cross will be brown?

[1 mark]

Tick **two** boxes.

0 ☐

0.25 ☐

0.5 ☐

1.0 ☐

Biology 2F
Skill 2e
Standard demand

0 8 . 4 Complete the genetic diagram in **Figure 12**.

- Identify any children with CF.
- Give the probability of any children having CF.

[3 marks]

Each parent does not have CF.

The following symbols have been used:

D = dominant allele for **not** having CF

d = recessive allele for having CF

Figure 12

		Mother	
		D	d
Father	D	DD	
	d		

Probability of a child with CF = _____

Biology 2H
Skill 2e
High demand

0 7 . 4

A recessive allele causes syndrome H.

A heterozygous woman and a homozygous recessive man want to have a child.

Draw a Punnett square diagram to determine the probability of the child having syndrome H.

Identify any children with syndrome H.

[5 marks]

Use the following symbols:

A = dominant allele

a = recessive allele

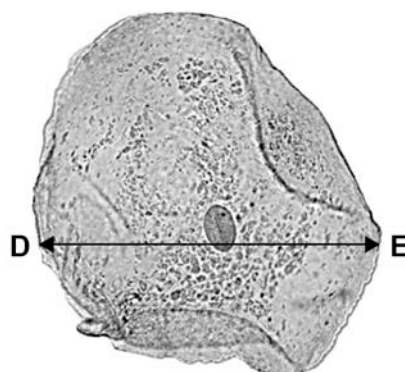
Probability = _____

Biology 1F
Skill 2h
Low demand

0 3 . 5 The cheek cell in **Figure 6** is magnified 250 times.

The width of the cell is shown by the line **D** to **E**.

Figure 6



Calculate the width of the cheek cell in micrometres (μm).

Complete the following steps.

[3 marks]

Measure the width of the cell using a ruler _____ mm

Use the equation to work out the real width of the cell in mm:

real size = $\frac{\text{image size}}{\text{magnification}}$ _____ mm

Convert mm to μm _____ μm

Synergy 1H
Skill 2h
High demand

Table 4

	Fluid A	Fluid B
pH	7.3	5.6
Sugar in mg/cm ³	118	1.18
Nitrate ions in mg/cm ³	10	600
Potassium ions in µg/cm ³	1.18	2500

08 . **3** In fluid **A**, how many times greater is the concentration of sugar than the concentration of potassium ions?

[2 marks]

Algebra

Physics 2F

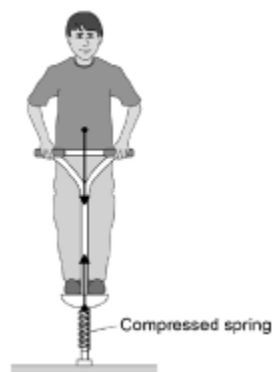
Skill 3b

Standard demand

0 9

Figure 15 shows the forces acting on a child who is balancing on a pogo stick. The child and pogo stick are not moving.

Figure 15



The child has a weight of 343 N.

Gravitational field strength = 9.8 N/kg

0 9

. 3

Write down the equation which links gravitational field strength, mass and weight.

[1 mark]

0 9

. 4

Calculate the mass of the child.

[3 marks]

Mass = _____ kg

The weight of the child causes the spring to compress elastically from a length of 30cm to a new length of 23cm.

- 0 9** . **5** Write down the equation which links compression, force and spring constant.

[1 mark]

- 0 9** . **6** Calculate the spring constant of the spring.

Give your answer in newtons per metre.

[4 marks]

Spring constant = _____ N/m

Trilogy Physics 2F
Skills 3c, 3d
Low demand

- 0 2** . **8** The spring constant for the spring in **Table 1** is 20 N/m.

Calculate the work done in stretching the spring until the extension of the spring is 0.050m

Use the correct equation from the Physics Equation Sheet.

[2 marks]

Work done = _____ J

Trilogy Physics 2F
Skills 3c, 3d
Low demand

0 1 . 2 The car travels a distance of 2040 metres in 2 minutes.

Use the following equation to calculate the mean speed of the car.

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

[2 marks]

Mean speed = _____ m/s

Physics 1H
Skills 3b, 3c, 3d
High demand

1 1 . 5 At the lowest point in the jump, the energy stored by the stretched bungee cord is 24.5 kJ.

The bungee cord behaves like a spring.

Calculate the spring constant of the bungee cord.

Use the correct equation from the Physics Equation Sheet.

[3 marks]

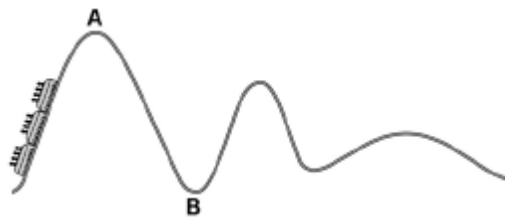
Spring constant = _____ N / m

Synergy 4H
Skill 3b
High demand

0 9

Figure 7 shows a rollercoaster.

Figure 7



The rollercoaster car is raised a vertical distance of 35 m to point A by a motor in 45 seconds.

The mass of the rollercoaster is 600 kg.

The motor has a power rating of 8 000 W.

0 9

. 2 The rollercoaster rolls from point A to point B, a drop of 35 m.

Calculate the speed of the roller coaster at point B.

Assume that the decrease in potential energy store is equal to the increase in kinetic energy store.

[6 marks]

Speed at point B = _____ m/s

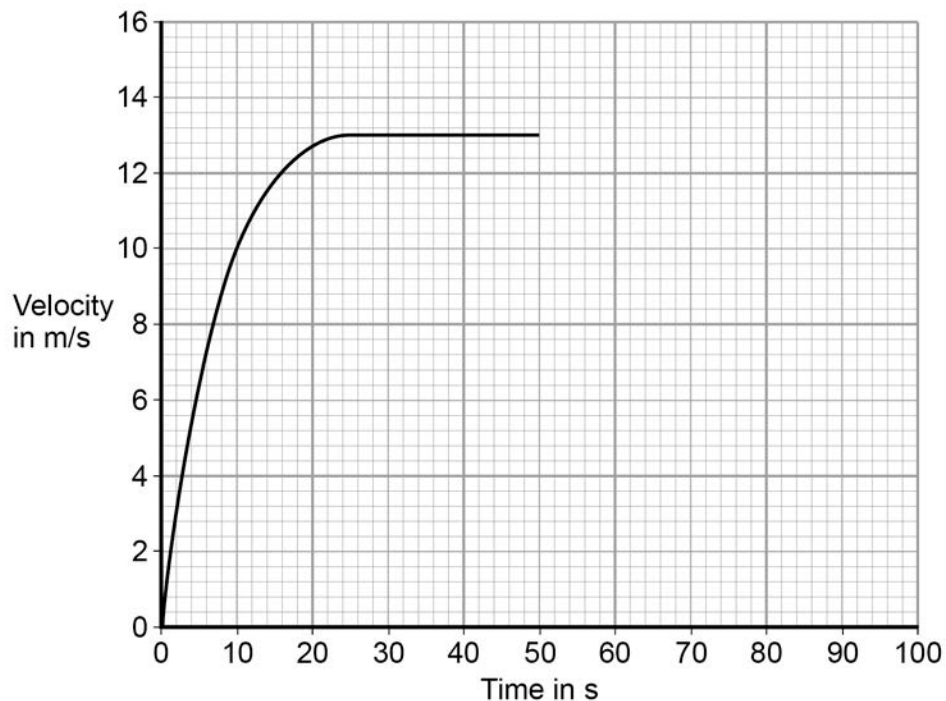
Graphs

Physics 2F
Skill 4a
Low demand

At the top of the slope the skier leaves the drag lift and skis back to the bottom of the slope.

Figure 13 shows how the velocity of the skier changes with time as the skier moves down the slope.

Figure 13



07 . **4** After 50 seconds the skier starts to slow down.

The skier decelerates at a constant rate coming to a stop in 15 seconds.

Draw a line on **Figure 13** to show the change in velocity of the skier as she slows down and comes to a stop.

[2 marks]

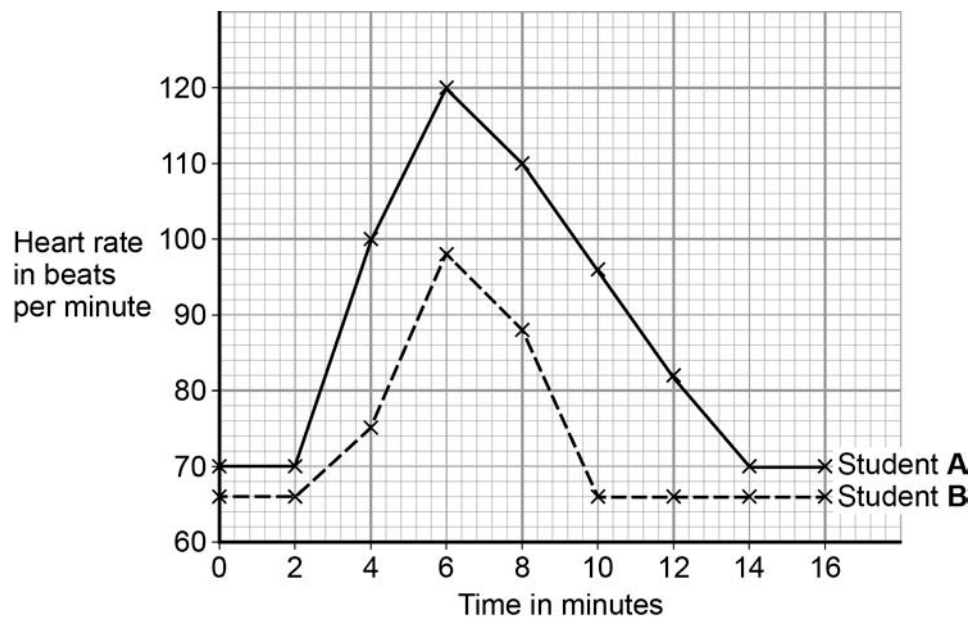
Trilogy Biology 1F
Skill 4a
Low demand

0 4

Some students investigated how exercise affects heart rate.

Figure 4 shows their results.

Figure 4



0 4 . 3

For how many minutes did the students run?

[1 mark]

Tick **one** box.

2 ☐

4 ☐

6 ☐

14 ☐

0 3 . 2 Table 3 shows the blood sugar levels for two people after eating a meal.

Table 3

Time after eating in hours	Blood sugar levels in mg per 100 cm ³ of blood	
	Person A	Person B
0	70	130
1	150	230
2	90	185
3	80	165
4	75	140

Use data from Table 3 to complete the graph in Figure 4.

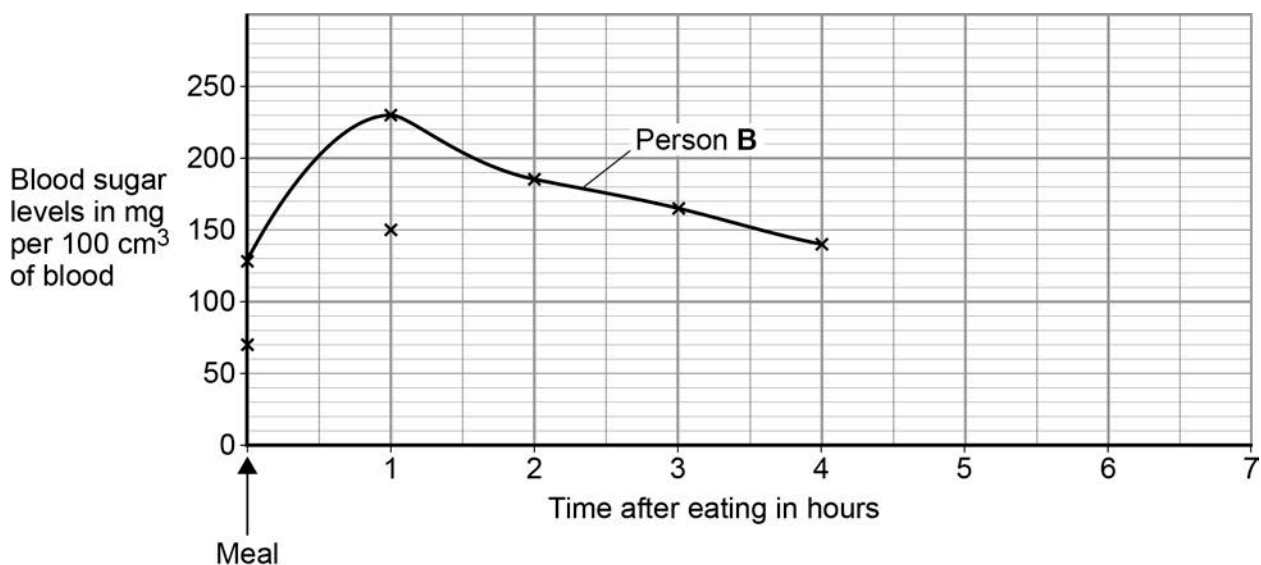
Plot the points for person A.

The first two points have been plotted for you.

Draw a line through all the points.

[3 marks]

Figure 4



Trilogy Chemistry 1F

Skill 4c

Standard demand

0 **8** . **2** **Table 3** shows the solubility of sodium chloride in 100 cm³ of aqueous solution at different temperatures.

Table 3

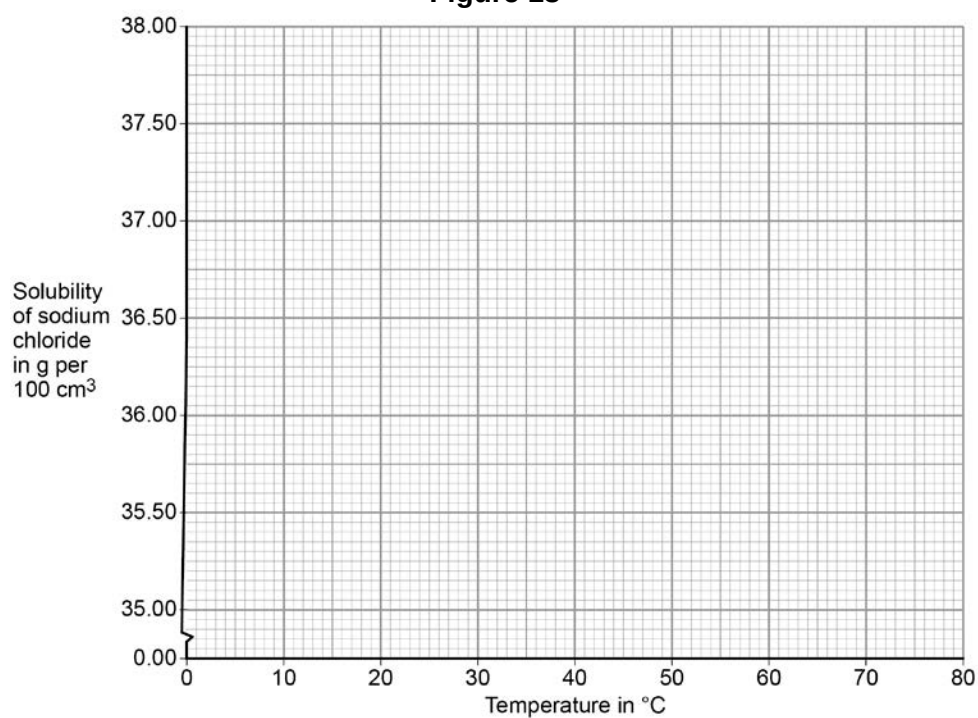
Solubility of sodium chloride in g per 100cm ³	Temperature in °C
35.72	10
35.89	20
36.09	30
37.37	40
36.69	50
37.04	60

On **Figure 13**:

- plot this data on the grid
- draw a line of best fit.

[3 marks]

Figure 13



Geometry and trigonometry

Physics 2H
Skill 5a
High demand

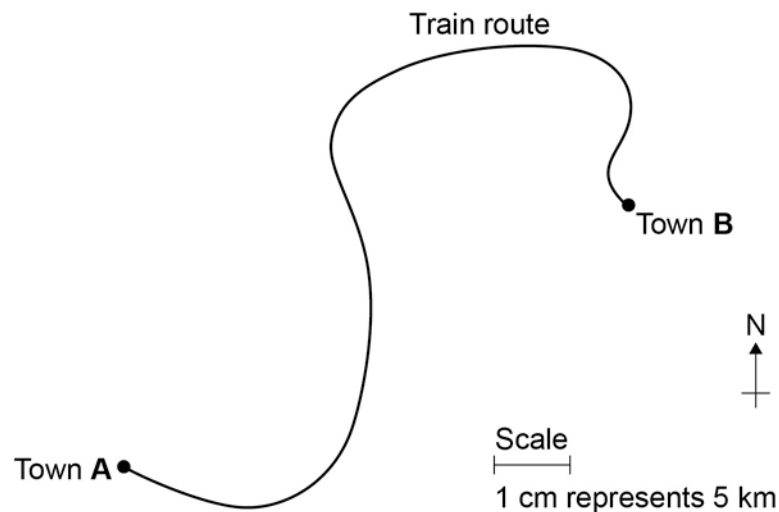
0 8

A train travels from town A to town B.

Figure 14 shows the route taken by the train.

Figure 14 has been drawn to scale.

Figure 14



0 8

. 2

Use **Figure 14** to determine the displacement of the train in travelling from A to B.

Show how you obtain your answer.

[2 marks]

Displacement = km

Direction = _____

Chemistry 2F

Skill 5b

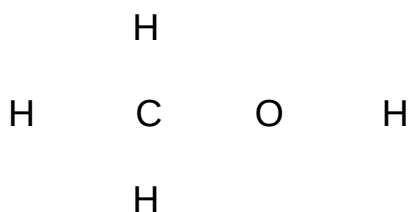
Low demand

0 6 . **3** A molecule of methanol has five single covalent bonds.

Draw the missing bonds in **Figure 6** to complete the displayed formula for methanol.

[1 mark]

Figure 6



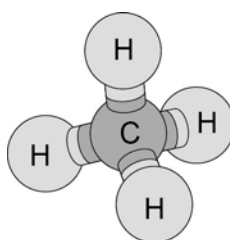
Synergy 3F

Skill 5b

Standard demand

0 5 . **1** **Figure 6** shows a 3D model of a molecule of methane (CH_4).

Figure 6



Draw the 2D structure of a methane molecule.

Mathematical requirements

Students will be required to demonstrate the following mathematics skills in GCSE Combined Science assessments.

Questions will target maths skills at a level of demand appropriate to each subject. In Foundation Tier papers questions assessing maths requirements will not be lower than that expected at Key Stage 3 (as outlined in Mathematics programmes of study: Key Stage 3 by the DfE, document reference DFE- 00179-2013). In Higher Tier papers questions assessing maths requirements will not be lower than that of questions and tasks in assessments for the Foundation Tier in a GCSE Qualification in Mathematics.

1	Arithmetic and numerical computation
a	Recognise and use expressions in decimal form.
b	Recognise and use expressions in standard form.
c	Use ratios, fractions and percentages.
d	Make estimates of the results of simple calculations.

2	Handling data
a	Use an appropriate number of significant figures.
b	Find arithmetic means.
c	Construct and interpret frequency tables and diagrams, bar charts and histograms.
d	Understand the principles of sampling as applied to scientific data (biology questions only).
e	Understand simple probability (biology questions only).
f	Understand the terms mean, mode and median.
g	Use a scatter diagram to identify a correlation between two variables (biology and physics questions only).
h	Make order of magnitude calculations.

3	Algebra
a	Understand and use the symbols: =, <>, >, $\propto$, $\sim$.
b	Change the subject of an equation.
c	Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only).
d	Solve simple algebraic equations (biology and physics questions only).

4	Graphs
a	Translate information between graphical and numeric form.
b	Understand that $y = mx + c$ represents a linear relationship.
c	Plot two variables from experimental or other data.
d	Determine the slope and intercept of a linear graph.
e	Draw and use the slope of a tangent to a curve as a measure of rate of change (chemistry and physics questions only).
f	Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate (physics questions only).

5	Geometry and trigonometry
a	Use angular measures in degrees (physics questions only).
b	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects (chemistry and physics questions only).
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes.

Mathematical skills references are taken from the DfE subject criteria.

Mark scheme

Arithmetic and numerical computation

Synergy 3F Question 10

Question	Answers	Extra information	Mark	AO / Spec.
10.1	3.3×10^2 m/s		1	AO1/1 4.7.1.1

Chemistry 1F Question 5.8

Question	Answers	Extra information	Mark	AO / Spec.
05.8	indication of $\frac{1}{1.6} = 0.625$ and use of indices $10^{-9} - 10^{-6} = 10^3$	Both steps must be seen to score first mark	1	AO2/1 4.2.4.1
	$0.625 \times 1000 = 625$ (times bigger)		1	

Question 2.7

02.7	$2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$	allow multiples	1	AO2/1 4.4.1.3
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Trilogy B2H
Question 6.3

06.3	$\sqrt{\frac{11.6}{490}}$		1	AO2/2 4.5.2.1
	0.1539	allow 01539 with no working shown for 2 marks	1	AO2/2 4.5.2.1
	0.154	allow 0.154 with no working shown for 3 marks	1	AO2/2 4.5.2.1
		allow ecf as appropriate		

Physics 2H
Question 12.3

12.3	$4.8 \times 10^{-4} = F \times 8 \times 10^{-2}$		1	AO2/1
	$F = 6 \times 10^{-3} \text{ (N)}$		1	4.7.2.
	$6 \times 10^{-3} = B \times 1.5 \times 5 \times 10^{-2}$		1	2
	$B = \frac{6 \times 10^{-3}}{7.5 \times 10^{-2}}$		1	4.5.4
	$B = 8 \times 10^{-2} \text{ or } 0.08$	allow 8×10^{-2} or 0.08 with no working shown for 5 marks a correct method with correct calculation using an incorrect value of F gains 3 marks	1	
	Tesla	accept T do not accept t	1	AO1/1 4.7.2. 2

Trilogy P1F
Question 7.5

Question	Answers	Mark	AO / Spec.
7.5	Level 2: A relevant and coherent argument which demonstrates processing and numerical analysis of the information presented and draw a conclusion which is logically consistent with the reasoning and refers to payback time for the vehicles.	3–4	AO3/2b 6.1.3
	Level 1: Simple comparisons are made which demonstrate a basic ability to numerically analyse the information presented. The conclusion, if present, may not be consistent with the calculations.	1–2	
	No relevant content	0	
	Indicative content • The electric car costs £12 000 more to buy • Running cost of electric car = £3 000 • Running cost of petrol engine car = £24 000 • Total cost of electric car = £30 000 • Total cost of petrol engine car = £39 000 • The electric car cost £1 750 less to run each year • The electric car will save £9 000 • Additional cost is covered in 6.9 years • So the electric car will be cheaper over the 12 year lifetime or Electric $27000 / 12 = 2250$ Annual cost = $2250 + 250 = 2500$ Petrol $15000 / 12 = 1250$ Annual cost = $1250 + 2000 = 3250$ So electric is £750 cheaper per year		

Physics 2F
Question 10.7

Question	Answers	Extra information	Mark	AO / Spec.
10.7	Level 2: A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.	3–4	4	AO2/1
	Level 1: Simple statements are made. The response may fail to make logical links between the points raised.	1–2		4.1.1.2
	No relevant content	0		4.5.6.3
	Indicative content • doubling speed increase the kinetic energy • kinetic energy increases by a factor of 4 • work done (by brakes) to stop the car increases • work done increases by a factor of 4 • work done is force x distance and braking force is constant • so if work done increases by 4 then the braking distance must increase by 4			
Total			14	

Handling data

Trilogy C2F Question 2.7

02.7	$(35 + 37 + 37/3) = 36.33$	allow $(35 + 48 + 37 + 37/4 =)$ 39(.25) for 1 mark	1	AO2/1 5.7.1.3
	36		1	

Synergy 3H Question 6.5

06.5	3 moles of electrons are needed to produce 27 g or 0.027 kg aluminium so moles of electrons to produce 1 000 kg = $1\,000/0.027 \times 3$ = 111 000	allow 111 000 with no working shown for 3 marks incorrect no. of sig. figs max 2 marks	1	AO2/1 4.5.2.5
			1	
			1	

Biology 2F Question 7.5

07.5	$(12 + 13 + 13 + 9 + 8 / 5 =)$ 11		1	AO2/2 4.5.2.1
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Trilogy P2F Question 2.7

02.7	0.100 m	if more than one box ticked apply list principle	1	AO3/2a 6.5.3 WS3.5
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Chemistry 2F
Question 6.1

06.1	Propanol		1	AO2/1 4.2.2.1 4.2.2.4 4.7.2.3
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Trilogy B2F
Question 4.4

04.4	0.5	allow ecf from 04.2	1	AO3/1b 4.6.1.4
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Biology 2F
Question 8.4

08.4	correct derivation of children's genotypes		1	AO2/1 4.6.1.6
	identification of children with cystic fibrosis (dd)		1	AO3/1b 4.6.1.6
	0.25	allow ecf allow $\frac{1}{4}$ / 25% / 1 in 4 / 1:3 do not accept 1:4	1	AO2/1 4.6.1.6

Biology 2H
Question 7.4

07.4	mother / woman's gametes correct: A a		1	AO2/2 4.6.1.6
	father / man's gametes correct: a a		1	AO2/2 4.6.1.6
	correct derivation of offspring	ecf	1	AO2/2 4.6.1.6
	identification of child with syndrome H or genotype aa		1	AO2/2 4.6.1.6
	0.5	ecf allow 50% / 1/2 / 1 in 2 / 1:1 do not accept 1:2	1	AO3/2b 4.6.1.6

Biology 1F
Question 3.5

03.5	45 (mm)		1	AO2/2 4.1.1.5
	45 / 250 or 0.18 (mm)	allow ecf	1	AO2/2 4.1.1.5
	180 (µm)	allow 180 (µm) with no working shown for 3 marks	1	AO2/2 4.1.1.5

Synergy 1H
Question 8.3

08.3	correct conversion of 1.18 µg to mg/cm ³		1	AO2/1 4.2.2.3
	$\frac{118}{0.00118} = 100\,000$	allow 1 mark for 100 (ie no conversion to mg) allow 100 000 with no working shown for 2 marks	1	

Algebra

Physics 2F

Question 9.3 – 9.6

09.3	weight = mass x gravitational field strength	accept gravity for gravitational field strength accept $W = mg$ accept correct rearrangement ie $\text{mass} = \text{weight} / \text{gravitational field strength}$ or $m = W/g$	1	AO1/1 4.5.1.3
09.4	$343 = m \times 9.8$ $m = \frac{343}{9.8}$ $m = 35$	allow 35 with no working shown for 3 marks	1 1 1	AO2/1 AO2/1 AO2/1 4.5.1.3
09.5	force = spring constant x compression	accept force = spring constant x extension accept $F = k e$ accept correct rearrangement ie constant = force / extension or $k = F/e$	1	AO1/1 4.5.3
09.6	compression = 0.07m $343 = k \times 0.07$ $k = 343 \div 0.07$ $k = 4900$	allow 4900 with no working shown for 4 marks allow 49 with no working shown for 3 marks	1 1 1 1	AO2/1 AO2/1 AO2/1 AO2/1 4.5.3

Trilogy Physics 2F
Question 2.8

02.8	$0.5 \times 20 \times (0.050)^2$ = 0.025 (J)		1 1	AO2/1 6.5.3
		allow 0.025 (J) with no working for 2 marks		

Question 1.2

01.2	2040 / 120 17 (m/s)		1 1	AO2/1 6.5.4.1.2
		allow 17 (m/s) with no working shown for 2 marks		

Physics 1H
Question 11.5

11.5	extension = 35 (m) and conversion of 24.5 kJ to 24500 J $24\,500 = \frac{1}{2} \times k \times 35^2$ 40		1 1 1	AO2/2 4.1.1.2 WS4.3
		allow 40 with no working shown for 3 marks an answer of '16.2' gains 2 marks		

Synergy 4H
Question 9.2

09.2	gpe = 600 x 9.8 x 35		1	AO2/1
	= 205 800		1	AO2/1
	gpe = KE = $\frac{1}{2} m v^2$		1	AO2/1
	$v = \sqrt{\frac{2 \times KE}{m}}$		1	AO2/1
	$= \sqrt{\frac{411\,600}{600}}$		1	AO2/1
	= 26.2 (m/s)	allow 26.2 with no working shown for 6 marks	1	AO2/1 4.6.1.5 4.7.1.9

Graphs

Physics 2F Question 7.4

07.4	straight line drawn from 13 m/s to 0 m/s		1	AO2/2
	finishing on x-axis at 65 s		1	4.5.6.1.5

Biology 1F Question 4.3

04.3	4		1	AO2/1 4.4.2.2
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Synergy 2F Question 3.2

03.2	all three plots correct suitable line drawn	accept two correct plots for 1 mark	2	AO2/2 4.3.1.5
			1	

Trilogy C1F Question 8.2

08.2	all points correct best fit line	$\pm \frac{1}{2}$ small square allow 1 mark if 5 points correct	2	AO2/2 5.3.2.5
			1	

Chemistry 2F Question 6.3

06.3	$ \begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{O} - \text{H} \\ \\ \text{H} \end{array} $		1	AO2/1 4.2.1.4 4.7.2.3
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Synergy 3F
Question 5.1

05.1	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$		1	AO2/1 4.6.2.4
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